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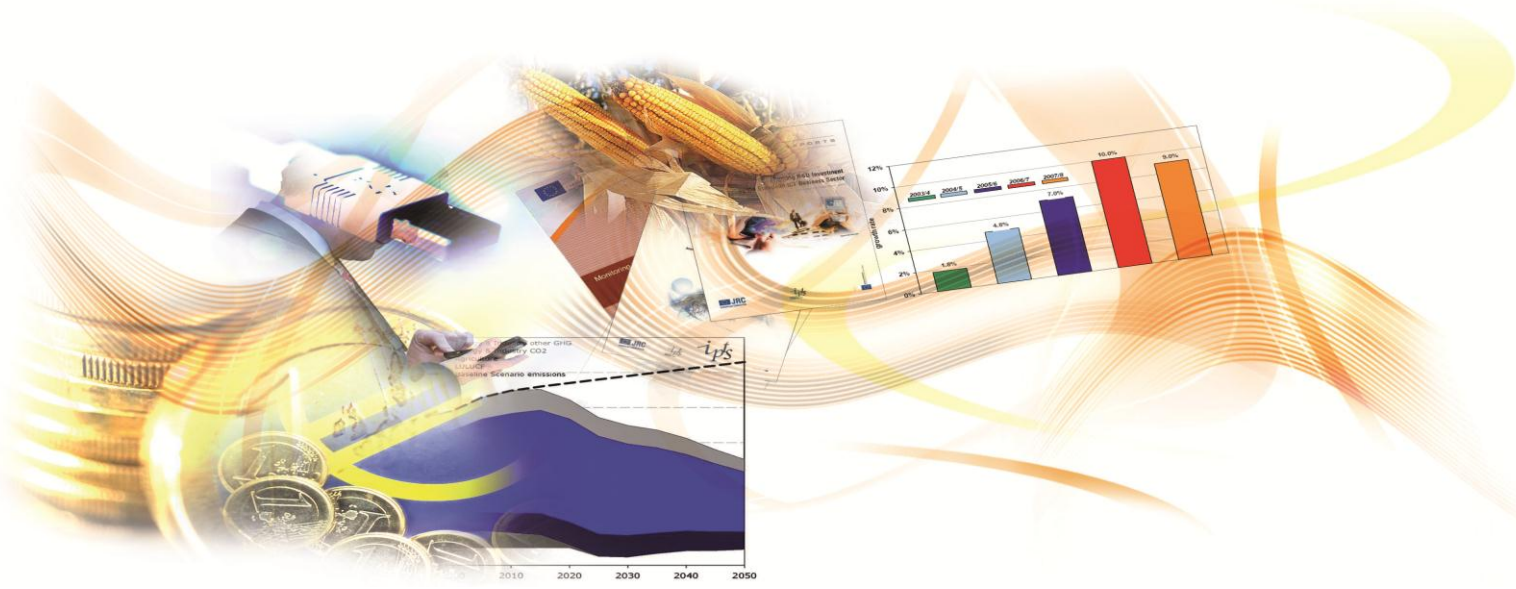

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Abstract

The Analytical Country Reports analyse and assess in a structured manner the evolution of the national policy research and innovation in the perspective of the wider EU strategy and goals, with a particular focus on the performance of the national research and innovation (R&I) system, their broader policy mix and governance. The 2013 edition of the Country Reports highlight national policy and system developments occurring since late 2012 and assess, through dedicated sections:

- national progress in addressing Research and Innovation system challenges;
- national progress in addressing the 5 ERA priorities;
- the progress at Member State level towards achieving the Innovation Union;
- the status and relevant features of Regional and/or National Research and Innovation Strategies on Smart Specialisation (RIS3);
- as far relevant, country Specific Research and Innovation (R&I) Recommendations.

Detailed annexes in tabular form provide access to country information in a concise and synthetic manner.
The reports were originally produced in December 2013, focusing on policy developments occurring over the preceding twelve months.

ACKNOWLEDGEMENTS AND FURTHER INFORMATION

This analytical country report is one of a series of annual ERAWATCH reports produced for EU Member States and Countries Associated to the Seventh Framework Programme for Research of the European Union (FP7). ERAWATCH is a joint initiative of the European Commission's Directorate General for Research and Innovation and Joint Research Centre.

The Country Report 2013 builds on and updates the 2012 edition. The report identifies the structural challenges of the national research and innovation system and assesses the match between the national priorities and the structural challenges, highlighting the latest developments, their dynamics and impact in the overall national context.

The first draft of this report was produced in October 2013 and was focused on developments taking place in the previous twelve months. In particular, it has benefited from comments and suggestions of Krzysztof Mieszkowski from JRC-IPTS. The contributions and comments from DG-RTD and Jan Kozlowski of Ministry of Science, Poland are also gratefully acknowledged.

The report is currently only published in electronic format and available on the ERAWATCH website. Comments on this report are welcome and should be addressed to jrc-ipts-erawatch-helpdesk@ec.europa.eu.

EXECUTIVE SUMMARY

Poland benefits from the constant **economic growth** and **gradual improvements of R&D-related indicators**. **GERD** as percentage of GDP was 0.67% in 2009, 0.74% in 2010, 0.76% in 2011 and 0.90% in 2012, but still remaining significantly **below the target level** of 1.70%, expected in 2020. The main source of R&D funds remains the government. **BERD** in 2012 was **only 0.33% of GDP** (EU: 1.3%), but the business expenditures on R&D gradually increased in the recent years. **Enterprises controlled by foreign capital** accounted in 2011 for 45.4% of R&D investments in business sector, 66.0% of business expenditures on R&D came from **large enterprises** and small and micro-enterprises were not a significant source of innovations, contributing only 13.5% of BERD. The weaknesses of the Polish innovation system, identified by "Innovation Union Scoreboard 2013", include: limited number of **innovative companies**, **unsuccessful linkages** and entrepreneurship efforts, while the Scoreboard appreciates the quality of **human resources** as well as the recent growth in **intellectual assets** (patents, trademarks and designs).

In 2010, Ministry of Science and Higher Education initiated a wide-ranging **reform of science and higher education** institutions, and the subsequent transformations established the full operational capacity of two **R&D funding agencies**: NCN (fundamental research) and NCBiR (applied research). Over 100 public higher education institutions (PHEIs) and over 200 public research organisations (PROs) undergo regular **performance evaluations**, managed by a newly established committee KEJN, with focus on quantifiable results and internationalization (first evaluation based on the new rules was carried out in 2013). The institutions are also expected to participate in competition-based distribution of research funds. By 2020, the government declared to distribute 50% of its entire science budget through competitive mechanisms, but already in 2012, the budget earmarked 63.61% of all science funds to be divided through competitions, including programs co-ordinated by NCN and NCBiR (MNiSW, 2013b).

Ministry of Economy prepared in 2013 the ***Strategy for the Innovation and Efficiency of the Economy for the years 2012-2020*** (SIEG). SIEG sets quantifiable objectives, related to R&I funding and outputs in the national system of innovations, as well as delegates specific tasks to other governmental institutions. Another policy document, the ***Enterprise Development Programme*** (PRP), focuses on support for RDI activities of business enterprises, and includes national **smart specialisations**, intended to guide the future public support for R&D. SIEG was adopted by the government in 2013, and PRP awaits its final adoption in 2014.

Polish efforts targeting smart specialisation are rooted in multiple foresight projects, commissioned by Ministry of Science and Higher Education and Ministry of Economy. 16 specific specialisations areas were identified on the national level, while Polish regions have their own S3 documents. The specialisations will be enacted in the 2014-2020 financial perspective through R&D support measures, based on the EU funds.

The identified structural challenges for Poland's RDI system include:

(1) **Low levels of business investment in R&D and in-house technological innovation** – with limited interest of business enterprises in R&D activities, low BERD/GDP ratios and small number of innovating enterprises, accompanied by the preference for acquiring foreign technological solutions instead of in-house R&D.
(2) **Limited synergies between the science and industry, restricting the innovative potential of the economy** – rooted in the traditional divide between academic institutions and business organizations, and difficult to overcome due to unfavourable

perceptions and attitudes, even though the recent science and higher education reforms encourage scientists to co-operate closely with the industry.

(3) **A need to concentrate financial resources on key strategic areas and RDI priorities** – with no clear prioritization or preferences for R&D directions expressed by government organizations, participants of the RDI system are disoriented and uncertain about possibility of receiving future support for their potential ventures.

(4) **Increasing internationalization and attractiveness of RDI system** – as the outputs of Poland's RDI system are below the EU average (scientific publications, citations, patents, FP7 participation), and foreign companies regard Poland mostly as low cost labour market, not source of knowledge and technology expertise.

(5) **Inducing knowledge spill-overs from foreign direct investments** – related to the lack of dedicated policies, attracting investments in R&D, as Poland still focuses on creating jobs through FDI instead of creating knowledge-based jobs.

The RDI policy mix evolved in recent years and in particular, the structural reforms of science and higher education from 2010-2011 yielded substantial improvements in its structure. The **portfolio of instruments is very comprehensive**, but several intervention areas seem not to have been adequately addressed, in particular: R&D tax measures and R&D-specific employment policies (including subsidies for hiring R&D personnel). The government is working on the proposed R&D tax exemptions, but no specific plans were announced by March 2014.

The existing policies demonstrate **alignment with most of ERA's priorities**, but they offer insufficient support for trans-national portability of research grants, gender mainstreaming, and open access to public resources. The recommended evolution of the RDI policy mix could include the increased support for business enterprises performing R&D, with **tax incentives for R&D performers.**

The EU Structural Funds planning process yielded promising results by engaging significant number of non-governmental stakeholders and setting the public discourse agenda, which now emphasizes the **need for endogenous innovation development, strengthening R&D efforts by business enterprises, and intensifying science-industry collaboration**. The transformation was reflected in the design of support measures, planned for 2014-2020 and included in the **Operational Program "Smart Development" (POIR)**. While the 2007-2013 perspective helped the Polish business sector catch up with Western European counterparts by implementing new technologies, the future plans focus on the development of own technologies and position in-house innovations as key sources of economic competitiveness.

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1 BASIC CHARACTERISATION OF THE RESEARCH AND INNOVATION SYSTEM

Poland is the 7th largest economy in the EU-28, accounting for 2.94% of EU-28 GDP in 2012. With 38.5m inhabitants, it represents 7.62% of EU-28 population. The country experiences positive **GDP growth** rates since the 1990s and its economy increased by 1.6% in 2009, 3.9% in 2010, 4.5% in 2011, 1.9% in 2012 and 1.6% in 2013, thus being one of the fastest growing EU-28 economies in the recent years (Eurostat, 2013).

Poland's **GERD** was €2,095.83 in 2009, €2,607.50 in 2010, €2,836.16 in 2011 and €3,429.85 in 2012, growing by 192.58% between 2002-2012 and by 94.48% between 2007-2012 (Eurostat, 2013). Between 2002 and 2012, GERD in Poland converted to Euro (€)[1] was increasing at an average annual rate of 11.98%, exceeding the rate for EU-28 (3.66%), and the most impressive growth was demonstrated in 2010 (24.41%), 2011 (8.77%) and 2012 (20.93%) (Eurostat, 2013). GERD per capita was €55 in 2009, €68.3 in 2010, €74.2 in 2011 and €89 in 2012, up by 189.90% from 2002 levels and exceeding the increase of GDP per capita of 80.00% for the same period (Eurostat, 2013). For years 2007-2012, GERD per capita went up by 92.22%, while GDP per capita – by 20.72% (Eurostat, 2013). In spite of this increase, the indicator remains low in comparison with EU-28 average.

GERD as percentage of GDP was 0.67% in 2009, 0.74% in 2010, 0.76% in 2011 and 0.90% in 2012, below the national targets for Poland and the EU-28 average. The main source of R&D funds in 2012 was the government, contributing 51.30% of GERD (compared with the EU's average for 2011 of 33.4%), while foreign funds for R&D build up 13.30% of GERD (EU-28 in 2011: 9.2%) (Eurostat, 2013). **GOVERD** for 2012 was 0.25% of GDP (EU-28: 0.26%), **HERD**: 0.31% of GDP (EU-28: 0.49%), and **BERD**: 0.33% of GDP (EU-28: 1.3%) (Eurostat, 2013). Nevertheless, the total value of R&D expenditures is substantial, and Poland's GOVERD belongs to the largest in the EU, while BERD of €1,276.34m in 2012 exceeded R&D expenditures of business enterprises in other new EU member states, except for the Czech Republic, but was significantly lower than in the old EU member states (Eurostat, 2013). Turnover from innovation for industrial companies in 2012 amounted to 9.2% (GUS, 2013e: 62), being lower than the EU-27 average of 14.37% for 2010 (EC DGEI, 2013: 71) but large enterprises (with 250 or more employees) were more innovative, registering the rate of 11.9% (GUS, 2013e: 63).

In 2012, **2,733 organisations registered expenditures on R&D** (up by 56.7% from 2010, 24.2% from 2011), including 2,110 business enterprises, 217 HEIs and 326 government units (including PROs) (GUS, 2014b). Enterprises controlled by foreign capital accounted in 2012 for 41.15% of R&D investments in business sector, and 65.21% of business expenditures on R&D came from large enterprises with 250 or more employees (GUS, 2014b). Small and micro-enterprises are not a significant source of innovations, contributing in 2012 only 13.79% of BERD (GUS, 2014b), with only 14.36% of SMEs introducing product or process innovations (EU-27: 38.44%) (EC DGEI, 2013: 71). In 2012, 105 public higher education institutions (PHEIs) and 189 public research organisations (PROs) were actively conducting R&D activities. PHEIs included 19 universities, 18 technical universities, 6 agricultural universities, 9 medical universities and 9 maritime & defence universities (GUS, 2014b). The largest PRO is Polish Academy of Sciences, encompassing multiple research institutes. Private higher education

[1] Monetary data presented in the report were converted from PLN to Euro using the average annual exchange rates, published by NBP: 1€ = 3.9946 PLN (2010), 1€ = 4.1198 PLN (2011), 1€ = 4.1850 PLN (2012), 1€ = 4.1472 PLN (2013).

institutions play a marginal role in the R&D arena (both in terms of R&D expenditures – 6.67% of HERD (GUS, 2014b) - and outputs), focusing on teaching.

Human Resources for Science and Technology (HRST) aged from 15 to 74 years amounted in 2012 to 7,241,000 persons (Eurostat, 2013). Total R&D personnel (absolute numbers) in 2012 consisted of 139,700 employees (40.23% women), and R&D personnel of business enterprises included 32,400 persons (GUS, 2013c: 5-6). Among the R&D personnel, researchers accounted for 103,600 persons and 18,900 employees in business enterprises (GUS, 2013c: 6). The share of people employed in high-tech sectors in the total employment in 2011 was: 2.7% for Poland and 3.8% for the EU-27 (Eurostat, 2012).

There were altogether 1,676,927 **students** in 2012 (58.74% women), 485,246 higher education graduates (GUS, 2013d: 29, 59) and 42,295 doctoral students (GUS, 2013d: 39). Poland accounts for approximately 11.4% of the EU-27 student population (ISCED 5-6) (GUS, 2012a: 306). The share of students in the population aged 20-29 is relatively high in Poland at 37.0%, compared with the EU average of 29.6% (GUS, 2012a: 306). The number of new doctoral graduates (ISCED 6) per 1000 population aged 25-34 is 0.5, which is lower than for EU-27 (1.5) (EC DGEI, 2013: 71). Poland also has a very low share of doctoral candidates coming from other EU countries (EC DGRI, 2011: 274), and more than 10 times lower share of non-EU doctorate students than the EU-27 average (EC DGEI, 2013: 71). Participation in adult lifelong learning initiatives is also lower than in many other EU countries – 4.7% of population aged 25-64, compared with 9.3% for EU-27 (EC DGRI, 2011: 105).

Citable **scientific publications** with at least one author with Polish affiliation, registered in Scopus bibliographic database, add up to 27,144 publications in 2009, 28,119 in 2010, 29,670 in 2011 and 30,666 in 2012 (SCImago, 2013). For the period of 1996-2012, an average Polish publication was cited 8.25 times (does not include documents not cited at all), and h-index (Hirsch index for the country was relatively low at 302, but higher than for all new EU member states (SCImago, 2013). 29.20% of Polish publications were co-authored with international partners (SCImago, 2013). Only 3.52% of Polish scientific publications were in 2008 among the 10% most cited publications worldwide (EU average: 10.90%) (EC DGEI, 2013: 71). Only two Polish universities were included in the 2012 Academic Ranking of World Universities by Shanghai Jiao Tong University (www.arwu.org) - University of Warsaw and Jagiellonian University, Cracow.

Polish Patent Office received the following numbers of **patent and utility model applications** from domestic applicants: 4,082 in 2010, 4,818 in 2011 and 5,351 in 2012 (UPRP, 2013: 13). 38.9% of applications in 2012 were filed by business enterprises, and 41.3% by PHEIs and PROs (UPRP, 2013: 15), in many cases not interested in commercialization of the inventions, but regarding the filings as the fulfilment of their institutional evaluation requirements. 14 top patent applicants in 2012 were public universities and PROs (UPRP, 2013: 21). The Office issued the below-listed numbers of patent and utility model certificates to domestic entities: 1,834 in 2010, 2,487 in 2011 and 2,362 in 2012 (UPRP, 2013: 13). 400 Polish patents were filed in the **European Patent Office** (EPO) in 2011 and 552 in 2012, with 45 patents granted to entities from Poland in 2011 and 80 in 2012 (EPO, 2013). Polish applicants filed 235 **PCT applications** at the World Intellectual Property Organization in 2011 (WIPO, 2012: 174) and 252 in 2012 (WIPO, 2013). The patenting activity is limited in comparison to larger EU economies.

New-to-market and new-to-firm products accounted in 2010 for 8.00% of sales of Polish firms (EU-27: 14.37) (EC DGEI, 2013: 71), and in 2012 the ration increased to 9.2% (GUS, 2013e: 62), high-tech exports in 2011 built up 5.9% of total exports (EU-27: 15.6%) (GUS, 2014a: 134), exports of knowledge-intensive services added up to 26.14% of total service exports (EU-27: 45.14%) (EC DGEI, 2013: 71) and revenues from patents and licences from abroad were only 0.02% of Poland's GDP (EU-27: 0.21%) (EC DGRI, 2011: 186).

Poland is divided into 16 voivodeships, and the **regional diversity** is mirrored by the differences in intramural expenditures on R&D. In 2012, Masovian voivodeship (with the country's capital Warsaw) had the highest GERD per capita (€219.8), followed by Lesser Poland (€116.4) and Pomerania (€105.31), while other regions registered much lower expenditures (GUS, 2013c: 4). 24.8% of entities performing R&D in 2010 were located in Masovia, 13.2% in Silesia, 9.5% in Greater Poland, 9.1% in Lesser Poland and 8.2% in Lower Silesia (GUS, 2012a: 246). The largest group of R&D personnel was concentrated in 2012 in Masovian voivodeship (26.6%) (GUS, 2013b: 6). In 2012, majority of funds for R&D projects from MNiSW and its agencies, were distributed to applicants from Masovia, and Lesser Poland (MNiSW, 2013a: 35).

Based on the total counts of publications in 2012, the dominant **fields of research** in Poland were: medicine, physics and astronomy, biochemistry, genetics and molecular biology, chemistry and engineering (SCImago, 2013). The fields having the highest impact (citations from 1996-2012) were: chemistry, decision sciences, earth and planetary sciences, materials science, mathematics, pharmacology, toxicology and pharmaceutics, biochemistry, genetics and molecular biology, immunology and microbiology, as well as physics and astronomy (SCImago, 2012).

High-tech and high-medium **technology sales** in 2011 were dominated by computers, electronics products, optical instruments, electrical equipment, chemicals, motor vehicles and other machinery and equipment (GUS, 2013b). **Technology exports** included also telecommunications, aerospace solutions and scientific instruments (GUS, 2013b).

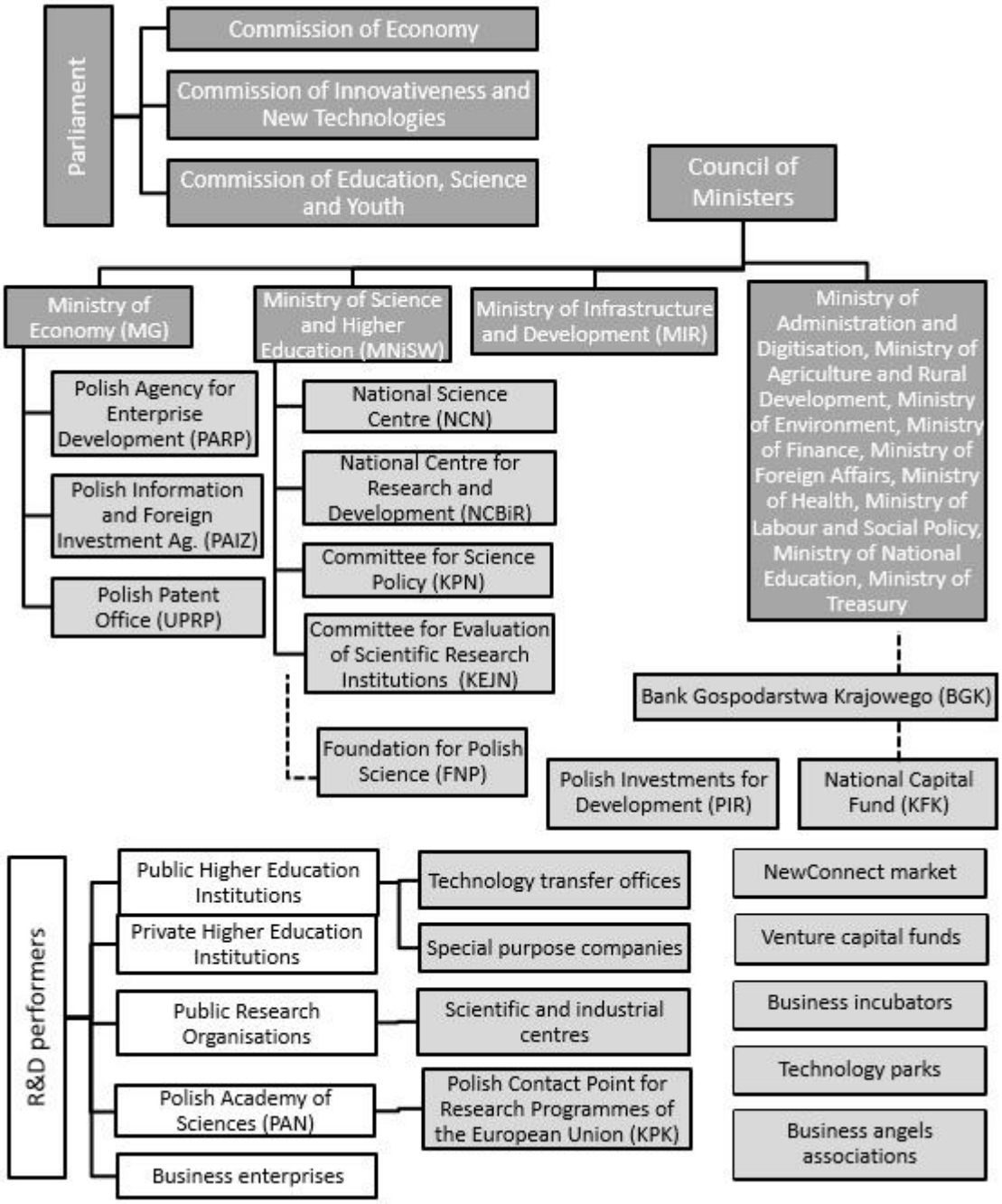
Among **R&D spenders** from the business sector in 2011, most active were: automotive companies, electrical equipment manufacturers, industrial machinery, metallurgy, chemical companies, pharmaceuticals, rubber and plastic products manufacturers, as well as producers of computers, electronic and optical equipment (GUS, 2012b: 420-421).

"Innovation Union Competitiveness report" by the European Commission, which divides all EU member states into 9 groups based on their knowledge capacity and economic structure and assigns Poland to the group displaying the worst performance, alongside with Bulgaria, Romania, Turkey and Croatia (EC DGRI, 2011: 430). "Innovation Union Scoreboard 2013" includes Poland in the group of "modest innovators" and outlines the major strengths of its RDI system: human resources (measured by the availability of specialists and graduates) and firm investments, while strong growth was identified in intellectual assets (EC DGEI, 2013: 47). Nevertheless, with the exception of human resources, the remaining strengths seem relatively insignificant in comparison with other EU countries. The identified weaknesses of the Polish innovation system are related to the limited number of innovative companies, unsatisfactory linkages and entrepreneurship efforts (particularly for SMEs). It is worth noting that in comparison to the previous Scoreboard from 2011, Poland is no longer criticised for the lack of "open, excellent and attractive research systems" (PRO INNO Europe, 2012: 44), what might be interpreted as recognition of the positive results of the recent science and higher education reform.

Figure 1 presents an overview of Poland's **research and innovation system**, outlining its main actors. The Parliament as the legislative body and the Council of Ministers as the executive shape the relevant national policies. Ministry of Economy (MG) defines the strategies related to innovativeness and supervises three government agencies: Polish Agency for Enterprise Development (PARP), supporting enterprises based on funds from the state budget and the EU Structural Funds, and through involvement in international projects, including COSME, Polish Information and Foreign Investment Agency (PAIZ) attracting foreign investors, and Polish Patent Office (UPRP). PARP co-ordinates the National Service System for Small and Medium-Sized Enterprises (KSU), a network of organisations providing consulting and training services for SMEs, as well as loans and credit guarantees, sponsored by the EU Structural Funds. Ministry of Science and Higher Education (MNiSW) manages the science budget and supervises

two key fund distribution agencies: National Science Centre (NCN), financing basic science projects, and National Centre for Research and Development (NCBiR), financing applied research and innovative development, including R&D projects of business enterprises. There are some overlaps between the activities of PARP (agency of MG, focused on support for enterprises) and NCBiR (agency of MNiSW, focused on applied research projects), related to funding R&I in business enterprises. MNiSW uses the advice of several specialized committees, including Committee for Science Policy (KPN) and Committee for Evaluation of Scientific Research Institutions (KEJN), analysing the performance of public sector R&D performers and thus influencing the distribution of institutional funding.

Figure 1: Poland's RDI governance system.



Foundation for Polish Science (FNP) is a non-governmental institution, partly funded from the science budget, the EU Structural Funds and other sources, awarding research grants and scholarships. Ministry of Infrastructure and Development (MIR) defines the policies and regulations related to the absorption of the EU funds, including instruments related to the support for innovative enterprises and R&D projects. Several other ministries have dedicated programs, stimulating innovations and research projects in relevant sectors. Poland also has a state-owned bank, *Bank Gospodarstwa Krajowego* (BGK), which supports innovative ventures by means of credits and venture capital investments through its VC arm, National Capital Fund (KFK). Funding for innovations is also available through the dedicated stock exchange market NewConnect, as well as newly established sovereign investment fund Polish Investments for Development (*PIR, Polskie Inwestycje Rozwojowe*), investing in large infrastructure and technology projects. The World Bank characterised the innovation support system as overly complex, with responsibilities shared among too many government agencies, and high administrative costs resulting from this "institutional disequilibrium" (Kapil et al., 2012: 39). At the same time, the system went through major changes due to the science and higher education reform and the preparations for new institutional structures, supporting the absorption of the EU Structural Funds in 2014-2020.

R&D performers include: Public Higher Education Institutions (PHEIs), Private Higher Education Institutions (focused mostly on education not research, with majority operating in fields of socio-economic sciences and humanities), Public Research Organisations (PROs), the large national research institution Polish Academy of Sciences (PAN), and business enterprises. PHEIs commercialize research outcomes through technology transfer offices and special purpose companies, intended to act as holding companies for academic spin-offs. PROs can in turn establish scientific and industrial centres, establishing linkages between research institutes and business enterprises. PAN manages the Polish Contact Point for Research Programmes of the European Union (KPK), facilitating the participation of Polish scientists in Horizon 2020 and other programmes. Main Council of Science and Higher Education (RGNiSW) is the official representation of PHEIs, PROs and PAN, and Conference of Rectors of Academic Schools in Poland (KRASP) represents the public and private universities.

Private-sector business support institutions include: venture capital funds, business incubators, technology parks and business angels associations, and their numbers increased in the recent years thanks to the financing from the EU Structural Funds. Business enterprises form numerous industry chambers and associations, which influence the relevant government policies as they are usually consulted in course of the legislative process.

16 regions (voivodeships) with their Marshall Offices define regional operational programmes for the distribution of the EU Funds, including also R&D-related components, and the regional structure is parallel to the centrally-distributed governance of the national RDI system.

2 RECENT DEVELOPMENTS OF THE RESEARCH AND INNOVATION POLICY AND SYSTEM

2.1. National economic and political context

Polish economy was spared in the Eurozone crisis, but the GDP growth in 2013 was slower than expected. In consequence, the state budget had to amended, and the budget cuts proposed by the government in August 2013 3.2% reduction of the annual science budget (decrease by 160.2m PLN, €38.6m). The cuts affected spending by NCBiR and NCN, but were not alarming, as in 2012, both institutions did not manage to spend proportionally higher shares of their budgets than the present reductions. GDP forecasts for 2014 are positive and despite the observed slowdown, Poland maintains one of the highest GDP growth rates in the EU. In 2012, Poland was one of top EU destinations for foreign direct investments according to a report by Financial Times (fDi Intelligence, 2013), with an annual increase of 5% compared with 2011, jointly with Spain outperforming all other European FDI markets.

The ruling centre-right party Civic Platform (PO) and the agrarian Polish People's Party (PSL) were losing support, but despite that the next parliamentary elections are planned for 2015. Due to internal changes within PSL, in November 2012 the Deputy Prime Minister and Minister of Economy resigned, and the personal change opened new opportunities to re-evaluate the Ministry's plans of action. In November 2013, another government reshuffle took place, and PSL was strengthened by the transfer of several opposition members of parliament.

In November 2012, Poland joined the European Space Agency (ESA), and PARP became the Polish contact point for companies, interested in participation in dedicated ESA tenders for space R&D projects, which commenced in 2013. In November 2013, Poland assumed the presidency of the Conference of Parties, United Nations Framework Conference of Climate Change (UNFCCC) and the government intensified activities related to addressing the climate change, including relevant R&D policies. NCBiR launched a dedicated financing instrument for environmental R&D (called GEKON), and planning efforts for spending the EU Structural Funds, 2014-2020, included substantial, dedicated funding for the corresponding efforts. In September 2013, a project run by the Ministry of Environment, called GreenEvo, intended to support firms, which develop innovative environmental technologies, was nominated by the European Public Sector Award (EPSA) in the annual competition.

In 2011 and 2012, significant changes in the higher education and science were introduced as part of the major sectoral reform. The academic community was initially highly critical of the reform, but the observed results have gradually soothed the critics. In late 2013, the government proposed further amendments to the legal acts, concerning science sector and higher education, intended to tweak challenges identified in the years following the reform's implementation (including better integration of universities with the labour market).

In 2012, public awareness of intellectual property rights issues increased due to visible protests against the Anti-Counterfeiting Trade Agreement (ACTA), and the Polish government halted its ratification. A corresponding process concerned the proposed regulations creating unitary patent protection within the EU, which was fiercely opposed by industry associations and patent attorneys, and the analysis of economic impacts, ordered by the government from a major international consulting firm, pointed to substantial costs, which the Polish economy would incur from the accession to the proposed system (Deloitte, 2012a). Poland was one of two EU countries, which decided not to sign the agreement on a unified patent court.

Poland prepares for the new EU budget (2014-2020), intensifying work on the Operational Program Smart Development (POIR), which will focus on innovations rather than infrastructure, support development of technologies rather than their implementation, and be guided by the principles of smart specialization. The planning efforts included broad inter-governmental and public consultations and critical reviews of evaluation of previous support measures. Parallel processes took place in all 16 regions, preparing their Regional Operational Programs (RPOs).In November 2013, there was a minor government reshuffle, resulting in the change in management of the Ministry of Science and Higher Education, but the policy directions remain unchanged. The government body in charge of the EU funds programming and distribution, Ministry of Regional Development, was merged with another organisation to create the large Ministry of Infrastructure and Development (MIR), perceived as the most powerful structure in the current government. The development seems fortunate for the RDI policy in Poland, as MIR actively promotes the transformation towards a knowledge- and innovation-based economy, and had positive experiences with leading the broad stakeholder dialogue when POIR was prepared.

2.2. Funding trends

2.2.1. Funding flows

In reply to *Europe 2020* strategy, MNiSW prepared a forecast of GERD to GDP ratio for Poland in 2020, with values ranging from 1.08% to 1.96%, and declared "most likely" target value of 1.70%, with 50% of GERD financed by business enterprises (MNiSW, 2011b; comp. also: Republic of Poland, 2011: 47). The forecast seems optimistic, as it is based on the assumptions of the key role of R&D in government policies and positive effects of the science and higher education reforms, initiated in 2010-2011. Nevertheless, the strong growth in GERD in recent years is congruent with the government plans.

Table 1 presents the key R&I funding indicators for Poland, outlining their continuous improvements, which nevertheless happen at a slow pace. The science and higher education reforms from 2010-2011 are likely to induce further increases in the coming years, by encouraging the involvement of the private sector in R&D activities. Already in the first year, following the reform - between 2011 and 2012, GERD to GDP ratio went up from 0.76% in 2011 to 0.90% in 2012, and BERD as percentage of GERD rose from 30.13% in 2011 to 37.21% in 2012. These changes accompanied the decrease of the share of GERD funded by the government, alongside with the strong shift of public funding towards competitively selected R&D projects.

Table 1. Basic indicators for R&D investments.

	2009	**2010**	**2011**	**2012**	**EU (2012)**
GDP growth rate	1.60	3.90	4.50	1.90	- 0.4
GERD (% of GDP)	0.67	0.74	0.76	0.90	2.06
GERD (euro per capita)	55.0	68.3	73.6	89.0	525.8
GBAORD - Total R&D appropriations (€ million)	1,051.67	1,891.48	1,630.59	1,615.9	86,309.49
R&D funded by Business Enterprise Sector (% of GDP)	0.19	0.20	0.23	0.33	1.30
R&D performed by HEIs (% of GERD)	37.06	37.19	35.10	34.43	24%

R&D performed by Government Sector (% of GERD)	34.31	35.89	34.53	27.96	12%
R&D performed by Business Enterprise Sector (% of GERD)	28.50	26.62	30.13	37.21	63%
Share of competitive vs institutional public funding for R&D	44.63% / 45.98%	48.36% / 33.54%	57.55% / 31.81%	63.61% / 32.94%	n/a
Venture Capital as % of GDP	0.001	0.002	0.007	0.0051	0.025 (EU-15)
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	5.5	5.7	5.2	n/a	5.6 (2011)
Employment in knowledge-intensive service sectors as share of total employment	43.0	42.2	43.2	n/a	49.3 (2011)
Turnover from innovation as % of total turnover	9.8 (2008)	n/a	n/a	9.2	13.3 (2008)

s - EUROSTAT estimate

Data Sources: EUROSTAT, December 2013; Ministry of Science and Higher Education; GUS

2.2.2. Funding mechanism

2.2.2.1. Competitive vs. institutional public funding

The science budget of 2012 (MNiSW, 2013b) was €1,615.9m (excluding R&D-related expenditures of other public administration institutions, defence, culture and national heritage), with 72.61% covered from the state budget and 27.38% from the EU Structural Funds. 32.94% of the budget was allocated to institutional funding, divided based on multiple criteria, including institutional evaluations and scientific rankings. €1027.8m (63.61% of the science budget) were distributed through competitions as research grants for R&D projects, research infrastructure, promotion of science, as well as scientific scholarships awards. €15.8m (0.98%) were dedicated to the international scientific and technical co-operation of Polish researchers, with most of these funds distributed through open competitions. Plans for 2013 (latest amendments from October 2013, comp. MNiSW, 2013c) stipulate the science budget at the level of €1,653.9m, with 66.07% of the funds distributed through competitions. Institutional funding for PHEIs and PROs are linked to their research activities and cannot be used for other purposes, such as e.g. education.

By 2020, the government plans to distribute 50% of the entire science budget through NCBiR (dealing with applied research) and NCN (focused on basic research), by means of competitive mechanisms. In 2012, NCBiR was managing 42.30% of the science budget and NCN - 11.95%. When administrative costs were excluded, NCBiR and NCN were distributing altogether 54.25% of the science budget through R&D grant competitions. Plans for 2013 assume that NCBiR distributes 44.76% of the budget, and NCN manages 12.35% of the funds (values excluding administrative costs, MNiSW, 2013c).

R&I funding in the recent years included substantial investments in research infrastructure, needed to catch up with foreign R&D performers. As a result, the degree of consumption of research equipment dropped from 75.2% in 2010 to 71.5% in 2012 (GUS, 2014a: 58). In 2012, €73.8m were spent on R&D infrastructure investments directly from MNiSW budget (MNiSW, 2013b), and further €64.5m were allocated for this purpose in 2013 (MNiSW, 2013c).

2.2.2.2. Government direct vs indirect R&D funding[2]

R&I funding is mostly distributed through subsidies, and fiscal instruments such as tax incentives are not popular – in 2012, only 94 companies resorted to tax exemptions related to the implementation of new technologies (MF, 2013: 17), compared with 97 companies in 2011 (MF, 2012: 5), but the number tripled compared with 2010 (MF, 2011: 17). Unfortunately, the existing tax exemptions support the acquisition of technologies or related services, and might discourage in-house R&D. This characteristic of Poland's fiscal system differs from other EU countries, where tax regulations are used to stimulate intramural research efforts. Particularly worrisome is the relatively low BERD, which is nevertheless constantly increasing. Newly introduced R&I support instruments stimulate the financial contributions of business enterprises, and NCBiR introduced several grant programs, combining private and public finance with 50% of funds covered from the state budget, 50% coming from private sponsors and additional requirements for own contributions by the grant beneficiaries in the range of 10-40%, thus multiplying the necessary private funding for individual projects. Ministry of Economy and Ministry of Finance analyse the feasibility of introducing R&D tax breaks to replace the existing exemptions, but the process was inconclusive as of December 2013.

Apart from direct R&D funding, innovative companies can benefit from multiple private funding streams, including venture capital funds and the New Connect stock market, attracting both Polish and foreign listings. Based on the EU Structural Funds, the government indirectly supports the innovative ventures by stimulating the growth of VC funds, business angels and specialized investment funds. Recently established sovereign fund Polish Investments for Development (PIR) initiated its first investments in 2013, targeting large infrastructure and technology projects and thus having the potential of stimulating demand in the high-tech markets.

An important change to the funding system, which will be introduced by the new Operational Program Smart Development (POIR), governing the distribution of the EU Structural Funds for 2014-2020, will be the availability of instruments targeting the entire technology development cycle, thus streamlining support for subsequent stages of R&D projects.

2.2.3. Thematic versus generic funding

Most of R&D funding is distributed as generic funding, not assigned to specific thematic priorities. Significant part of funds distributed by NCBiR are clearly focused on specific research themes, in accordance with precisely defined grant programs and strategic plans (National Research Program, KPB), while NCN assigns financial resources based on the bottom-up approach and evaluation of all submitted project proposals. There are numerous dedicated funding programs, including humanities and social sciences, medical and pharmaceutical innovations, defence R&D, shale gas-related technologies, graphene technologies.

In 2012, MNiSW and its agencies allocated funds to 3,215 new R&D projects (MNiSW, 2013a: 31). There was a significant increase in funding for applied research through NCBiR, which supported 405 projects (€225.5m) in 2011 and 743 projects (€660.8m) in 2012 (MNiSW, 2013a: 32, 34). Basic research funding, distributed by NCN, went up as well – from 1,852 funded projects (€122.1m) in 2011 to 2,226 projects (€238.2m) in 2012 (MNiSW, 2013a: 32, 34).

[2] ***Government direct R&D funding*** includes grants, loans and procurement. *Government indirect R&D funding* includes tax incentives such as R&D tax credits, R&D allowances, reductions in R&D workers' wage taxes and social security contributions, and accelerated depreciation of R&D capital.

The EU Structural Funds for 2014-2020 will be distributed taking into account regional and national smart specializations, and this shall help focus the funding streams. However, the national and regional programs (POIR and RPOs) use the smart specialization policy documents mostly as sources of priorities, i.e. lists of R&D and technological areas, eligible for funding, while there are no specific financial commitments to allocate pre-determined shares of budgets for selected themes. The only exception are funds earmarked for R&D related to climate change, which need to amounting to at least 10% of the distributed funding. POIR will also include support for "sectoral programs", which were offered by NCBiR to target specific technology types, but the Operational Program does not specify sectors or technology types concerned.

2.2.4. Innovation funding

In recent years, public funding for innovation in Poland extended beyond the support for R&D. The absorption of externally sourced technologies and knowledge was perceived as an important way of modernising the economy, increasing its innovativeness and improving the total factor productivity. The main stream of RDI funding based on the EU Structural Funds in 2007-2013, POIG, included multiple support measures related to innovation rather than R&D. Tax exemptions since 2008 support acquisition of innovative technologies and know-how, stimulating the use of externally developed innovations. The government agency PARP assumed the leading role in promoting the innovativeness of business enterprises, distributing the relevant public funds, co-ordinating training activities through the networks of certified service providers KSU and conducting awareness campaigns. These Polish initiatives preceded the more recent European interest in supporting non-R&D-related innovations and can be a source of many good practice examples, but at the same time, many observers were critical of them claiming that more than 50% of POIG funding was used to fund imports of foreign technologies and know-how, supporting the introduction of process innovations but not necessarily new products and services.

Funding for innovations will be continued in the new financial perspective of 2014-2020, as the Operational Programme "Smart Growth" (POIR) includes selected measures supporting innovations, which were evaluated as the most successful instruments in previous years. Innovation support will increasingly rely on revolving instruments as opposed to subsidies. PARP will be the agency in charge of non-R&D innovation support in the coming years, while NCBiR will focus on R&D support. The support includes also measures dedicated for clusters, technology parks and innovation incubators. In POIR, both R&D and innovation activities have adequate, substantial funding allocated, but the focus for 2014-2020 shifts towards R&D, as this area has been identified as the main target in the national RDI policy, supporting the transition from diffusion of innovations towards the endogenous development of new technical solutions. In addition, Regional Operational Programmes for all 16 regions of Poland include measures, related to innovation support in business enterprises, often offered as revolving financial instruments.

2.3. Research and innovation system changes

MNiSW implemented a wide-reaching institutional reform of science and higher education, enacted in 2010-2011. In 2013, PHEIs and PROs went through the first nation-wide institutional assessment, based on the new pro-effectiveness regulations. 3.8% of all 963 scientific institutions were awarded the highest "A+" rank, and 31.9% were assigned to the "A" class. The results are directly linked to the institutional funding, awarded from the science budget, but the number of institutions distinguished within the "A" category might be considered too high, thus limiting

motivations for continuous improvements but satisfying the expectations of the scientific community. Contrary to some initial publications concerning the evaluation, scientific institutions assigned to the lowest, "C" class, are not dissolved or merged with other organisations, but rather motivated to improve their research activities with very limited funding available for them in the year following the evaluation.

Criteria for funding applied R&D projects promote a linkage between performance, research quality and availability of funding. NCBiR became the main source of R&I directions, funding applied research projects through multiple new, focused initiatives. It demonstrated responsiveness to new research trends while defining new program themes, and set new standards in project evaluations by involvement of not only scientists, but also technology transfer specialists. The Centre initiated co-operation with industry and other government institutions – good examples are **joint programs with the aviation industry** (research projects co-funded by NCBiR and business), with a copper and silver mining company **KGHM** (co-funding non-ferrous metals R&D projects, carried out by other companies - program "*CuBR*"), **Industrial Development Agency ARP** (support for new shale gas-related technologies), **National Fund for Environmental Protection and Water Management NFOŚiGW** (support for development and implementation of eco-innovations) and **General Directorate for National Roads and Motorways** (transportation-related R&D). Other targeted programs, coordinated by NCBiR, address the development of **new energy technologies, improvement of mining safety, energy efficiency in buildings, support for innovative drugs or social innovations**. The Centre was also quick in its reaction to the growing popularity of **new semiconducting material graphene** and established a dedicated financial support instrument, thus capitalizing on existing expertise of Polish researchers in this emerging area. NCBiR programs require financial contributions from applicants, and most funds are equally available to business enterprises, HEIs and PROs. NCBiR supports also **commercialisation of R&D results** by means of programs BroTech (support for technology brokers), SPIN-TECH (funding for companies, established by PHEIs and PROs to transfer technologies) and pilot program BRIdge VC (combining private and public funding for innovative, high-tech ventures). The Centre initiated in 2012 a program called "GO_GLOBAL.PL", supporting firm commercializing R&D outcomes in international markets, and established partnership with a leading tech start-up accelerator in Silicon Valley to help Polish companies gain access to the US market. In January 2013, Ministry of Economy launched a similar initiative, Silicon Valley Acceleration Centre (SVAC), in partnership with another technology accelerator in San Jose, CA. NCBiR launched also a new program STRATEGMED, committing €86m in 2013 to fund projects related to lifestyle diseases.

PHEIs were obliged to introduce intellectual property management regulations, guaranteeing that inventions and research outcomes are controlled by the universities, and to **establish special purpose companies**, dealing with transfer of university technologies to industry or acting as parent companies for academic spin-offs. The start-up costs of some of these technology transfer companies are covered by the program SPIN-TECH, managed by NCBiR. PROs were in turn encouraged to establish co-operative agreements with industrial companies, dubbed 'scientific- industrial centres'. The Ministry of Science and Higher Education launched a funding program "*Innovation Brokers*" ("*Brokerzy innowacji*") to cover the costs of hiring technology brokers by PHEIs in order to help them commercialize selected research results. PARP started a program, co-funding innovation audits at SMEs and subsequent consultancy services, facilitating the implementation of desired innovations.

The Ministry of Treasure and Bank Gospodarstwa Krajowego established in December 2012 **a state-owned company "Polskie Inwestycje Rozwojowe S.A."** (PIR, Polish Investments for Development). PIR operates as a **sovereign investment fund**, supporting investment projects, important for the country's economic development, and the future investment targets are likely

to include among others innovative ventures. The company started operations in 2013. Its efforts seem to be focused rather on infrastructure or energy investments than innovative ventures.

Polish government bets high stakes in two specific technological areas, which are highly prioritised due to their expected impacts on the national economy and industrial competitiveness. R&D related to the new semiconducting material graphene and environmentally-friendly shale gas exploration were subsidised from the science budget, and included on the list of national smart specialisations. The development of graphene-based technologies was supported by NCBiR-funded program GRAFTECH, and one of its tangible outcomes was the commercialisation of a unique, patented method of graphene manufacturing. In December 2013, a company Nano Carbon, jointly owned by the government agency ARP and one of the largest companies in Poland, KGHM, started mass-market supply of grapheme for laboratories and high-tech manufacturers, making it the first publicly available graphene. Shale gas exploration efforts are in turn accompanied by intensive R&D efforts, focused on adjusting the mining technologies to the Polish geological conditions and ensuring the compliance with strict environmental regulations, in particular protecting the water resource and reducing wastewaters from the industrial processes. The projects were co-funded from NCBiR's BLUE GAS program, and by the end of 2013, the government was finalizing its work on the institutional design of the shale gas exploration licenses and payment system.

In February 2014, NCBiR jointly with an Israeli VC fund Pitango and a Polish financial group INVESTIN established a new venture capital fund "PI Ventures", with the initial capitalization of €50.5m (50% from public sources), planning to invest in the most promising high-tech ventures, supplementing the currently available funding instruments.

2.4. Recent policy developments

In November 2009, the Council of Ministers decided to divide the future efforts related to the national development strategy into 9 strategic documents, including the **Strategy for the Innovation and Efficiency of the Economy for the years 2012-2020 "Dynamic Poland" (SIEG)** (RM, 2013a). SIEG's draft was published in May 2012, after social and governmental consultations, and the final document was adopted by the Council of Ministers in January 2013. It is the most extensive strategic document setting R&I policy priorities, and adequately reflects the efforts of public administration. The development of the strategy was coordinated by the Ministry of Economy, and the document is superior to other relevant policy documents.

Objective 2 of SIEG focuses on stimulating innovativeness through the increase in effectiveness of knowledge and work (RM, 2013a: 9), and specific sub-objectives address key challenges of the RDI system, including stimulation of private expenditures on R&D, internationalisation and innovativeness.

SIEG contains quantitative indicators, setting the following levels of GERD to GDP ratio: 0.93% in 2015 and 1.70% in 2020 (RM, 2013a: 89). BERD should amount to 0.33% GDP in 2015, and 0.80% in 2020 (RM, 2013a: 89). High-tech and medium-high technology products would build up 35% of sold production in 2015, and 40% in 2020, compared with 31.7% in 2009 (RM, 2013a: 89), high-tech exports would form 6.5% of total Polish exports in 2015, and 8.0% in 2020, while the value for 2009 was 5.7% (RM, 2013a: 89), and share of innovative enterprises would grow to 20.0% in 2015 and 25.0% in 2020, compared with 17.55% of all enterprises in 2009 (RM, 2013a: 89).

In January 2013, the Ministry of Economy published a draft of the ***Enterprise Development Program*** **(PRP)** (MG, 2013a), as a program implementing SIEG's objectives related to business enterprises. PRP includes proposals for future policy measures, as well as structural and procedural changes within the public administration sector. The Ministry pointed to the excessive number of support measures for innovations, with overlaps creating confusion among potential applicants (MG, 2013a: 7), and past preferences for supporting the absorption of new technologies, instead of funding the development of innovations (MG, 2013a: 9-10). PRP attempts to streamline the public support system for enterprises, based on the following principles:

- use of non-refundable grants for highly innovative R&D projects, and revolving financial instruments (such as loans) for the absorption of innovations (MG, 2013a: 11, 17),
- preference for funding R&D projects related to technologies, which had been identified as key technologies in the *Technological Foresight of Industry – Insight 2030* (MG, 2013a: 43),
- preference for financing initiatives of consortia not individual organisations (MG, 2013a: 44), thus stimulating the bottom-up development of business networks and partnerships between industry and academia,
- modification of application evaluation procedures, de-emphasizing paper-based project applications assessed by anonymous reviewers, in favour of interactive presentations of project concepts and collective decisions by panels of domain experts (MG, 2013a: 12),
- attempts to introduce tax benefits for R&D performers (MG, 2013a: 44-47),
- limiting support for the creation of new business clusters, focusing instead of stimulating their development with proportional involvement of private capital (MG, 2013a: 72),
- strengthening linkages between science and industry, including support for internships of scientists in business enterprises and secondments of company employees in scientific institutions (MG, 2013a: 75).

The draft of PRP was sent for intergovernmental and public consultations, but final version of the document was not adopted as of March 2014. The Ministry of Economy actively campaigned for the introduction of R&D tax deductions, and the intergovernmental consultations concerning these specific arrangements were the reason for delaying the adoption of PRP.

The final version of PRP will also include an annex, called **"KIS" (National Smart Specialization)**, taking into account results of foresight studies and empirical data analyses. KIS will supplement another strategic document, adopted by the Council of Ministers in August 2011 - **"National Research Program. Foundations for the science and technology policy and innovation policy of the state" (KPB)** (RM, 2011). KPB defined long-term objectives, which are subsequently decomposed into more detailed strategic plans, prepared by the Council of NCBiR and NCN as their strategic research programs, with medium-term objectives and assigned funds. KIS has more universal nature, having implications for science, technology and industry, and builds on KPB, outcomes of industrial foresight studies, as well as quantitative and qualitative analyses. KIS will be used as the basis for distribution of funds for R&D in the upcoming Operational Program for 2014-2020.

The restrictive fiscal policy of the Polish government spared R&I funding from major budget cuts. The EU Structural Funds (2007-2013), dedicated for the support of innovative activities in Poland, are gradually becoming depleted, but the government introduced new initiatives, funded from the state budget. In consequence, there was no observable decrease in the availability of funding for R&D projects and innovative ventures. R&D funding agencies were introducing additional support measures to ensure an appropriate coverage of the entire innovation cycle.

PARP launched in 2012 **a new program, supporting the first implementations of patented inventions**, filling in an important funding gap, usually referred to as "the valley of death", and helping entrepreneurs commercialize their technical solutions. In March 2013, NCBiR started a similar project "DEMONSTRATOR+", allocating €120.2m the development and demonstration of solutions based on research results. NCBiR introduced also in 2012 numerous new programs, targeting specific applied research themes and stimulating co-operation between science and industry. In addition, PARP introduced an updated support measure Another NCBiR program was "BRIdge Mentor", where an experienced consulting company, selected in an open competition, offers mentoring to scientists, interested in commercialisation of own research results. PARP launched in 2013 a "large innovation voucher" program, facilitating the distribution of funds to SMEs to cover the costs of product or technology development by scientific institutions. An interesting initiative is a joint NCBiR-NCN program TANGO, supporting the implementation of practical results of NCN-financed, fundamental research projects, as TANGO closes the gap between basic and applied research, encouraging scientists to look for commercially feasible uses of their research.

The government introduced a new fiscal measure, which came into force in 2013 – before, **tax deductible expenses of creators have amounted to 50% of their revenues**, and the important tax deduction has benefited among others researchers, but in 2013, an upper limit on the level of deductions was introduced, in consequence reducing income of many academics.

The Minister of Science and Higher Education defines priorities related to large research infrastructure investments in the ***Polish Roadmap for Research Infrastructures*** **(PMDIB)** (MNiSW, 2011a). The Roadmap helps consolidate the scientific potential in specific fields of research and rationalises the management of infrastructure, as it encourages the formation of research consortia to avoid the duplication of investments and stimulates the joint use of the funded infrastructure by multiple research teams. In 2013, the Minister initiated a process of updating the Roadmap by issuing a new call for submissions from research institutions, and the amendments to the Act on science financing, accepted by the government and submitted to the Parliament in December 2013, embed PMDIB into the formal system of science budgeting, thus ensuring the availability of funds for large infrastructure projects, identified in the Roadmap.

In December 2012, the Ministry of Administration and Digitization published draft guidelines of the planned Act on open public resources. Contents generated by government institutions (including public R&D organizations) are supposed to be available through open access, and the new regulation will in particular concern: scientific journals financed from the science budget and scientific publications created as the outcomes of publicly funded projects. The plans are aligned with the Commission Recommendation from 17 July 2012 on access to and preservation of scientific information (2012/417/UE), but detailed proposals were criticised due to multiple legal shortcomings, and the legislative process had no follow-up in 2013.

The PHEIs and PROs activities, related to the commercialisation of research results, were evaluated by the Supreme Audit Office (NIK), and the publicly available audit reports painted a rather gloomy picture of these efforts (NIK, 2013), but most of the audited activities had actually been initiated before the IPR in science reform of 2010-2011. The disappointments in the slow uptake of the academic technology transfer encouraged the Ministry of Science and Higher Education to propose amendments to the Act on higher education and start the public consultations process in July 2013. According to the proposal, researchers employed by PHEIs and PROs, as well as students and doctoral students, would retain rights to their inventions. This presents an exception from the general rule related to the employee inventions, which in the Polish legal system belong to their employers. The inventors would be free to decide about commercialization routes (including direct co-operation with business enterprises), but would need to pay a predetermined level of royalties to their employing institutions, entitled to 25% of future profits. The proposed regulation is expected to stimulate the commercialisation of

research results by offering direct financial motivation to scientists and simplifying technology transfer processes, which are currently complicated due to the applicability of regulations concerning public finance. Many PHEIs and PROs perceive the proposed regulation as a major disruption in their operations, depriving them of the intellectual property and contradicting the science and higher education reforms from previous years. Nevertheless, the move could increase the involvement of scientists and stimulate the science-industry co-operation, as MNiSW expects. The same act stipulates also that agreements related to the management of intellectual property rights between universities and their special-purpose company, dealing with technology transfer, will not be subject to public procurement regulations and will not require the consent of the Minister of Treasure. The proposed law amendments were agreed by the government in December 2013 and passed to the Parliament to proceed with the legislative procedure.

In August 2013, the Council of Ministers submitted to the parliament proposed amendments to the act on public procurement, relaxing the R&D services from the legal restrictions by raising the maximum value of procurement-free orders from €14k to €30k. They also facilitate the use of single source procurement ("*zamówienie z wolnej ręki*") for orders related to R&D projects, which are not directly used for commercial manufacturing purposes. Moreover, public procurement results could be easily nullified if the organisation did not receive R&D funds, which were supposed to finance the concerned order. The amendments were adopted in February 2014 and are expected to facilitate R&D projects, conducted by scientists from public universities and research institutes, and stimulate their co-operation with business enterprises.

As a parallel activity, NCBiR announced in July 2013 a pilot project supporting the use of pre-commercial procurement (PCP) by Polish public administration, intended to encourage other government organisations to learn from experiences and adopt a similar approach.

The Ministry of Infrastructure and Development (MIR) coordinates the preparation of operational programs, which will guide the future distribution of the EU Structural Funds. According to the EU budget, Poland would receive €76.8b of cohesion funds in 2014-2020. The main R&D-related funding stream will be constituted by the Operational Program Smart Development (*Program Operacyjny Inteligentny Rozwój – POIR*), with the proposed budget of €8,614m. An important difference from a similar funding stream for 2007-2013 will be the definite focus on R&D and development of innovations - while in the past, more funding was allocated to the transfer of technologies, needed to catch up with Western economies, in many cases leading to acquisitions of innovative solutions by business enterprises, including technology imports. POIR objectives are linked to the expected increases in GERD and BERD, and thus the generation of innovative solutions by means of R&D projects. The draft Partnership Agreement, which will determine the 2014-2020 funding framework, sets targets of BERD as 0.8% of GDP in 2020 and 0.9% of GDP in 2023 (MIR, 2013a: 96). The Agreement defines ex-ante conditionality criteria for R&D funding on national and regional levels, including the requirement to define smart specialisation strategies.

Education, life-long learning and intangible knowledge transfer will be supported by the Operational Program Knowledge, Education and Development (*Program Operacyjny Wiedza, Edukacja, Rozwój – POWER*), supposed to distribute €4,419m. Some projects with RD&D components will be funded through the Operational Program Infrastructure and Environment (*Program Operacyjny Infrastruktura i Środowisko – POIŚ*), accumulating €27,514m for environment- and infrastructure-related investments. Several regions in the Eastern Poland, which still are catching up with more developed parts of the country, will benefit from the Operational Program Eastern Poland (*Program Operacyjny Polska Wschodnia – POPW,* €2,117m), which will encompass among others dedicated support measures for R&D-related infrastructure and projects (€485m). A new funding stream will be constituted by the Operational Program Digital

Poland (*Program Operacyjny Polska Cyfrowa – POPC*), where €2,255m will be used to enhance ICT infrastructure and stimulate the effective use of information and communication technologies.

Apart from the national-level operational programs, there will also be 16 Regional Operational Programs (*Regionalny Program Operacyjny – RPO*), with €2,472.5m earmarked for R&D-related instruments, which are complementary to the country-wide interventions. In the new financial perspective, one of Polish regions - Mazovia with the country's capital, Warsaw - will have a position different from other regions as its regional GDP per capita is significantly higher, and thus the availability of cohesion funds in Mazovia (including funds for R&D) will be slightly restricted.

The design of operational programs resulted from a broad consultative process, taking into account formal evaluations of support measures from the 2007-2013 perspective, involvement of teams of external experts, cycles of meetings with stakeholders interested in particular funding streams, submission of comments to several drafts of programs and a series of open conferences in different regions of Poland to gather feedback on the proposed documents. POIR had altogether 56 institutional co-authors, including many non-governmental stakeholders (MIR, 2013b: 125-128). For the regional programs, the Council of Ministers decided that a pre-condition for the acceptance of a program will be the identification of regional smart specialisations, and this triggered the intensive works on relevant strategies in 16 regions of Poland. The proposed funding system will be negotiated with the European Commission in 2014.

POIR focuses on promoting **applied R&D carried out by business enterprises** and innovative activities of companies, including efforts to **intensify the science-industry co-operation** and taking a broad view of **the entire innovation cycle**, trying to offer support from the inception of creative ideas to their successful market implementation (MIR, 2013b: 20), and relying on the identified **smart specialisations** (MIR, 2013b: 24). POIR intends to support altogether 4,000 R&D projects by business enterprises between 2014 and 2020 (MIR, 2013b: 34), inducing private co-funding for R&D in the amount of 16,970m PLN (MIR, 2013b: 37) and leading to 2330 cases of science-industry collaborative R&D projects (MIR, 2013b: 37, 58, 71).

The Operational Program uses financial instruments, including revolving loans for acquisition and implementation of technological innovations (MIR, 2013b: 44), public guarantees for innovative projects to reduce entrepreneurs' risks (MIR, 2013b: 44) and public-private partnerships with venture capital funds to increase private co-funding for selected R&D projects (MIR, 2013b: 35). POIR indicators include the intention to support at least 240 business enterprises by means of financial instruments (MIR, 2013b: 46). Dedicated measures will also encourage business enterprises to contract R&D works from PHEIs and PROs ("innovation voucher" - MIR, 2013b: 55) and support the preparation of applications in Horizon 2020 and COSME programs (MIR, 2013b: 56). POIR will also offer funding for 30 research infrastructure investments (MIR, 2013b: 74), included in the PMDIB, but only if the applicants ensure the access to the infrastructure by other organisations and submit proposed infrastructure-level access policies and pricing, based on calculated setup and maintenance costs (MIR, 2013b: 71).

From the institutional point of view, the POIR support measures concerning applied R&D, development of technologies and scientific research will be managed by NCBiR, while support for implementation of innovations and improvement of corporate strategies of business enterprises will be co-ordinated by Ministry of Economy and PARP. The Central Statistical Office in co-operation with relevant ministries designed an online Development Monitoring System **STRATEG** (http://strateg.stat.gov.pl/), supporting the implementation of policies and monitoring the progress, with a sub-system dedicated to R&I policies.

Government agencies prepare for the challenges of RDI funds distribution in the 2014-2020 perspective, using the opportunity to re-evaluate its activities and experiment with new

institutional arrangements. For example, NCBiR issued in December 2013 calls for proposals for applied R&D projects by business enterprises, committing to complete the evaluation of proposals and issue funding decisions within 60 days from the call closing date. The significantly improved efficiency of the evaluation process will be adopted next year for POIR support measures. The Centre contracted also Reimbursable Advisory Services from the World Bank to conduct a complex evaluation of NCBiR's existing funding programs, intended to identify inefficiencies and best practices before the POIR starts. Public administration made also efforts to maximize the benefits from the past RDI investments, based on the EU Structural Funds for years 2007-2013 (POIG) by facilitating access to information about the co-funded projects and helping match them with potential commercial partners: MNiSW created an online, keywords-based, searchable map of all publicly co-funded research infrastructure projects, while MIR established a similar online system for R&D projects based on POIG funding (http://www.mapadotacji.gov.pl/). It is worth noting that by mid-2013, only ~50% of projects funded from POIG were completed, corresponding to ~20% of the total allocated funding (MIR, 2013b: 19), and the other R&D efforts funded from the 2007-2013 perspective still continue, therefore the impacts of POIG on the Polish innovation system are expected to exceed the currently observed economic results.

2.5. National Reform Programme 2013 and R&I

NRF 2013 emphasized the importance of further investments in RI, commitments to continuously improve the quality of higher education and to the "*upskilling of Polish R&D sector staff, including also the employees of companies carrying out activities in the field of R&D*" (RM, 2013b: 20). The document reported main measures and policies relevant to R&I, which were enacted in 2012 (RM, 2013b: 21-22), emphasizing the importance of funding applied research and commercialization of research results, and linking the efforts to the main policy document SIEG. For the year of 2013, it set target GERD at the level of 0.83% GDP (RM, 2013b: 21), while the actual GERD exceeded this target and amounted to 0.90% of GDP.

Main actions planned for 2013-2014 include:

- the introduction of PRP to establish a comprehensive, systematic approach to supporting business enterprises,
- the implementation of support measures in operational programs, distributing the EU Structural Funds, 2014-2020,
- further work on financing RI, including earmarking of funds for projects included in the PMDIB update,
- calls for proposals in numerous R&D funding programs,
- funding research commercialisation through measures targeting researchers and scientific institutions (RM, 2013b: 24-28).

The above-listed efforts were indeed enacted by the government, and they can be considered beneficial for further development of the Polish R&D system, as described in other chapters of the report.

There are also some actions, which have not been implemented in spite of the declarations in NRP 2013. The Ministry of Economy was supposed to establish a final list of technology and research areas, considered national smart specialisations (Q2 2013), and propose relevant implementation program (Q2-Q3 2013) (RM, 2013b: 28), but the relevant documents are not published yet. The government committed also that 1% corporate tax deductions, used to fund scientific institutions, expected to reduce tax incomes by 60m PLN, would enter into force

"*during the first year after removing Poland from the scope of excessive deficit procedure*" (RM, 2013b: 24), and the condition could not be satisfied in 2013.

2.6. Recent evaluations, consultations, foresight exercises

Since 2004, Polish government agencies have distributed a substantial amount of EU Structural Funds, used among others to support R&D efforts. Poland belongs to the EU leaders in this respect, with efficient fund distribution mechanisms and controlling functions. The government commissioned *ex ante* and mid-term evaluations of the Operational Program Innovative Economy (POIG), including evaluation of consistency between POIG interventions and the EU horizontal policies (Agrotec, 2011), coherence of POIG with government policy documents (PSDB, 2010), complementarity of POIG interventions with other EU-funded programs (PSDB, 2011), evaluation of funding priorities 3, 4, 5 and 6 of POIG (PAG Uniconsult, 2011), and evaluation of complementarities and effectiveness of support for entrepreneurs (PAG Uniconsult, 2012). Important findings from the evaluation studies include: lack of systemic approach due to the existence of separate financial instruments for R&D facilities and R&D projects, problems related to the periodic character of funding with uncertainty of continuation, lowering motivation of R&D performers, and bureaucratic obstacles encountered by beneficiaries (PAG Uniconsult, 2011: 9). In 2013, all the newly designed operational programs on the national and regional levels were subject to *ex ante* evaluations and extensive stakeholder consultations, and the major R&I funding program, the Operational Program Smart Development (POIR) was preceded by an extensive, evidence-based diagnosis of the national system of innovations. As part of the preparations for the 2014-2020 perspective, the government commissioned also detailed studies, intended to facilitate the design of new support measures, including: evaluation of project selection modes (CRSG, 2013) and evaluation of financial engineering instruments (PAG Uniconsult, Taylor Economics, 2013). An important finding from the latter study was lack of evidence for crowding-out of private funding as the public interventions from 2013-2020 were identified as addressing areas of limited interest for private capital (PAG Uniconsult, Taylor Economics, 2013: 7). The Ministry of Infrastructure and Development contracted the World Bank to evaluate smart specialisation strategies, prepared by regions as a pre-condition for future funding from the EU Structural Funds. The social processes leading to the development, evaluation and improvement of POIR involved multiple stakeholders and initiated a broad public dialogue, concerning the need to modernize the economy and focus on the development of innovations. The needs to increase Polish expenditures on R&D, raise the innovativeness of the private sector and stimulate the science-industry cooperation became important theme of popular press publications and political speeches. This was an important change, as the RDI-related topics were not considered important in previous years, when the economy was booming thanks to the low labour costs and large infrastructure investments. The increased awareness is likely to facilitate the absorption of innovation-related funds in POIR, and is already given prominence by the largest consulting firms and think tanks. An interesting example is the BERD2020 index, calculated by KPMG, forecasting the probability of meeting the ambitious objective of increased business R&D expenditures (BERD) by 2020 (KPMG, 2013), and other advisors promote their own intellectual products, shaping the views of the business community.

Between 2007 and July 2013, altogether 786 evaluation studies were carried out with reference to the EU Structural Funds (including small-scale analyses and on-going evaluation efforts of funding institutions), and the database listing all the projects and hyperlinks to source materials is regularly updated on the government website www.ewaluacja.gov.pl/WYNIKI/Strony/Wyniki_badan.aspx. English-language summary of

evaluations related to support measures for R&I, based on the EU Structural Funds, was published by PARP in: Pokorski (2011). PARP regularly evaluates its support measures, and the information about evaluation projects from 2012 is available online at http://badania.parp.gov.pl/index/more/31068. R&D funding agencies NCN and NCBiR adopted a similar approach, conducting *ex ante* evaluations before introducing new financial support instruments, and regularly reviewing results of interventions, but the full evaluation reports are not publicly available. NCBiR published evaluation results (presentations) on its website http://www.ncbr.gov.pl/o-centrum/ewaluacja/ewaluacja-2012/ and announced plans for 15 evaluations in 2013 (including studies concerning science-industry cooperation, commercialisation of research results and use of publicly funded RI by scientific institutions) (NCBiR, 2013). NCN conducted an extensive survey among the applicants of NCN's first grant competitions(http://ncn.gov.pl/sites/default/files/pliki/statystyki/ncn_prezentacja_badania_ankietowe_wsrod_wnioskodawcow.pdf) and used the findings to improve the programs. MNiSW also resorted to evaluative techniques to draw conclusions from multiple science and technology foresight studies, conducted by specific regions and industries. The Ministry of Economy is also using evaluations to modify innovation policy instruments – a recent example was the amendment of legislation concerning tax incentives for companies acquiring new technologies, resulting from the observed limited interests in the support instrument. The Ministry worked with the World Bank to evaluate the proposed reshuffling of the enterprise support system and received insights from external experts, outlining the existing barriers related to the "culture of risk aversion", "overly legalistic approach to program management" and lack of necessary industry exposure and specialist knowledge in government implementation agencies (Kapil et al., 2012: 39), as well as disadvantages of selection procedures excessively relying on "paper-based" applications without direct contacts with applicants, which were supposed to prevent corruption, but established a system, in which the funding for R&D was not allocated to the best applications, but to the applicants who managed to comply with all the detailed requirements, often larger enterprises, resorting to the help of specialist consulting companies (Kapil et al., 2012: 40). Supreme Audit Office (NIK) conducted in 2012 a comprehensive audit of science funding, which indicated that in spite of the increases in research budgets, no significant increases in science outputs could be observed (in terms of publications in highly ranked journals, patents and implementations of research results) (NIK, 2012: 8). According to the audit, some PHEIs and PROs incorrectly document implementations of research results (NIK, 2012: 21), and NCBiR does not apply sufficiently strict criteria when evaluating projects, accepting misleading declarations from funded organizations, and signing acceptance protocols in spite of missing deliverables (NIK, 2012: 41-43). Another audit concerned the commercialisation of research results at PHEIs and PROs, revealing the insufficient scale of these efforts and procedural problems, faced by scientific organisations when trying to transfer the academically developed technologies to the industry (NIK, 2013).

Polish Patent Office conducted an extensive study related to IPR protection by SMEs with the intention to improve the effectiveness and efficiency of the patenting procedures and raise the numbers of patent applications by business enterprises.

In 2013, NCBiR was named "*the Innovator of the Year*" by Warsaw Business Journal. The award is presented annually by the largest English-language economic newspaper in Poland. The distinction for NCBiR recognizes its effectiveness in stimulating industry-science collaboration, experimenting with new funding programs and maintaining close relations with the business community. The Centre demonstrated the ability for organisational learning, by streamlining its internal processes in response to the demands of business enterprises and committing in December 2013 to speed up processing project applications so that funding decisions are made within 60 days. NCBiR works also with the World Bank on a complex evaluation of its funding programs, looking for possible improvements before the new EU financial perspective starts.

2.7. Regional and/or National Research and Innovation Strategies on Smart Specialisation (RIS3)

Polish government identified prioritized technological and scientific areas, presented as National Smart Specialisation (KIS), as the outcome of multiple-year intellectual exercise, combining industrial and scientific perspectives. KIS was based on cross-analyses of the outcomes of two complementary foresight exercises: MG-coordinated "*Technological Foresight of Industry – Insight 2030*" (2010-2012, 99 technologies identified as key for the growth and competitiveness of the Polish industry) and MNiSW-led "*National Foresight Program Poland 2020*" (2006-2009, concluded with 680 detailed R&D themes, turned into National Research Program, KPB, listing 7 strategic R&D directions). The extensive lists of technologies and research areas were compressed into more general groupings, while additional economic and bibliometric indicators helped select the specialities having the highest economic impact, further verified by stakeholder dialogue. KIS consists of 16 identified national specialisations, but the list will evolve based on annual reviews and updates (MG, 2013c: 39). The national specialisations are not regarded as superior or linked to the regionally identified specialisations (MG, 2013c: 40). KIS will become an annex to another policy document PRP and guide the implementation of support measures for business enterprises and scientific organisations, including POIR and PMDIB. The draft of KIS was passed for public consultations in October 2013 and is expected to be adopted by the government in January 2014.

Some government documents suggest that KIS will be directly translated into project eligibility criteria in R&D support measures included in POIR, but its intended use is not entirely clear yet. POIR states that support for business R&D efforts will include projects from all thematic areas, "*not excluding* the concentration of support on areas defined as smart specialisations" (MIR, 2013b: 33). Only in the case of applied R&D conducted by scientific organisations, the supported projects need to correspond to the KIS list (MIR, 2013b: 69).

Another limitation of the Polish S3 approach is the understanding of the essence of smart specialisation strategies. According to the draft Partnership Agreement, S3 is "resource concentration on key priorities, helping exploit the national and regional development potentials" (MIR, 2013a: 29-30). Similar understanding was shared by the KIS draft, maintaining that "smart specialisation strategy consists in setting economic priorities for RDI and focusing investments on areas, ensuring the increase in value added for the economy and its competitiveness in foreign markets" (MG, 2013c: 2). Both quotes refer rather to the traditional notion of economic specialisation than to the concept of smart specialisation. They only assume prioritisation of intervention areas by selecting R&D and technology areas of top economic importance. However, they are missing the "smart" dimension, as the proposed interventions would not be differentiated, i.e. every prioritized specialisation would benefit from the same support instruments, even though the actual requirements could be different due to varying technology maturity stages, international competitive situations or readiness of Polish business enterprises to deliver specific solutions.

In 2013, substantial progress was also achieved with RIS3, due to the planning efforts for the new operational programmes 2014-2020. Poland is divided into 16 regions (voivodeships), and each region has its own Regional Operational Program (RPO), guiding the distribution of the EU Structural Funds. The ROPs include policy measures, related to R+I, in some cases overlapping with the corresponding measures, available on the national level. List of ROPs for 2007-2013 and relevant statistics are available at the government website: http://www.funduszeeuropejskie.gov.pl/RPO/Aktualnosci/Strony/default.aspx. Several years

ago, all 16 regions prepared and formally adopted Regional Innovation Strategies. List of regional policy documents with updated web links is available at http://www.rim-europa.eu/index.cfm?q=p.baseline&r=PL.

These documents are being updated in line with the RIS3 framework, reflecting the smart specialization of regions. Since the preparation of RIS3 is the condition for accepting the RPOs, the process intensified in 2013. Regional authorities were arranging multiple knowledge transfer events, learning from best practices and sharing experiences related to RIS3, and experts from the European Commission and MNiSW were regularly involved in these efforts. Some of the existing RIS3 are rather general, not targeting specific technologies or market segments (to avoid possible technology lock-ins, as the planning horizon reached the year of 2020). The Ministry of Infrastructure and Development contracted the World Bank to evaluate the regional smart specialization strategies and recommend possible improvements. RIS3 are directly linked to ROPs and focus on stimulating private co-funding for projects, while benefiting from the monitoring and evaluation frameworks of ROPs.

2.8. Policy developments related to Council Country Specific Recommendations

The Council of the European Union adopted in June 2013 Country Specific Recommendations (CSR), relevant for R&I policy in Poland (CEU, 2013). Poland was identified as "one of the worst performers in broader innovativeness indicators" (CEU, 2013: 7), with very low levels of GERD and BERD (however, the recommendations were based on data for 2011, while both indicators significantly increased in 2012). The Council noted past reliance of Polish business enterprises on technology absorption (defined as "application of already existing technologies through fixed capital investment"), which needs to be replaced by development of new technologies ("a transition towards a more indigenous innovation-based model") (CEU, 2013: 7). The statement is a very adequate summary of the government policies, as the main R&I-related funding program for the EU Structural Funds for 2007-2013 (POIG) was indeed focused on technology absorption, intended to facilitate the catch-up of Polish companies with their foreign competitors by supporting access to new technologies, as well as improving the research infrastructures, which had been dramatically under-invested before. The programming of the funds for 2014-2020 in Poland was guided by an explicitly stated shift in focus, coherent with the Council's remarks: the new operational program (POIR) will primarily support development not absorption of technologies, and the broad consultations, which supported the drafting and further modifications of the Program, helped promote this shared vision among stakeholders.

Interestingly, when comparing the diagnosis with the contents of CSR'2012, one could note that the Council was no longer explicitly concerned that Poland could not meet its national target related (GERD to GDP ratio) by 2020, but instead appreciated the recent science and higher education reform as it "initiated a major restructuring to induce science-industry cooperation" (CEU, 2013: 7).

The Council urged Poland to: (1) strengthen the linkages between R&I and industrial policy, (2) nurture the application of revolving instruments and tax incentives to stimulate business R&D, (3) better adjust the support instruments to different stages of the innovation cycle (CEU, 2013: 10).

The recent changes in the R&I system in Poland are clearly directed at addressing the above-listed challenges, but their effectiveness is not clear yet. Recommendation (1) refers to the dominant theme of the recent science and higher education reform – PROs and PHEIs are

motivated to engage in co-operative projects with industry, their institutional evaluation depends among others on measurable achievements in the area of technology transfer, and numerous R&D funding instruments require the formation of consortia, involving academic and business organizations. In particular, programs offered by NCBiR induce industry and academia co-operation and are successful in motivating companies to invest in scientific projects – in 2011, €88.1m and in 2012, €306.3m were spent by business enterprises due to their commitments in NCBiR-funded projects (MNiSW, 2013a: 5).

CSR (2) was enacted by the government with dedicated support instruments that finance the participation of Polish applicants in international projects, including FP7. The state-owned bank BGK offers credits, supporting technology projects, and it has intensified these operations thanks to the amendments of relevant laws. SMEs can benefit from publicly funded loans and credit guarantees, particularly focusing on innovation-related investments, and their distribution is offered within the National Service System for Small and Medium-Sized Enterprises (KSU), co-ordinated by PARP. BGK's venture capital arm, KFK, invests in private VC funds, covering up to 50% of capital, available to applicant companies. As of December 2013, KFK was involved in 16 VC funds, supporting among others innovative ventures. Among the recently announced initiatives, NCBiR prepared a program called "BRIdge VC", intended to orchestrate public and private funds for the support of R&I projects, which require bridge financing or could benefit from venture capital. POIR includes revolving instruments mostly for projects related to more mature technologies/implementation of innovations, preferring subsidies for high risk R&D efforts. As for R&D tax breaks, their introduction is planned according to a policy document PRP, and in December 2013, intensive discussions between the Ministry of Economy and Ministry of Finance were held to finalize the proposal.

Recommendation (3) emphasizes the need for systemic, integrated approach to prioritization and support, so that the entire innovation cycle is considered, from the inception of new ideas to their successful commercialization. Poland used to have multiplicity of dedicated support instruments, but the instruments were offered by several different government agencies and some participants of the national system of innovations did not understand their synergies and complementarities. Nevertheless, the portfolio of instruments was comprehensive and covered most elements of the innovation cycle, and in the years of 2012 and 2013, new support instruments were introduced to fill the identified gaps: support for the first implementations of patented technologies (PARP), the internationalization of high-tech enterprises (NCBiR), the establishment of technology transfer companies by PHEIs and PROs (NCBiR), and the support for innovation brokers, acting as agents selling PHEI-generated technologies (MNiSW). In the new financial perspective of 2014-2020, there are further improvements, which will streamline the support for the entire cycle. R&D-related measures will be managed by NCBiR to avoid competence overlaps among government agencies. The Council's recommendation was accordingly taken into consideration when co-ordinating the development of policy framework, with high-level strategy, supporting efficiency and innovativeness of the economy (SIEG), implementation program targeting business enterprises (PRP), definition of Polish scientific and technological specialities (KSIS) and the major R&I funding program (POIR). Moreover, broad social consultations of the above-mentioned documents helped ensure the integration of industrial policy and the necessary R&I focus. In 2013, this was also observed in the changing public discourse, with politicians, government agencies, think tanks, consulting firms and business enterprise associations focusing on the notion of innovation as the future source of economic growth and competitiveness.

3 PERFORMANCE OF THE NATIONAL RESEARCH AND INNOVATION SYSTEM

This chapter is aimed to assess the performance of the national research and innovation system and identify the structural challenges faced by the national innovation system.

3.1. National Research and Innovation policy

Table 2. Innovation Union Scoreboard indicators for Poland (data for 2011).

HUMAN RESOURCES	
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	0.50
Percentage population aged 30-34 having completed tertiary education	36.90
Open, excellent and attractive research systems	
International scientific co-publications per million population	213
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	3.52 (2008)
Finance and support	
R&D expenditure in the public sector as % of GDP	0.53
Venture capital as % of GDP	0.051
FIRM ACTIVITIES	
R&D expenditure in the business sector as % of GDP	0.23
Linkages & entrepreneurship	
Public-private co-publications per million population	5.30
Intellectual assets	
PCT patents applications per billion GDP (in PPS€)	0.45
PCT patents applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	0.12
OUTPUTS	
Economic effects	
Medium and high-tech product exports as % of total product exports	0.88
Knowledge-intensive services exports as % total service exports	26.14
License and patent revenues from abroad as % of GDP	0.05

Data Source: Innovation Union Scoreboard 2013

Poland's RDI system experienced significant changes in the recent years, and key R&D indicators are constantly improving. The country transforms the science and higher education systems, focusing on quantifiable effects of R&D and increasing the importance of competition-based funding for R&D.

GERD as percentage of GDP remains low in comparison with EU-28 average and targets for Poland – it was 0.67% in 2009, 0.74% in 2010, 0.76% in 2011 and 0.90% in 2012 (Eurostat, 2013). Nevertheless, the country improved the size of its relative R&D investments, which in 2006 accounted only for 0.56% of GDP, and the observed increase is substantial. Between 2007 and 2012, the GERD went up by 94.48%, and **Poland's annual growth in GERD was the fourth strongest in the EU** (GUS, 2013a: 51). GOVERD at 0.25% of GDP was not very distant from the EU average of 0.26%, but HERD of 0.31% of GDP was relatively low (EU-28: 0.49%), and BERD even lower as 0.33% of GDP (EU-28: 1.3%) (Eurostat, 2013). If absolute values of R&D expenditures are analysed, the amount of funds allocated to R&D in Poland stands out in comparison to many other EU countries. Poland's GOVERD expressed in Euro (€) was in 2012 the 7th largest in the EU (after Germany, France, Spain, UK, Italy and Netherlands) (Eurostat, 2013). Unfortunately, the substantial government expenditure does not seem to stimulate corresponding increases in business investments in R&D. Even more funds on R&D are spent in Poland from EU's Structural Funds than from the national civil R&D budget (EC DGRI 2011: 255), and thanks to the availability of the EU funds, the government spends a relatively small share of its total budget on R&D – GBAORD in 2009 was only 0.76% of total government expenditures, compared with EU-27 average of 1.53% (Eurostat, 2012) (no data available for 2010, 2011 or 2012).

The growth in R&D-related spending indicates that political actions bear their first fruits, but the country needs more intensive efforts in order to effectively transform its RDI system. The transformation is inhibited by the substantial size of the system (number of institutions, researchers, students and projects), and its democratic character, i.e. legal requirements for consultations of draft legislations with the representatives of science sector. Scientists working for PHEIs and PROs are well-organised in powerful associations, receiving media attention, and introductions of the recent reforms were preceded by consultations, resembling negotiations with labour unions. In consequence, some initially planned measures were modified in order to satisfy public requirements, thus diminishing their actual effectiveness. Various studies concerning R&D performers in Poland indicate that limited interests in innovations or applied research might also be linked to attitudes and perceptions, resulting from cultural and historical factors, and governmental institutions were trying to address these problems by awareness campaigns.

3.2. Structural challenges of the national R&I system

The analysis of the Polish data indicates the following key challenges, faced by the national innovation system.

Key challenge 1: Low levels of business investment in R&D and in-house technological innovation

The primary challenge for the RDI system in Poland is stimulation of business expenditures on R&D and in-house technological innovations in business enterprises. R&D funding of business enterprises accounted in 2012 for 37.21% of GERD, while the EU-28 average for 2012 was 63% (Eurostat, 2013). Polish BERD was low at 0.33% of GDP (EU-28: 1.3%) (Eurostat, 2013). Also, a very low percentage of funds allocated by the Polish government as state aid is granted to

cover costs of R&D (EC DGRI, 2011: 340). Companies prefer to spend more on non-R&D related innovations: 1.25% of their turnover, with EU's average of 0.71% (PRO INNO Europe, 2012: 63). Poland's share of venture capital in GDP is only 0.051% (EU-27: 0.094%) (EC DGEI, 2013: 71), but the percentage of GDP generated by public procurement was inversely high at 8.20% (EU-27: 3.60%) (EC DGRI, 2011: 366).

Instead of domestic generation of innovations, Poland resorts to imports and among the large EU member states, it maintains the highest share of GERD allocated to royalties and licence fees paid to foreign suppliers, as over 50% of domestic expenditures on R&D cover transactions in foreign knowledge products (EC DGRI, 2011: 403). Future increases in Poland's GERD might primarily benefit foreign technology suppliers, not national RDI sector, unless more targeted measures are introduced. The high domestic demand for new technologies and absorptive capacity collide with the much weaker potential for local knowledge production. The government expenditure on R&D seems to have a crowding out effect, not stimulating the expected increases in BERD. Nevertheless, the absolute BERD at €1,276.34m in 2012 was higher than in other new EU member states, with the exception of the Czech Republic, while still significantly lower than the BERD of most of the old EU members (Eurostat, 2013).

In 2012, 2,110 business enterprises declared expenditures on R&D (GUS, 2014b), and only 521 registered purchases of research equipment, classified as fixed assets (GUS, 2014b). Among economy sectors investing in R&D in 2012, manufacturing accounted for 53.53%, and information and communication sector for 20.34% of total business spending, while agriculture, construction, finance and insurance had only minor importance (GUS, 2014b). Similarly, the R&D personnel in business enterprises concentrates in the manufacturing sector (46.06%) and the information and communication industry (28.50%) (GUS, 2014b). Some sectors, which were key to the Poland's economic growth in the recent years, have only limited R&D investments and relevant employment.

65.21% of business expenditures on R&D were in 2012 spent by large enterprises, employing 250 or more persons, while medium enterprises (50-249 employees) accounted for 22.60%, small enterprises (10-49 employees) – for 9.28% and micro-enterprises (up to 9 employees) – 2.90% (GUS, 2014b). The ranking of top 1000 European companies based on R&D expenditures of the 2013 EU Industrial R&D Scoreboard included only 4 Polish companies, all of them with predominantly local capital (JRC, 2013). Spending of SMEs on R&D remain alarmingly low in comparison with other EU countries – in 2008, BERD by SMEs corresponded to 0.07% of GDP in Poland, while the corresponding average for the EU-27 was 0.25% (EC DGRI, 2011: 326). Alarming are the low shares of SMEs innovating in-house (11.34%; EU: 31.83%), introducing product or process innovations (14.36%; EU: 38.44%) and innovative SMEs collaborating with other organisations (4.15%; EU: 11.69%) (EC DGEI, 2013: 71). One should however remember that many micro-enterprises in Poland are one-person companies, established by individuals seeking to optimize the social insurance, health insurance and tax rates and signing subcontracting agreements instead of employment contracts. Regional distribution of BERD presents additional problems as 34.4% of all business enterprise expenditures on R&D in Poland are spent in Mazovia (mainly Warsaw) (GUS, 2013b).

With reference to BERD, the World Bank expressed the suspicion that Polish enterprises tend to under-report their R&D expenditures and the scope of innovative activities (Kapil et al., 2012: 9). This is an important remark, as the existing R&D reporting mechanisms are burdensome for enterprises, and not integrated with standard financial and fiscal reporting. **Many R&D performers have never reported any relevant R&D expenditures**, and the details about R&D expenditures of individual companies are protected by statistical data confidentiality principles, guarded by the Polish law, making cross-verification impossible. In the Polish legal system, business enterprises have **no penalties for failing to report or for inadequately underreporting the R&D expenditures**, while at the same time, they have **no incentives to**

report them (no related tax benefits, no additional benefits when applying for R&D subsidies). Moreover, the existing accounting and tax regulations might motivate many companies to classify their R&D efforts as expenditures on fixed assets rather than on intangible assets development. Many high-tech companies are suspected not even to know how to classify R&D expenditures, and benefit from the permissible accounting regulations by using an internal chart of accounts, which does not foresee booking R&D expenditures at all.

The dynamic development of Poland's economy and changes to the total factor productivity suggest that the official government data on BERD might be under-estimated, and the proposition was supported by the World Bank experts (Kapil et al., 2012: 9). In addition, the suspicion is compliant with empirical evidence of significant increases in R&D expenditures of selected business sectors, e.g. BERD of the Poland's ICT sector increased by 14% between 2010 and 2011 according to the most representative, national survey of ICT companies in Poland, conducted annually by the specialist magazine Computerworld (Czerniejewski, 2012). Ministry of Environment surveyed the most innovative providers of environmental technologies and discovered that only exactly 5% of them declared any R&D expenditures in 2012, while all of them were actively conducting R&D efforts, funded mostly from private sources (Klincewicz et al., 2013).

The reported BERD consists in a significant part from private expenditures incurred to accompany the public co-funding, which is formally required to be adequately booked by corporate accountants. There is a strong suspicion that **the actual R&D expenditures of the Polish business sector are much higher than the reported BERD**. Even though the Central Statistical Office continuously works on improving the R&D data collection, the problem lies rather with the Ministry of Finance and existing accounting and tax regulations, and the situation might improve as soon as companies have financial incentives to start reporting in-house expenditures on R&D, in particular R&D tax benefits.

While the counts of patent applications in Poland are limited, in 2012 only 38.9% of them were submitted by business enterprises (UPRP, 2013: 15). Nevertheless, the counts of patent applications by business enterprises have increased compared with previous years. Sales of innovative products (both new-to-market and new-to-firm) corresponded to 8.00% of Polish business enterprises, while the EU-27 average was 14.37% (EC DGEI, 2013: 71). In manufacturing sector, 5.4% of sold production can be classified as high technology and 27.0% – as medium-high technology (GUS, 2013b). People working for high technology companies corresponded in 2011 to 4.9% of total employment in manufacturing, and employees of medium-high technology firms were 20.9% of all employed in the sector (GUS, 2013b). Employees of high-tech manufacturing account for 0.08% of total employment (EU: 1.1%), and medium-high tech manufacturing – 4.1% (EU: 4.6%) (EC DGRI, 2011: 398). In service sector, knowledge-intensive services account for 34.3% of total sales volumes (GUS, 2013b). However, employment in services as the share of total employment (55.9%) is lower than for the EU-27 (70.5%) (EC DGRI, 2011: 390), thus driving down the share of employment in knowledge-intensive services in total employment – Poland: 29.5%, EU: 38.1% (EC DGRI, 2011: 398). Poland's 2011 share of high-tech export in total export was 5.2%, compared with 15.4% for EU-27 (GUS, 2013a: 129). Licence and patent revenues from abroad were over 10 times lower than the EU average, accounting for 0.02% of Poland's GDP (EU-27: 0.21%) (EC DGRI, 2011: 186). Exports of knowledge-intensive services as a share of total service exports at 26.14% remain lower than for EU-27 (45.14%) (EC DGEI, 2013: 71).

In 2010, only 33 companies used tax exemptions for acquisition of new technologies, with an average exemption of €237k (MF, 2011: 17), and after amending the relevant legislation, in 2011 the number of beneficiaries went up to 97, and average exemption increased to €678k (MF, 2012: 17), while in 2012, there were 94 beneficiaries, but the average exemption value nearly doubled to €1,116.8k (MF, 2013: 17). The data demonstrate very low interests in the key fiscal instrument,

intended to support innovations in business sector – only 94 out of 378,964 corporate tax payers (MF, 2013: 2) used the exemptions in question. Between 2008 and 2010, 6 enterprises lost the status of R&D centre, associated with additional fiscal incentives, and in October 2013, there were only 28 companies with the registered R&D centre status (MG, 2013b).

The data suggest that the majority of business enterprises in Poland look for sources of competitive advantage other than innovations. Government RDI policies of the recent years were constantly attempting to change the attitudes and behaviours, but they do not bear fruit in terms of the expected increases in BERD, numbers of innovative enterprises and innovative products. Many companies successfully operate as low cost subcontractors of Western partners, and are not motivated to innovate. Substantial public spending on R&D is not accompanied by parallel increases in business investments, and this cast doubts on the overall effectiveness of the public support system for RDI. In the background document, prepared for the Strategy for the Innovation and Efficiency of the Economy for the years 2012-2020, the Ministry of Economy suggested that "the existing system, intended to support innovativeness of enterprises, favours the purchases of ready-to-use solutions, thus supporting transfers of foreign solutions" (MG, 2012: 6), what might be considered as an important factor stifling the in-house innovativeness of the Polish business sector.

Key challenge 2: Limited synergies between the science and industry, restricting the innovative potential of the economy

Total R&D expenditures in 2012 were distributed among basic research (36.7%), applied research (21.0%) and experimental development (42.3%) (GUS, 2014a: 58), while the business sector allocated 75.56% of its expenditures on experimental development, 18.72% on applied research and 5.72% on basic research (GUS, 2014b). This imbalance could stimulate the co-operation between the science and industry companies, but the observed outcomes are disappointing.

The number of research projects carried out by PHEIs and PROs, contracted by the industry, remains low, numbers of joint patent applications are insignificant and only 2.5 per million Polish publications, registered in Web of Science database, were jointly co-authored by academics and business sector representatives, compared with the corresponding ratio of 36.2 for the EU-27 (PRO INNO Europe, 2012: 63). Between 2000 and 2009, only 0.5% of scientific publications from the University of Warsaw were co-authored with business, and the ratio for the Jagiellonian University in Cracow was even lower at 0.2% (Klincewicz, 2012).

Business enterprises in 2012 funded only 2.14% of R&D costs at PHEIs, and 9.06% at PROs, while the largest PRO, Polish Academy of Sciences, benefited only from 1.82% of business contributions to its R&D budget (GUS, 2014b).

Business enterprises in Poland employed in 2012 in total 1,357 scientists, holding PhDs or academic titles, out of the total population of 70,810 employed scientists with these qualifications (GUS, 2014b). In 2012, altogether only 18.22% of all researchers in Poland were employed by business enterprises (GUS, 2014b), and the share was significantly lower than the 2008 estimate for the entire EU: 45.8% (EC DGRI, 2011: 115).

The disappointing results of academic technology transfer were summarized by the country-wide analysis by the Supreme Audit Office (NIK, 2013), and MNiSW even decided to depart from its previous legislations, facilitating the management of IPRs to academic inventions by PHEIs and PROs, to focus on empowering inventors instead, hoping that assigning them rights to their research results would increase the propensity to collaborate with business enterprises.

Key challenge 3: A need to concentrate financial resources on key strategic areas and RDI priorities

In the past, investors and R&D performers were finding it difficult to identify clear priorities in the government's RDI support policies. Even though the planning documents declared strategic areas in terms of fields of research or technology types, the directions are very general and so broadly distributed, that it is hard to actually regard them as priorities. R&D performers could benefit from a clear and consistent focus of the government, coupled with increased financial support for these key areas. The process is distorted by the legal requirements to reach consensus with the scientific community about the intended priorities, and in the recent years, such consultations derailed some initially ambitious plans for funding reforms. Outcomes of government-funded, large-scale technology foresight efforts were not transformed into specific, measurable objectives for the RDI system. The challenge is gradually disappearing due to the current RDI planning efforts, including the identification of national smart specialisations (PRP/KIS) and establishing relevant funding measures (POIR). As the process is ongoing, it is premature to judge its outcomes by the end of 2013, but it seems to have addressed concerns, covered by this particular structural challenge.

Intramural R&D expenditures of business enterprises in 2011 were mostly allocated to engineering and science research (GUS, 2013b), and the field accounts for the largest share of the R&D personnel (37.9% in total, 79.6% of R&D personnel in business enterprises) (GUS, 2012a: 263). Among engineering and technical sciences, most funds were spent on the domains of electrical, electronic, information, mechanical and materials engineering (GUS, 2012a: 54). Contradictory to the focus of business enterprises and composition of R&D personnel, Polish students (including doctoral students) tend to prefer social sciences and humanities. Table 3 presents a comparison of the importance of diverse science fields.

Table 3. Relative importance of fields of science in Poland.

	Engineering and science (excluding natural sciences)	Natural sciences	Medical and health sciences	Agricultural sciences	Social sciences	Humanities
Intramural R&D expenditures, 2010	47.0%	24.7%	10.3%	7.7%	6.2%	4.2%
Intramural R&D expenditures of business enterprises, 2010	74.7%	13.0%	8.2%	2.3%	1.0%	0.8%
Employment in R&D, 2010	37.9%	19.3%	13.4%	6.6%	12.3%	10.4%
Employment in R&D in business enterprises, 2010	79.6%	11.5%	5.4%	2.2%	0.8%	0.5%
Public funding for R&D projects, 2012	73.2%	6.7%	10.1%	2.7%	3.7%	3.6%
Doctoral candidates, 2010	17.6%	15.5%	9.4%	4.8%	20.22%	32.41%

Data source: GUS (2012a: 54-55, 305), MNiSW (2013: 46).

Polish scientists had the highest absolute counts of publications in 2012 in the areas of medicine, physics and astronomy, biochemistry, genetics and molecular biology, chemistry and engineering (SCImago, 2013). When citations to publications from 1996-2012 are concerned, the most

important research areas are: chemistry, decision sciences, earth and planetary sciences, materials science, mathematics, pharmacology, toxicology and pharmaceutics, biochemistry, genetics and molecular biology, immunology and microbiology, as well as physics and astronomy (SCImago, 2013).

European Commission's report concerning the research and innovation performance of member states used bottom-up bibliometric analyses to reveal scientific and technological specialisations of countries based on Scopus database records and European Patent Office filings: food, agriculture and fisheries, energy, ICT and advanced materials (EC DGRI, 2013: 207-208). Interestingly, the report confirmed the adequacy of RDI directions, identified in Polish policy documents, but also pointed to the relatively low level of specialisation of the country (EC DGRI, 2013: 208).

Public funding, distributed by NCN in 2011-2012, was mainly used to fund projects in Science & Technology and medical sciences, but the distribution among fields of research was based on a bottom-up approach and depended on the submitted project proposals. Funds for applied research, distributed by NCBiR, are in turn allocated in multiple programs, including targeted interventions, stimulating research in selected areas, such as: aviation, ICT, nuclear energy, shale gas, graphene-related research, environmental technologies.

Analysis of sales data indicates that the most important types of Poland's high technology products are: computers, electronic products and optical instruments, while among the medium-high technology products, chemicals, electrical equipment, other machinery and equipment and motor vehicles dominate (GUS, 2012a: 319). Poland's high-tech exports consisted in 2011 of: computers and office machinery (35.9%), electronics and telecommunications (29.4%), aerospace (13.1%) and scientific instruments (10.1%) (GUS, 2013b). The EU Structural Funds for business enterprises, distributed by PARP and NCBiR, were not earmarked for specific technology types (with the exception of dedicated instruments for ICT-related projects) and thus do not encourage the pursuit of technological specializations.

Without the necessary focus of efforts and financial resources on specific, well-defined science and technology areas, participants of the innovation system do not understand the RDI priorities of the government. In many cases, the lack of government commitments and related uncertainty discourage the R&D performers from investments and in-house development. Specific RDI priorities need to be formulated and shared, as the clarity would support the orchestration of other necessary resources (finance and people). In 2013, Polish regions were preparing their RIS3 documents, contents of which address these concerns, and the Ministry of Economy prepares KIS as the list of national specialisations. By the time of finalizing the report, many of these documents have not been formally adopted.

Key challenge 4: Increasing internationalization and attractiveness of RDI system

Polish companies are avid users of foreign technologies – over 50% of GERD covers the purchases of foreign products and services (EC DGRI, 2011: 403). Statistics concerning formal transfers of technologies to industrial enterprises in 2012 document the conclusion of 878 inward licensing agreements, 399 joint R&D projects, 821 acquisitions of means automation (e.g. manufacturing lines) and 592 technical consulting service projects, with technologies supplied mostly by entities from other EU countries (GUS, 2014a: 146). Licence and patent revenues received by Polish companies from abroad were in 2009 over 10 times lower than the EU average, accounting for 0.02% of Poland's GDP (EU-27: 0.21%) (EC DGRI, 2011: 186). Exports of knowledge-intensive services as a share of total service exports (33.05%) also

remained lower than for EU-27 (48.13%) (PRO INNO Europe, 2012: 63), while the share of high-tech exports in total exports was 5.2% (EU-27: 15.4%) (GUS, 2013a: 129).

Poland has also a very low share of doctoral candidates from other EU countries (EC DGRI, 2011: 274), and almost 10 times less non-EU doctorate students than the EU-27 average (PRO INNO Europe, 2012: 63). The legal framework and financing conditions do not attract experienced foreign researchers, but the availability of specialist research instruments and infrastructure, funded from the EU's structural funds, stimulates short-term visits of international scientists.

The share of Polish publications co-authored with international partners in 1996-2012 was 29.20% (SCImago, 2013). The largest academic institutions are highly internationalized – University of Warsaw had 44.5% of publications from 2000-2009 co-authored with foreign scientists, and Jagiellonian University – 39.0% (Klincewicz, 2012), but other institutions are less inclined to co-operate with international partners. In 2009, Poland had 186 scientific publications with international co-authors per one million population – a ratio significantly lower than the EU-27 average of 491 (EC DGRI, 2011: 186) and one of the lowest among all EU countries. At the same time, the average cost of a scientific publication authored by Polish researchers is relatively lower than for publications originating in other EU countries, outlining the cost advantage of Poland's research system. Recent science and higher education reforms, intended to stimulate the internationalization of scientific publications, were subject to a fierce criticism by scientists, dissatisfied with the requirements to publish in highly ranked English-language journals, use citation-based indicators from international databases or prepare grant proposals in English so that they could be evaluated by foreign experts.

Polish researchers maintain the most intensive collaborative ties, evidenced by joint publications, with Germany, France, the United Kingdom, Italy and Spain (EC DGRI, 2011: 187). Counts of patents with foreign co-inventors are low, but the most intensive collaboration concerns Germany, Sweden, France, Italy, Switzerland and the UK (EC DGRI, 2011: 188). It should be emphasized that Polish researchers and inventors have limited ties to the US organisations, compared with their counterparts from other countries. Poland has the lowest participation in FP7 per 1,000 researchers (in FTE) among all EU-27 states (EC DGRI, 2011: 261).

As of March 2011, Poland ranked 11th in terms of the number of applicants to FP7 in the EU (2.53% of EU), with only 327 SMEs submitting proposals (EC DGRI, 2011: 190), and top foreign collaborators for Polish researchers coming from Germany, the UK and Italy (EC DGRI, 2011: 190). By the end of October 2012, altogether 1,627 projects involving Polish researchers were funded in FP7 (MNiSW, 2013a: 59), and only in 184 projects Polish institutions acted as projects coordinators (MNiSW, 2013a: 60). The number of projects with Polish coordinators increased to 224 by November 2013 (KPK, 2013: 3), but the number of Polish business enterprises benefiting from FP7 was still relatively low: only 481 organisations, compared with 809 PHEIs and 603 PROs, and Poland benefited in total from 1.14% of all FP7 allocated to beneficiaries from EU-28 (KPK, 2013: 5). Interestingly, the international mobility of Polish researchers employed in higher education sector (interpreted as research or studies abroad for at least 3 months) is close to the EU average (EC DGRI, 2011: 276), but these movements do not contribute to substantial increases in joint research projects or publications.

Dedicated funding instruments support the internationalization of the Polish RDI system, including grants targeting international co-operation, offered by NCN, NCBiR and Polish Science Foundation (based respectively on the science budget and the EU Structural Funds), and in years 2014-2020, the support will be strengthened thanks to dedicated support measures in POIR.

The observed characteristics of Poland's RDI system resemble the performance of developing countries, with business sector focused on adoption of foreign technologies and researchers

maintaining limited links with the international scientific community. In spite of wide availability of funds for international projects and the active international mobility, Poland remains the net payer to the FP7 and does not capitalize on opportunities within the EU. Individual and institutional evaluation frameworks do not reward researchers or institutions for the degree of internationalization, and many PHEIs primarily understand the internationalization as student mobility.

Key challenge 5: Inducing knowledge spill-overs from foreign direct investments

In 2011, 45.4% of R&D investments in business sector were generated by enterprises controlled by foreign capital (GUS, 2013b) and the country's major R&D initiatives are funded by the EU Structural Funds. Altogether 442 entities (including 162 business enterprises) benefited in 2010 from foreign funds supporting R&D, with majority of external funds coming from the European Commission (GUS, 2012a: 194). Enterprises with foreign ownership are more technologically advanced - 10.5% of their sold production can be classified as high-tech, and 37.9% – as medium-high tech, compared with 6.8% and 27.2% for the total population of manufacturing enterprises in Poland (GUS, 2012a: 318). Poland experiences a constant influx of foreign direct investments, being one of the most attractive FDI locations in the EU. The country attracted foreign investments of €9,343m in 2009, €10,507m in 2010 and €14,832m in 2011, but the trend was stopped by a sharp drop to €4,716m in 2012 (NBP, 2013), with majority of FDIs originating in other EU countries (NBP, 2013). Preliminary data for 2013 indicate a renewed, substantial inflow of FDIs (PAIZ, 2013a). The tendency is also confirmed in a report by Financial Times, identifying Poland and Spain as two EU countries benefiting most from the FDIs in 2012 (fDi Intelligence, 2013).

Government agency supporting FDIs (PAIZ) was involved in large FDI projects in BPO, automotive, electronics and ICT sectors, with investors mostly from the US, Germany, UK, China and France (PAIZ, 2012). The character of the largest FDIs in Poland evolves towards knowledge-based activities, and in 2013, PAIZ started intentionally attracting investments in R&D sector, working on 15 large-scale R&D projects, supposed to employ 1,504 researchers in foreign-owned business enterprises (PAIZ, 2013b). The agency jointly with NCBiR and consulting company CRIDO published also a dedicated guidebooks for foreign investors, introducing R&I support measures available in Poland and sharing positive experiences of investors already operating in the country (PAIZ, 2013c).

According to the World Bank estimates, R&D-intensive FDI accounted only for 4.5% of the total FDI in Poland in 2010, compared to 13% in Hungary and 21% in Slovakia (Kapil et al., 2012: 3). Less attention is paid to the creation of linkages between the foreign enterprises and local companies or scientific organisations, there are also no dedicated instruments to promote knowledge spill-overs from FDIs. Polish government does not use instruments such as local content requirements, or technical standards favouring local suppliers, and foreign investors benefit from public support without the need to commit to the establishment of RDI linkages or local R&D projects. Without appropriate measures, the economy might attract excessive number of foreign investments, motivated by low labour cost in Poland and manufacturing efficiencies, but do not benefit from foreign expertise in R&D and knowledge creation. Recently, even the interests in low cost labour are questioned due to the unclear future of the Special Economic Zones (SSE), selected geographical areas where investors can enjoy sizeable tax exemptions. Ministry of Finance opposes the extension of existing benefits, and the uncertainty negatively impacts new foreign investments. In early 2014, the government proposed amendments to the SSE-related legislation, ensuring their further operations. Apart from SSEs, foreign investors

setting up operations in Poland can still benefit from all the support measures, available within the Polish innovation system.

3.3. Meeting structural challenges

The policy mix in Poland seems to adequately address the needs for transformation of the PROs and PHEIs, but falls short of the necessary support for innovative business enterprises. However, this has already been identified by government institutions, and policy planning and programming of support measures took into account the need to stimulate the innovativeness of the private sector. Table lists five previously identified structural challenges in the Polish RDI system, with policy measures adopted in order to address each of these challenges.

Table 4. Policy measures addressing structural challenges in Poland.

Challenges	Policy measures/actions addressing the challenge [3]	Assessment in terms of appropriateness, efficiency and effectiveness
(1) Low levels of business investment in R&D and in-house technological innovation	• Observed changes in policy focus from innovation absorption to R&D support, demonstrated in SIEG, PRP and POIR • New project grant schemes by NCBiR, increasing the share of private investments • POIR with substantial budget for applied R&D by business enterprises, inducing co-funding • Plans to offer tax incentives to R&D performers, which will be elaborated in 2014	Recent funding programs by NCBiR induced substantial new investments in R&D by business enterprises: €88.1m in 2011 and €306.3m in 2012 (MNiSW, 2013a: 5). POIR is likely to successfully promote the increased innovativeness due to better-targeted interventions, and growing importance of R&D as evidenced by public discourse. NCBiR, the agency appointed to co-ordinate R&D funding in POIR, was awarded the title of 'the innovator of the year' by a major Polish business newspaper, which demonstrates the growing confidence of industry in the transformation ahead. Detailed proposal for future R&D tax breaks not presented yet.
(2) Limited synergies between the science and industry, restricting the innovative potential of the economy	• Co-operative research grants from NCBiR and public support for joint participation in Horizon 2020 • Most of POIR funding for R&D includes preferences for business-industry consortia • Evaluation of PROs and PHEIs depends among others on documented technology transfers to industry and co-operative projects • New institutional solutions, supporting the establishment of special purpose companies by PHEIs and scientific and industrial centres by PROs • Draft amendments to the Act on	Challenge addressed in the recent science and higher education reform, but results are yet to be seen. Business companies participate jointly with scientists in multiple funding programs by NCBiR, PHEIs and PROs have first successes in commercializing academic inventions, and the worlds of science and industry have slowly started discovering each other in Poland. The new R&D funding regime, introduced by POIR, will likely intensify the co-operation and motivate scientists to proactively embrace the technology market.

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

Challenges	Policy measures/actions addressing the challenge [3]	Assessment in terms of appropriateness, efficiency and effectiveness
	higher education, assigning the scientists IPRs to academic inventions to facilitate their co-operation with industry	
(3) A need to concentrate financial resources on key strategic areas and RDI priorities	• KPB perceived as list of R&D priorities by the government in the pre-2014 period • Strategic research programs by NCBiR Council, matching KPB priorities and focusing support on selected technology areas • Smart specialization strategies of Polish regions and on the national level (KIS) • POIR and RPOs will fund projects consistent with national or regional specialisations (formal requirement for project selection)	Low levels of specialisation in the Polish innovation system pre-2014. Strong prioritization in KIS, expected to focus future R&D funding on technological areas identified as key for the Polish economy. The support measures in POIR and RPOs are undifferentiated as long as projects concern one of identified specialisations: compliance with a given regional or national specialisation is merely regarded as funding eligibility criterion.
(4) Increasing internationalization and attractiveness of RDI system	• Multiple support instruments, stimulating international co-operation in R&D (MNiSW, PARP) and planned further support in POIR • Institutional reform of science and higher education facilitated the employment of foreigners without Polish academic degrees and titles • PAIZ attracting foreign investors, with recent focus on R&D-related investments • Foreign investors, establishing subsidiaries in Poland, can benefit from all policy measures	Poland is not an attractive destination for experienced foreign researchers, doctoral students and postdocs, due to institutional barriers for non-Polish citizens and low income level in the science sector. FDIs gradually shifting focus from production and service facilities to R&D. Poland perceived as one of top future R&D destinations by international companies according to the 2013 EU Survey on Industrial R&D Investment Trends.
(5) Inducing knowledge spill-overs from foreign direct investments	• Proposed amendments to the legislations establishing Special Economic Zones, ensuring their continued operations	Many foreign investors are not adequately embedded within the national system of innovations, and past policies designed to attract FDIs focused on the creation of new jobs, while government commitments towards the investors are long-term and thus difficult to modify; lack of relevant instruments such as requirements for local content or local partnerships.

The overview presented in Table 4 reveals that most structural challenges have been addressed by the new policy instruments and government initiatives in 2013. There have been important, positive changes in RDI policies in Poland in the last year, supplementing the reform of science and higher education from 2010-2011 and adequately addressing the business enterprise sector as funders and performers of R&D.

Successful coping with the structural challenge (1) depends on the implementation of announced instruments, including tax exemptions and loans used to complement R&D subsidies. The

implementation of R&D-related tax incentives seems likely in the coming years due to the intensified efforts of the Ministry of Economy and advanced intergovernmental consultations, and would be highly beneficial for the national innovation system, as Poland remains one of not many countries in the EU not offering R&D tax breaks. Limited synergies between science and industry (challenge 2) call for a significant change in perceptions and attitudes among participants of the national system of innovations. Even though the recent institutional reform of science and higher education introduced measures, encouraging scientists to initiate co-operation with business enterprises, many companies did not appreciate the potential benefits, or were cautious when dealing with PROs and PHEIs in light of earlier, disappointing experiences (comp. Bąk, Kulawczuk, 2009). This is gradually changing, with new R&D funding programs bringing the two groups closer to each other. Starting from 2014 (POIR), the funding for applied R&D will be available to business enterprises or consortia of business and scientific organisations, and project selection criteria are expected to further stimulate the co-operation.

Challenge (3) is related to the imperfect prioritization in RDI policies, with most of the funding being generic not thematic. Policy documents, outlining priorities for R&D activities, used to be too general and did not offer sufficient guidance to organizations carrying out research and commercializing its results. However, the planning efforts in 2013, related to the ex-ante conditionality of the EU Structural Funds, contributed to the definition of national and regional smart specialization policies, which are more concrete and clearly linked to the future RDI support framework. In many POIR and RPOs support measures, funding will be concentrated on areas of specialisation, identified in the above-mentioned policy documents. This is positive as it will increase the currently low specialisation in the Polish innovation system, but unfortunately these specialisations are regarded mostly as priorities or funding eligibility criteria (i.e. projects concerning the identified topics can apply for funding), without differentiating support measures for individual specialisations (while nurturing some of them might require diverse actions, sometimes more focused on technology development, while at other times – more successful technology exploitation).

Internationalization and attractiveness of RDI system (4) remain important themes for public interventions, but Poland is not attractive for experienced foreign researchers, doctoral students and postdocs. In spite of recent legal changes, local traditions still prevent foreigners from pursuing scientific careers in Poland. Besides, income levels in R&D sector are significantly lower than in many other EU countries, so the internationalization and mobility of the Polish RDI system mean rather emigration of the best Polish specialists than attracting foreigners. Interestingly, the limitations can actually be turned into an important advantage for Poland, as evidenced by results of "the 2013 EU Survey on Industrial R&D Investment Trends", in which international investors regarded Poland as the 4th most attractive R&D location within the EU after Germany, France and the UK, and outside of the EU, only US, China and India were attracting more interest (JRC-IPTS, 2013: 18). Even though most of the surveyed investors did not yet setup activities in Poland, they were considering the move and declared that the factors motivating to establish R&D activities in Poland were: labour costs in R&D sector, quantity and quality of R&D personnel (JRC-IPTS, 2013: 22). The government agency PAIZ changed its focus in 2013, more actively working on foreign investments in R&D, as opposed to the past interest in creating new workplaces.

Challenge (5), related to spill-overs from FDIs, cannot be linked to any dedicated measures. Foreign investors tend to be attracted by the low income levels, locating in Poland manufacturing, service and R&D operations. PAIZ attracted more knowledge-based projects, including R&D centres in the recent year, but there are no dedicated policy measures, which could facilitate these efforts. Governmental institutions in Poland interpret European legislation in ways, which prevent them from introducing local content requirements or encourage foreign investors to become more actively embedded in the networks on regional or national levels.

Unfortunately, in many cases this leads to the use of local knowledge resources and skilled researchers by international companies, without visible spill-over effects for the economy, and the phenomenon became a popular theme of policy criticism in Polish political and economic media, fuelling some anti-EU sentiments.

4 NATIONAL PROGRESS IN INNOVATION UNION KEY POLICY ACTIONS[4]

4.1. Strengthening the knowledge base and reducing fragmentation

Promoting excellence in education and skills development

R&D personnel in Poland accounted in 2011 for 0.48% of the labour force (EU-27: 1.07%)(Eurostat, 2013). Unemployment of trained specialists (human resources for science and technology, HRST) is relatively low at 4.4% in 2012 (similar to EU-27), but has gradually been increasing since 2008, when it was only 2.7% (Eurostat, 2013). Poland experiences an outflow of specialists: in 2009, 260,000 of HRST holding Polish citizenship were residing in other EU countries, making Poland the 4th largest supplier of skilled workforce after Germany, Italy and the UK. Within the entire EU-27, Polish specialists residing abroad accounted for 9.8% of all HRST migrating between the member states (Eurostat, 2013).

Graduates of S&T studies might feel uncertain about job prospects in Poland, as only 2.0% of doctorate holders in engineering and technology continue working as researchers, and 12.64% of them were unemployed in 2009, while 70.26% of them have already stayed abroad (Eurostat, 2013). At the same time, shares of doctorate holders below their qualification for years 1990-2006 in Poland were: 4.2% for doctorate holders in jobs not related to their doctoral degree and 2.5% for doctorate holders in occupations other than professional and managerial, being much better than for most other EU countries (Auriol, 2010: 14). Doctoral students receive relatively small government scholarships, insufficient for financial support during their Ph.D. research, and tend to complain about the limited availability of research grants. Critics suggest that the new generation of Polish researchers mimic some of negative inclinations of their predecessors and thus prevent positive transformations in the sector. In 2009, almost half of researchers at the PHEIs had been employed by the same institution for more than 10 years (Deloitte, 2012b: 53), and over a half had open-ended (tenure) employment contracts (Deloitte, 2012b: 76). Since that time, the Polish science sector has gradually been transformed towards a greater openness and a merit-based employment. Universities started re-modelling their curricula based on the learning outcomes approach and involvement of external stakeholders, mandated by the law and expected to further improve the quality of higher education. The reform from 2011 introduced also obligatory IPR management classes for all university students.

Modalities and procedures for doctoral studies in Poland went changed in 2011, and doctoral studies need to have formally adopted programs, with learning outcomes defined for specific study modules, and adequate quality assurance procedures. The newly defined criteria for obligatory, external accreditation of study programs include: research performance, teaching and research infrastructure, co-operation with business, use of inputs from employers when defining learning outcomes, existence of teaching quality assurance system, existence of study program with defined learning outcomes and methods for verifying their achievement.

In 2011, law amendments increased the transparency of procedures for the award of doctoral and post-doctoral (*habilitation*, "*dr hab.*") degrees and professor's titles. Job offers at PHEIs and PROs are published online on websites of the employing institution, the Ministry of Science and Higher Education and the EURAXESS portal. Share of research posts advertised on the

[4] The chapter is based on an earlier analysis, presented in: Klincewicz (2013).

EURAXESS Jobs portal per thousand researchers in public sector in 2011 was 2.5% compared with the EU-27 average of 24.4% (Deloitte, 2012b: 51), but it rather reflects the limited number of new job openings than unwillingness to publish the job offers.

The science and higher education reform from 2010-2011 encouraged open, competitive recruitment of researchers and fixed-term employment contracts with regular performance reviews. Declarations of endorsement of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers were issued among others by the Conference of Rectors of Academic Schools in Poland (KRASP), the Polish Academy of Sciences and the Foundation for Polish Science (FNP). The Act on higher education (including amendments from 2011) introduced numerous regulations, which are consistent with the Charter & Code, strengthening the HR policies of higher education institutions and empowering their employees. Researchers working for public research institutes benefit from corresponding regulations, defined by the Act on the Polish Academy of Sciences (2010) and the Act on research institutes (2010). Career tracks in scientific organizations are defined by hard laws, with precisely defined criteria for promotion and award of scientific degrees and titles. Employment terms and conditions are defined by law and organizational bylaws, which are set in cooperation with labour unions. National laws, fellowships and research grant frameworks implement the principles of merit-based support for skilled researchers. Even though the endorsement for the Charter & Code and acceptance for general directions related to the HR Strategy for Researchers are wide-spread in Poland, most organizations do not define own, formal HR strategies, carry out self-assessments or prepare action plans.

It is worth noting that in the National Reform Programme 2013, the government referred to the necessary "*upskilling of Polish R&D sector staff, including also the employees of companies carrying out activities in the field of R&D*" (RM, 2013b: 20).

Research infrastructures

Polish R&D sector benefited from significant public investments in the development of RIs in Poland. The Act on principles of science financing (2010) established open competitive calls for large R&D infrastructure investments, and subsequent ordinances of the Minister of Science and Higher Education earmarked parts of science budget for RIs, defined investment criteria, selection modes involving peer-reviews, and opened up the competitions to business enterprises as well. In 2011, the Ministry published the Polish Roadmap of Research Infrastructure (PMDIB), compliant with ESFRI standards and including 33 investment projects, selected in a nation-wide competition, which are considered unique, key for specific R&D projects. PMDIB consolidates the scientific potential, stimulates rational decision making about investments, encouraging cooperation and joint use of the funded RIs by multiple research organizations. Inclusion in PMDIB was set as a pre-condition for future funding from the EU Structural Funds for large infrastructure. In 2013, a call for updates to the Roadmap was announced. In years 2007-2013, multiple support measures based on the EU Structural Funds helped finance the R&D infrastructure investments, both on the national and regional levels. Infrastructure can also be funded as part of R&D projects, using funds distributed by the government agencies NCN and NCBiR. The Ministry published an online map of 2228 existing research infrastructure investments in the Polish science sector, which is searchable based on RIs project names, keywords and fields of research, thus facilitating the identification of the required RIs (www.nauka.gov.pl/nauka/inwestycje-w-obszarze-nauki-i-szkolnictwa-wyzszego). In the future operational program POIR, dedicated funding for RI projects linked to PMDIB is included, and its importance is also emphasised in the highest-level innovation policy document SIEG. Future focus on RIs investments is gradually shifting towards the optimal use of the existing infrastructure, and enhancing support for projects capitalizing on the existing investments, often in cooperation with business enterprises. The Ministry of Science and Higher Education continues the development of an online system POLON, which will publish detailed information

about scientific organizations, including the availability of research infrastructures (with dedicated registers of infrastructure, laboratories and research instruments).

The scale of research infrastructure investments in Poland is impressive and many scientific organizations benefit from specialist equipment, facilitating ambitious research initiatives. At the same time, the infrastructure is still being under-utilized, but the future focus on funding R&D projects based on the RIs might increase the applications. The investments covered from the EU Structural Funds are also associated with irrational fears of many researchers, misunderstanding the funding rules and mistakenly believing that the RIs cannot be used for cooperation with business partners or applied research projects. NCBiR addressed the apprehensions by recently publishing relevant, legal interpretations.

The Act on foreigners (2003, including amendments from 2011) paved the way for granting access to the RIs to foreign researchers, participating in R&D projects, including simplified visa procedures in specific cases. Cross-border access to RIs is facilitated by the legal framework, related to IPRs in publicly funded R&D projects - in most cases, the rights are owned by research performers not the public institutions. The Ministry of Infrastructure and Development defined the principles of cost eligibility in Operational Program "Innovative Economy", 2007-2013, which is the main source of RIs investments, based on the EU Structural Funds. The rules establish the possibility of using results of the co-funded projects for revenue-generating purposes, with revenues deducted from the public project funding. While many researchers regard the rule as unwelcome restrictions on the use of the RIs, legal definition assures clarity when beneficiaries use the RIs in commercial projects, or projects with foreign partners. Some research institutions have facility-level policies, enabling the access to RIs (e.g. computational grants at the University of Warsaw, offered to interested external scientists on a competitive basis), but such approaches are not popular yet. The existing legal framework does not prevent foreign researchers from using the RIs in Poland, but at the same time, the number of measures promoting and supporting the use of infrastructure is very limited. At this stage of R&D system development, the motivation to share results of RI investments with non-residents seems to be relatively low, with the exception of R&D projects, which could directly benefit the host institution.

4.2. Getting good ideas to market

Improving access to finance

Poland offers a comprehensive portfolio of measures, funding R&I efforts. The available instruments concern a broad range of technologies, including both generic and targeted instruments, and NCBiR regularly identifies and fills thematic funding gaps. Importantly, most R&D funding programs are not restricted to PHEIs and PROs, but also available to business enterprises, supplementing dedicated instruments for companies. The existing measures focus on subsidies, with only minor role played by other financial instruments, but this will most likely change in the 2014-2020 perspective. Private investors in innovative ventures can also benefit from public support, including VCs, business angels and technology incubators. The support is channelled through subsidies, with beneficiaries selected in open competitions, while there are no relevant tax exemptions for R&D funders. Moreover, R&D performers can neither benefit from tax breaks (exemption is a tax exemption for registered R&D centres, with restrictive eligibility criteria and thus used by a very small number of organisations). Policy documents including PRP and POIR intend to shift the balance from subsidies towards other support measures.

Users of innovations can also benefit from targeted subsidies, concerning selected areas such as certain renewable energy sources, energy efficiency or medical products, and companies

implementing innovative technologies can have parts of the costs deducted from their corporate income taxes.

SMEs enjoy specific support measures, including co-funding for technology development, IPR protection and international sales activities. Some of these measures are being gradually refined, especially when new cost categories are identified as eligible and important (e.g. in IPR protection support, funding international patenting will be supplemented by freedom-to-operate analyses from 2014). In 2013, several government institutions carried out evaluations intended to reduce the bureaucratic burden of project applicants and streamline the processes. Many of the existing instruments undergo regular, on-going evaluations, but international benchmarking exercises are rare. In recent years, two government agencies PARP and NCBiR supplement each other with R&I-oriented support measures, and this promotes continuous improvements within the entire system.

Protect and enhance the value of intellectual property and boosting creativity

The existing regulatory framework, supporting the intellectual property rights, offers robust protection on the national level, but in 2013, the Polish Patent Office carried out an extensive evaluation of the patenting procedures and opinion survey of SMEs, attempting to improve the internal organisation and raise the numbers of patent applications by business enterprises. R&D partnerships between private and public organizations were actively promoted during the recent science and higher education reform. Traditionally, the ownership of academic patents is controlled by the employer, thus facilitating the knowledge transfers. There is a strong support for public-private partnerships in R&D area, including the possibility of commercializing publicly funded research-results, encouragement for establishment of academic spin-offs and measurement of performance in commercial knowledge transfer (including licensing and sale of IPRs) as part of institutional assessments of R&D organizations. The Act on principles of science financing (2010) facilitated funding for joint initiatives between scientific organizations and business enterprises, especially the formation of research consortia. The Act on higher education (including amendments from 2011) encouraged public higher education institutes to co-operate with business enterprises and obliged universities to form special purpose companies, dealing with technology transfer, and to define bylaws regulating IPR management. Act on National Research & Development Centre (NCBiR) (2010) facilitated access to public funds for applied R&D granted to business enterprises, also based on consortium agreements with scientific organizations, and confirmed that IPRs to publicly funded inventions rest with the creators. Specific grant programs of NCBiR play an important role in bringing together business and science, as in many cases research consortia have better chances to be awarded the funding. The Ministry of Science and Higher Education published also guidebooks, helping understand the legal and economic aspects of research commercialization.

However, an amendment to the Act on higher education, proposed by the government in 2013, significantly affects the existing IPR regime, as researchers employed by PHEIs are expected to retain rights to their inventions, with the employing institutions entitled to a share of future commercialisation profits. This amendment might increase the motivation to commercialise results of scientific research and facilitate technology transfers by removing the PHEI inventions from the realm of public finance and releasing the relevant transactions from many legal restrictions. Besides, dedicated financing programs promote patenting by SMEs and scientific institutions and offer co-funding for commercialisation of academic inventions. Based on an analysis of economic impact assessment, the Polish government decided against joining the unitary patent system and did not sign the agreement on a unified patent court.

Since IPRs are assigned to the R&D performers, transfers and commercialization are facilitated, but at the same time, the measures make the publicly funded knowledge and innovations

proprietary. Open access projects are relatively small scale, and the necessary legal framework has not been established yet. The problem of restrictions on access to knowledge and multimedia contents gained particular prominence due to the very visible protests against the ACTA agreement in early 2012. Access to public information is facilitated through formal legal procedures, which oblige public administration (including PHEIs and PROs) to share the information and data in response to individual requests. In order to facilitate the procedures and aggregate all relevant data on a widely available Internet platform, the Ministry of Administration and Digitization is working on an act, which would grant open access to all publicly-funded research findings.

Public procurement

Polish PHEIs and PROs obliged to comply with public procurement regulations complain about the imposed limitations as restricting their innovativeness. In August 2013, the government proposed and in February 2014, adopted amendments to the Act on public procurement, addressing the specific cases of purchasing services related to scientific research, development projects and research services. The maximum cap for releasing such orders from the public procurement regulations was increased from €14k to €30k. In addition, orders for R&D work, not intended to be directly used for commercial manufacturing purposes, can now be arranged through single source procurement ("*zamówienie z wolnej ręki*"), and procurement results could be nullified if the purchasing organisation fails to secure the needed, external funding for its R&D project. The amendments seem to adequately address the previous concerns of the research community and facilitate the science-industry co-operation.

Another identified challenge is the reluctance of the Polish public administration towards the use of pre-commercial procurement (PCP), i.e. products and services, which do not yet exist and require intensive R&D efforts upon the selection of suppliers, with the involvement of clients and iterative definition and modification of specific requirements. The reluctance might be linked to feared legal complications and preferences for the traditional public procurement scenario. At the same time, PCP seems particularly suitable for projects, supposed to address socio-economic challenges, for which no ready-to-use solutions exist. In July 2013, NCBiR launched a pilot project supporting the use of PCP, with an open call collecting proposals for socio-economic challenges, which could subsequently we addressed in a broad PCP process, with a 50m PLN budget. The project is intended to demonstrate the feasibility of PCP within the Polish legal framework and encourage other institutions to follow this example.

4.3. Working in partnership to address societal challenges

R&D priority areas, defined by the high-level policy document KPB, coincide with the grand challenges of the common research agendas. JOREP (Joint and Open REsearch Programs) report revealed that the Polish participation in European initiatives was wider than the involvement in bilateral initiatives (JOREP, 2012: 20), but the national budget allocated was significantly higher for bilateral projects (50%) than for European initiatives (19%) (JOREP, 2012: 21). In recent years, R&D funding agencies NCN and NCBiR play active roles in managing the Polish participation in various initiatives, with funds earmarked for beneficiaries from Poland. Transnational co-operation plays an increasingly important role in the national science system, with the government offering co-funding for Polish participation in international initiatives, relying on results of evaluations of research proposals in international programs and defining the national research infrastructure roadmap in line with the European efforts.

The support for Polish involvement in international initiatives is high on the government agenda, and especially NCBiR is very active in launching new co-funding streams. Poland actively

participates in several European Innovation Partnerships, and the national involvement is co-ordinated through relevant units in Ministries of Health and Economy, and a representative of Poland is one of 7 members of the expert group evaluating the performance of EIPs.

4.4. Maximising social and territorial cohesion

Polish policy documents SIEG and KPB identify the need for smart specialization, and the draft National Smart Specialisations (KIS) was presented for public consultations in October 2013. The results of technological foresight "*Insight 2030*" yielded an impressive list of 127 priority technologies, and the Ministry of Economy proposed a more focused approach, with KIS including only 16 selected areas, which were identified though a comprehensive, evidence-based analysis, taking into account KPB, "*Insight 2030*" and themes of previously funded R&D projects.

Much more progress can be observed on regional level, as all 16 Polish regions identified regional smart specialisations and prepared the relevant strategic documents, which were a pre-condition for submitting the Regional Operational Programs for distributing the EU Structural Funds in 2014-2020. The regional S3 documents vary in contents. Some regions selected only general development directions, and there are overlaps in areas of interest, thus reducing interregional differentiation. The government tasked experts from the World Bank with an evaluation of the regional S3 efforts, and the outcomes might support future planning on the national level and a better co-ordination of regional S3s.

S3 on national and regional levels will define future distribution directions of the EU Structural Funds, so the plans will have tremendous importance for R&D performers. Especially on the national level, KIS will be the first document encouraging more focused R&D efforts, but the upcoming social consultations of KSIS might water-down the initial proposal.

4.5. International scientific cooperation

In 2011, public and private R&D organizations in Poland were employing only 1,194 foreigners (1.4% of all R&D employees), but the number increased since 2010 by impressive 11.6% (GUS, 2013a: 73). Only two PHEIs from Poland are included in the Academic Ranking of World Universities, positioned relatively low on the list. Polish researchers actively collaborate with their foreign counterparts, with 29.18% of Polish publications co-authored with international partners (SCImago, 2012), but in many cases, the Poles were not the first authors of scientific articles or the leading partners in research projects. Polish researchers maintain limited collaborative ties to the US R&D organisations, publishing, patenting or forming R&D consortia more frequently with colleagues from Western Europe (EC DGRI, 2011: 187-190). Poland was not listed by foreign researchers with doctorate as one of top destinations for academic mobility, 1996-2006 (Auriol, 2010: 29), but the existing grant or fellowship programs for foreigners gradually improve the perceptions.

Poland participates in the EU Scientific Visa package and through EURAXESS portal, actively promotes research opportunities in Poland and maintains a network of service points for foreign researchers. Researchers with good career records within foreign research systems can be awarded the title of professor without the need to satisfy the formal requirements of holding a Polish post-doctoral degree, and foreign academic degrees and titles from countries-members of the Lisbon Recognition Convention are recognised through simplified modalities. The actual employment barriers relate to limited motivation of R&D institutions to employ foreigners, uncompetitive salary levels and need to speak Polish language in order to successfully perform certain research tasks. Poland attracts significantly less doctoral students from other continents than the EU average (EC DGEI, 2013: 71).

5 NATIONAL PROGRESS TOWARDS REALISATION OF ERA

5.1. More effective national research systems

The recent science and higher education reform increased the importance of competitive funding for R&D. According to the 2012 science budget, 63.61% of the budget were distributed through competitions, and the institutional funding (32.94%) was allocated based on the results of scientific evaluation. Funds for basic research (11.95% of the science budget in 2012) are distributed by means of open, nation-wide competitions, managed by NCN, based on the bottom-up approach: applicants are free to define their preferred research topics without a need to address any pre-selected research themes, but should select one of 25 review panels, representing scientific disciplines. NCN has dedicated programs for young scientists, and accepts also applications from researchers not currently employed by scientific institutions or working for the industry. Applied research funding was distributed by NCBiR (42.30% of the science budget in 2012) by means of multiple programs with broad thematic focus, linked to the National Research Program (KPB), as well as competitions in which applicants can independently select their research areas. NCBiR supports both academia and industry, and some programs require the formation of consortia between business and scientific institutions, or involvement of specialist companies tasked with commercialization of the research results. Program LIDER supports young researchers, offering them up to €478k for projects, intended to generate innovative technological solutions and establish new research teams. MNiSW issues open calls for proposals for other funding streams – investments in research infrastructure through the Polish Roadmap for Research Infrastructures (PMDIB), funds for science promotion and international research co-operation. Institutional funding is also distributed based on competitive criteria, linked to the results of institutional evaluation, conducted by a dedicated committee KEJN, using transparent criteria, including bibliometric indicators.

Calls for proposals organised by NCBiR and NCN require applicants to submit research proposals in English and Polish (with the exception of selected basic research disciplines, including humanities). All applications are reviewed using standard peer-review principles, and discrepancies between individual reviews of the same application are additionally investigated. In many competitions, the applications are reviewed by foreign scientists, but the practice is restricted to the most significant calls for proposal due to the scale of operations. In 2011, MNiSW, NCN and NCBiR reviewed altogether 18,406 project proposals, and in 2012 – 16,102 proposals (MNiSW, 2013: 31). In particular, International reviewers are involved in the selection of R&D projects for the most experienced researchers, large research infrastructure investments and selection of the leading academic institutions (KNOWs). NCBiR co-operates also with international VC funds in one of its funding programs, ensuring that the selected projects are not only scientifically sound but also have commercialisation potential in global markets. In 2013, NCN increased the transparency of project proposal evaluation procedures by making public the names of experts – members of evaluation panels.

It is worth noting, that the transformation of the R&D funding system in the recent years yielded impressive results, promoting the openness and transparency, encouraging international competitiveness of research, and increasing the number of researchers benefiting from public funding.

5.2. Optimal transnational co-operation and competition

The transformation in the Polish science sector involved increased international exposure, with project applications prepared partly in English, possibility of involving foreign reviewers, use of bibliometric indicators related to international co-operation and additional funding facilitating the involvement of Polish researchers in transnational research consortia. Policy documents value the importance of international competition in research areas, and many funding programs by NCBiR intend to increase the competitiveness of carefully selected, world class research initiatives. Regardless of the efforts, the involvement of Polish researchers in international initiatives is still limited when compared with their counterparts from Western European countries, especially when measured by FP7 participation, counts of joint scientific publications with foreign partners or joint transnational patents. The science budget includes dedicated funding streams for transnational R&D projects, but they are mostly intended to subsidize the participation of Polish research teams.

The National Research Program (KPB) covers topics, congruent with most of the grand challenges, covered by the ERA priority 2, but they are mostly being addressed by national research projects. There are e.g. earmarked funds for research related to lifestyle diseases, low-carbon and environmental technologies and ICT. The R&D priorities were defined thanks to foresight programs and the practice of mid-term and ex post evaluations became very common in the recent years. The Polish Roadmap for Research Infrastructures (PMDIB) guides the efforts to develop the national and regional RI in line with the ESFRI (European Strategic Forum on Research Infrastructures) framework.

The new funding program POIR, distributing the EU Structural Funds for 2014-2020, includes instruments targeting grand challenges, supporting the development of international research agendas, promoting the internationalization of science and facilitating external access to publicly-funded RI. The specific support measures, included in POIR, were prepared taking into account ERA Priority 2 and the first tangible results of these efforts are to be seen in 2014.

5.3. An open labour market for researchers

The legislation changes, accompanying the science and higher education reform, made it easier for Polish and foreign researchers to study and work in Poland.

Openness on the local level means introduction of publicly announced competitions for any new position at PROs and PHEIs, with MNiSW aggregating all job offers on its website. Academic careers are determined by the recently introduced legislations, with clear and transparent conditions for promotions and required timespans for progressing between specific career stages. Some funding programs additionally promote the mobility of researchers by encouraging to conduct R&D projects in organisations different than the home institution. The international mobility of Polish researchers is also close to the EU average (EC DGRI, 2011: 276).

Poland maintains multiple EURAXESS service centres and a website (www.euraxess.pl), offering support for incoming foreign researchers. The website lists job vacancies, as well as information about available research grants and fellowships. Apart from Marie Curie grants, programs available to foreigners are limited and focused on researchers from Central and Eastern Europe, Caucasus and Central Asia. Professor positions in Poland are now available to persons without Polish post-doctoral degrees (*habilitation*, "*dr hab.*" degree), providing that they can demonstrate substantial experiences in managing team research projects. Studies can be conducted in foreign languages and research theses can be prepared and defended in English. Unfortunately, research careers in Poland do not seem attractive when compared with opportunities abroad. Salaries of researchers in PROs and PHEIs are regulated by the government, stipulating maximum

remuneration, which remains relatively low. In addition, R&D funding agencies NCN and NCBiR introduced recommendations for maximum remuneration levels in the funded projects, and the levels might discourage the participation of foreign specialists.

5.4. Gender equality and gender mainstreaming in research

Polish research system is inclusive from the perspective of gender, and the equal treatment of both genders is culturally rooted in the old, socialist tradition of equal access to jobs. There are no publicly known targets, related to gender parity and required representation of women in scientific committees, but the share of women in R&D sector (40%) is significantly higher than the EU-27 average (32%) (EC DGRI 2012: 230), and there are more women than men students and higher education graduates. Nevertheless, women account for a minority in business enterprises R&D positions, as well as S&E students and researchers. MNiSW organizes annual competitions for female S&E students, in co-operation with one of female magazines, and sets examples of successful female researchers in various promotional materials.

5.5. Optimal circulation, access to and transfer of scientific knowledge including via digital ERA

MNiSW offers extensive support for the circulation of knowledge linked to the mobility of researchers, and multiple policy instruments stimulate the involvement of Polish researchers in projects led by foreign institutions. With regard to codified knowledge, the government has been focusing on the assignment of IPRs to the R&D performers, facilitating transfers and commercialization, but also making the knowledge and innovations proprietary. MNiSW and other government institutions funded small-scale projects, testing the possibilities of granting open access to specific publications. A recent law amendment stipulates however that the IPRs to academic inventions will belong to the scientists not their employers, and this is likely to intensify the science-industry collaboration, but also facilitate more openness if this is the scenario preferred by the creators. Another step towards the openness is the legal requirement to publish online contents of PhD theses. The issue of unrestricted access to knowledge and content gained particular prominence due to the very visible protests against the ACTA agreement in early 2012. Access to public information is facilitated through formal legal procedures, which oblige public administration (including PHEIs and PROs) to share the information and data in response to individual requests. In order to facilitate the procedures and aggregate all relevant data on a widely available Internet platform, the Ministry of Administration and Digitisation is working on a bill, granting open access to publicly-funded research findings.

ANNEX 1. PERFORMANCE THE NATIONAL AND REGIONAL RESEARCH AND INNOVATION SYSTEM

Feature	Assessment	Latest developments
1. Importance of the research and innovation policy	(+) RDI policies are embedded in the national policy framework, which is comprehensive, coherent and integrated, with the top-level document National Development Strategy from 2012, SIEG as one of 9 domain strategies (addressing directly innovativeness and competitiveness of the economy), PRP as implementation program related to business enterprises, and POIR as the framework governing the future distribution of the EU Structural Funds (+) RDI challenges are addressed on multiple levels, with complementary policies related to education, product and service markets, financial and labour markets, entrepreneurship, spatial planning and infrastructure, all of which have the potential of further strengthening the innovativeness and R&D activities (+) Targeted policy initiatives, addressing major societal challenges by means of R&D, offered by NCBiR (government agency co-ordinating the funding for applied R&D activities) and complementary activities, related to the diffusion of relevant innovations, enacted by PAPR and the KSU network(-) The relevant policies had been forged through a complex and difficult process of inter-governmental consultations, with several ministries / government agencies attempting to have stronger influence over the RDI policy setting process, so the current system resulted from a consensus, which does not satisfy some of the agencies and is likely to be revised whenever an opportunity arises, due to government changes (-) The RDI policy framework has only recently been established and since many elements are novel in the Polish context, it will take some time to fully enact the policies, especially as many planned actions are linked to the 2014-2020 financial perspective	(+) The importance of RDI emphasized by public policies in 2012-2013, particularly with reference to the planning for EU Structural Funds, 2014-2020 (+) Important elements of the strategic policy framework – SIEG, PRP, POIR – established in 2012-2013 (+) Government agency tasked with applied R&D funding (NCBiR) has dedicated budgets for programs related to major societal challenges and co-funds participation of Polish researchers in relevant, trans-national initiatives (+) Specific share of R&D budget from the EU Structural Funds in Poland earmarked for climate change-related projects
2. Design and implementation of research and innovation policies	(+) RDI policies based on a multi-annual strategy with assigned budgets (both from the state budget and the EU Structural Funds) (+) The funding for RDI was not reduced in spite of the economic downturn of the recent years (with only minor adjustment in the middle of 2013), thus ensuring predictability of funding (+) RDI policies have been drafted and improved through broad social consultation process, involving relevant, non-governmental stakeholders (+) RDI policies include an integrated, hierarchically structured system of objectives/priorities, the number of priorities is limited to facilitate the implementation of the policies and corresponds to the EU priorities in RDI	(+) Multi-annual strategy (SIEG) adopted in 2013, and key policy planning documents (PRP, POIR, KIS) drafted the same year (+) Extensive stakeholder consultations for each of the policy documents, with particularly broad process for POIR (Operational Program for EU Structural Funds), leading to changes in public perceptions of the importance of innovations for the competitiveness of

Feature	Assessment	Latest developments
	(+) Active use of progress monitoring by using output indicators, ex-ante and ex-post evaluations (+) Implementation of smart specialisation strategies on the national and regional levels in 2013-2014 (+) Use of joint-programming opportunities by co-funding participation of Polish researchers in trans-national projects, and plans to further expand it in the 2014-2020 perspective (including plans to benefit from complementarities and synergies between national instruments and Horizon 2020) (-) RDI policies are steered by several ministries / government agencies; in the recent years, the rivalry between them supported continuous improvement, but it could also potentially be damaging in the future (-) Smart specialisation strategies are focused on prioritisation (i.e. selection of specialisations), without differentiating policy interventions for the identified specialisations to further increase their effectiveness	the national economy (+) Stability of RDI budgeting process and availability of funding not restricted in spite of economic downturn in 2013 (+) Many evaluations and benchmarking exercises related to RDI policies carried out in 2011-2013 in order to crease evidence-based policies (+) Policy monitoring system "STRATEG" established to regularly collect and make available indicators supporting policies, including in the RDI area
3. Innovation policy	(+) Innovation-related policies promote not only technological innovations, but also innovations in a broader sense (also organisational and marketing innovations, innovations in service sector, eco-innovations) – demonstrated in particular by activities of PARP, the government agency supporting business enterprises, and NCBiR, the applied R&D funding agency (+) Stimulation of open innovations recognized as important policy direction, both in SIEG, PRP and POIR (with dedicated support instruments and funding) (-) Supply and demand-side policies in certain sectors are not always consistent (e.g. renewable energy sources, information technologies, pharmaceuticals)	(+) Support measures by PARP and NCBiR addressing non-technological innovations (+) Importance of non-technological innovations confirmed in policy documents (SIEG, PRP, POIR) (+) Planned support measures for open innovations for the financial perspective of 2014-2020 (POIR)
4. Intensity and predictability of the public investment in research and innovation	(+) Public investment in R&D in Poland is the EU's 7th largest in absolute terms and has been increasing in recent years (+) Significant increases in GERD and BERD in 2012 could be interpreted as positive outcomes of the 2010-2011 science reform and evidence for effectiveness of public R&D policies (+) Predictability of the public funding for innovations due to multi-annual plans and stable science budget, in 2013 strengthened by explicitly expressed R&D priorities (+) Public support instruments designed to leverage private sector investments, including public-private partnerships in joint sectoral R&D funding programs (NCBiR) (+) Use of innovative financing solutions explored by public institutions with reference to R&D, in particular: co-operation with VC funds to finance R&D ventures (NCBiR), sovereign investment fund (PIR), liaising with business angels and investment funds (PARP), supporting	(+) Multiple sectoral R&D programs launched by NCBiR in public-private partnerships with other institutions, thus increasing the private investments in R&D beyond the co-financing contributed by project applicants (+) POIR includes support measures using innovative financing solutions (not only direct subsidies), based on experiences of recent years, made by NCBiR, PARP, KFK and BGK (+) Sovereign investment fund PIR established to support large, capital-

Feature	Assessment	Latest developments
	VC targeting mature, innovative companies (KFK) and offering credits for implementation of technological innovations (BGK) (+) Corporate tax exemptions for companies acquiring technological innovations (stimulating technology transfer) (-) Lack of tax benefits for R&D performers - plans to introduce them were undergoing inter-governmental consultations by the end of 2013, no dates or scope agreed	intensive ventures (+) Intensive work on the planning of future R&D tax breaks by Ministry of Economy and Ministry of Finance – but no final design of the instrument agreed by the end of 2013
5. Excellence as a key criterion for research and education policy	(+) Science and higher education reform of 2010-2011 put strong emphasis on and incentivises the excellence in R&D, including by competitive project funding and institutional funding linked to the results of R&D evaluations (+) Public funding for R&D allocated based on clear rules, defined by legal acts, with clear rationale for using respectively competitive and institutional funding (+) Research infrastructure investment prioritized by means of a national roadmap (PMDIB), with funding planned for 2014-2020, and selection based on transparent procedures with peer-reviews analyzing the importance and excellence of the intended research projects, which would use the infrastructure, and commercialization opportunities (+) Regular evaluations of scientific institutions based on research excellence, with transparent rules and use of bibliometric indicators (+) Use of external peer-reviews for competitive project funding by R&D funding agencies NCN and NCBiR (+) Research excellence regarded as important criterion to evaluate individual researchers, with legal requirement to conduct regular assessments of a researcher's professional progress at PHEIs and PROs (+) Open recruitment procedures at PHEIs and PROs, with job offers published online on MNiSW portal, and selection procedures defined in a formal manner by individual institutions (+) Employment regulations help reconcile private and professional life at PHEIs and PROs, and share of women researchers is above the EU average (-) Limited portability of research grants across institutions in Poland –funding agreements are signed with specific organisation and cannot easily be transferred (-) No cross-border portability of Polish research grants (-) Limited transparency of recruitment procedures at PHEIs and PROs, resulting in the tendency to hire candidates identified before the recruitment started in spite of the appearance of the openness (-) PHEIs and PROs do not fully benefit from alternative sources of funding such as philanthropy and corporate investments, due to the lack of legal or tax incentives for the potential donors (-) Employment conditions at PHEIs and PROs in Poland are relatively unattractive when compared with many EU	(+) Over 60% of science budget in 2011 and 2012 distributed as competitive funding, with the share increasing further in 2013 (+) First nation-wide R&D evaluation based on new rules conducted in 2013, dividing scientific organisations into three categories and linking institutional funding to the research excellence (+) MNiSW initiated the update process of RI roadmap (PMDIB) in 2013, and secured funding for 30 large-scale RI projects for 2014-2020 (+) Fundamental research funding agency NCN improved the transparency of external peer-reviews by introducing the habit of publishing names of review panel members

Feature	Assessment	Latest developments
	countries due to low remuneration of researchers, with maximum salary levels stipulated by law, thus causing regular brain drains of some of the best researchers (-) Lack of compelling incentives, attracting leading international scientists to work in Poland	
6. Education and training systems	(+) Higher education reform of 2010-2011 improved the quality of teaching, by focusing the education on the achievement of pre-defined learning outcomes, and involving stakeholders (including business community) in the definition and oversight of study programs; the progress is verified by regular accreditation procedures, obligatory for all higher education providers (+) Funding program for "ordered study specialties" increased the supply of graduates in science and technology areas important for the economy (+) Funding for innovative study programs on graduate and postgraduate levels, as well as professional training, ensured by means of the EU Structural Funds (+) MNiSW-coordinated competitions promoting quality of teaching and innovative study designs (+) Proposed amendments to the Act on higher education from 2013, further involving stakeholders (including business enterprises) in the teaching and program design at PHEIs (-) Some PHEIs assured only formal compliance with the new legal requirements, related to the quality of teaching, without actually transforming their study programs (procedural changes not accompanied by attitude changes among lecturers) (-) Availability of additional public co-funding for selected study programs distorted the education market, and forced PHEIs to lower study requirements in order to complete the projects and receive cost reimbursements	(+) Proposed amendments to the Act on higher education strengthen relations between PHEIs and business stakeholders (+) Competitions and funding programs, supporting innovative designs of study programs and promoting the improvement of the quality of teaching
7. Partnerships between higher education institutes, research centres and businesses, at regional, national and international level	(+) Science reform from 2010-2011 established institutional framework supporting science-industry co-operation, including the formation of special purpose companies by PHEIs, academic spin-offs and consortia of business and scientific organisations (+) Dedicated funding programs, supporting commercialisation of research results, including support for university spin-off companies, technology incubators/transfer centres and establishing the profession of innovation brokers, acting as agents promoting and selling/licensing university technologies (+) Involvement of VC funds in the evaluation of and financial support for academic innovations in a targeted funding program by NCBiR (+) Funding short-term business internships for researchers, bringing them closer to business enterprises and jointly work on the development of innovations	(+) Multiple dedicated funding programs established by MNiSW, NCBiR and PARP to support science-industry partnerships (+) Introduction of funding for innovation brokers, working as agents selling/licensing university technologies (MNiSW, 2013) (+) Financial support to university spin-off companies through program SPIN-TECH (NCBiR, 2013) (+) Funding program

Feature	Assessment	Latest developments
	(+) MNiSW and PARP co-funding Polish participation in transnational initiatives, including FP7 and CIP (starting from 2014: Horizon 2020 and COSME) (+) PARP offers innovation vouchers, used by business enterprises to purchase R&D services from scientific organisations (+) Amendments to the Act on higher education, assigning the ownership of academic inventions' IPRs to their creators (scientists, not their employing institutions), proposed in 2013, are likely to further stimulate the commercialisation of academic inventions (+) The EU Structural Funds in 2014-2020 (POIR) will support the formation of science-industry consortia (funding eligibility requirement for many types of R&D projects), intensify the co-operation within strategic clusters, facilitate the commercialisation of research results and promote Polish participation in trans-national R&D programs (-) In spite of the efforts of recent years, the scale of technology transfer from science to industry is perceived as unsatisfactory (-) Employment mobility between PHEIs/PROs and private sector is not easy due to differing requirements for researchers positions	involving VC funds in evaluation and financing of R&D results by NCBiR (+) Strong focus on the formation of science-industry consortia in R&D projects, planned for the financial perspective 2014-2020 (POIR) (+) Proposed amendments to the Act on higher education, assigning IPRs to scientists at PHEIs and PROs
8. Framework conditions promote business investment in R&D, entrepreneurship and innovation	(+) Comprehensive policy framework introduced by PRP, targeting innovation and entrepreneurship (+) Availability of private funding and support, including VC funds, NewConnect market and KSU network, as well as public funding for VCs from KFK and for incubators/business angels from PARP (+) Organisational efforts to reduce administrative burdens, eliminate excessive bureaucracy and improve business environment, resulting in significant improvements in Poland's position on the World Bank's ranking of ease of doing business (+) IPRs are respected and can be enforced, while IPR protection by business enterprises could be co-funded from public sources (-) Accounting and tax regulations do not encourage investments in R&D (-) VCs and other financial institutions prefer low-risk investments instead of high-tech ventures	(+) Preparation of policy framework (PRP) in 2013 (+) Continuous incremental administrative changes to remove obstacles and facilitate the business operations (+) Plans to introduce R&D tax exemptions (+) Dedicated instruments, encouraging VCs and financial community to finance high-risk ventures, planned for the financial perspective 2014-2020 (POIR)
9. Public support to research and innovation in businesses is simple, easy to access, and high quality	(+) RDI support schemes offered by PARP, NCBiR and other public organisations clearly differentiated and targeting specific business challenges (+) RDI support measures addressing previously identified market failures – responsiveness of government agencies, particularly: PARP, NCBiR (+) Attempts to restrict bureaucracy and shorten the time to evaluate, contract and offer payments in publicly funded	(+) Support measures by NCBiR and PARP introduced in 2011-2013 to target previously identified market failures, e.g. in the area of demonstration of R&D results, implementation of patents,

Feature	Assessment	Latest developments
	projects (including NCBiR's efforts in 2013) (+) Funding schemes undergo regular evaluations at PARP, NCBiR and NCN (+) Attempts to ensure complementarity to Horizon 2020 support in the 2014-2020 financial perspective for the EU Structural Funds (POIR) (+) Support measures stimulating international co-operation and motivating Polish researchers to engage in trans-national projects in 2014-2020 perspective (POIR) (+) Young innovative companies benefit from a large number of funding opportunities, based on public funds and offered through non-public sector intermediaries (including business incubators, investment funds, business angel networks etc.) (+) Measures promoting internationalisation of young technological companies offered in 2007-2013 and 2014-2020 financial perspectives, and targeted sectoral initiatives offered by Ministry of Economy, PARP and NCBiR (-) Limited use of FP7 and CIP funding programs in Poland, and limited interest of private sector in trans-national initiatives (-) No quantitative targets set for attracting Horizon 2020 funding to business sector in Poland (-) Complaints of business enterprises concerning the bureaucracy and invasive controls of beneficiaries of EU Structural Funds - but government agencies work to improve the procedures	etc. (+) Applied R&D funding agency NCBiR significantly shortened the application evaluation procedures in 2013, and contracted World Bank to evaluate the procedures in its funding programs to increase the efficiency before the 2014-2020 EU financial perspective starts (+) Many public funding schemes were externally evaluated in 2011-2013 in order to prepare for the future EU Structural Funds programming (+) POIR includes instruments ensuring complementarity of Polish R&D funding with Horizon 2020 and plans to use criteria and evaluation procedures established on the EU level (+) POIR will include dedicated support for young innovative companies, including through business incubators and business angel networks (+) Dedicated sectoral initiatives supporting internationalisation of young technological companies offered by Ministry of Economy, PARP and NCBiR in 2012-2013, including programs involving technology accelerators in Silicon Valley and Western European countries
10. The public sector itself is a driver of innovation	(+) Many innovations introduced by public sector organisations, including innovative support instruments for RDI (+) Formal initiatives supporting the improvement of public procurement by using more qualitative criteria (including Green Public Procurement, pre-competitive procurement) (+) Reform of public procurement regulations in 2013, facilitating the performance of R&D projects at PROs and PHEIs	(+) Pilot program supporting pre-competitive public procurement (NCBiR, 2013) (+) Use of public- private partnerships to fund R&D projects (NCBiR, 2012-2013) (+) Reform of public procurement regulations,

Feature	Assessment	Latest developments
	(+) Pilot program, supporting pre-competitive procurement in public administration, launched by NCBiR (+) Public-private partnerships in R&D funding introduced as multiple institutional arrangements by NCBiR (-) Lack of incentives to use public procurement in order to promote innovations (-) Non-quantitative criteria rarely used in public tenders (in most cases, selection based on price only) (-) While some public sector organisations (or their parts) are very innovative, others tend to operate in very conservative ways, unwilling to take risks or start novel initiatives, so the overall innovativeness of the public sector is relatively low (-) Open access to publicly funded research and public data is still not adequately regulated, and the legislative draft prepared by MAIC in 2012 had no follow up in 2013	facilitating the performance of R&D projects (2013) (+) Legislative initiative launched to ensure open access to publicly owned or funded resources (MAIC, 2012), but not follow-up in 2013

ANNEX 2. NATIONAL PROGRESS ON INNOVATION UNION COMMITMENTS

	IU Commitment	Main changes	Brief assessment of progress / achievements
1	**Member State Strategies for Researchers' Training and Employment Conditions**	(+) The Charter & Code endorsed by the Conference of Rectors of Polish Universities (KRASP), the Polish Academy of Sciences (PAN) and the Foundation for Polish Science (FNP) (+) Numerous regulations in the amended Act on higher education (2011) compliant with the Charter & Code (+) HR policies of PHEIs need to be consulted with labour unions (-) Lack of active promotion or governmental incentives for the implementation of the Charter & Code and HRS4R	(+) Pro-active approach by PHEIs and PROs (+) Selected provisions implemented in national legislation in 2011 (-) Lack of government co-ordinated efforts to implement HRS4R
4	**ERA Framework**	**Covered by the ERA Communication Fiche and Annex 3**	**Covered by the ERA Communication Fiche and Annex 3**
5	**Priority European Research Infrastructures**	(+) Development of national RI roadmap (PMDIB) (+) Updates to PMDIB in 2013 (+) Securing funding for PMDIB projects from the EU Structural Funds, 2014-2020 (POIR)	(+) Active development of RI, based on roadmapping practices to eliminate duplication and motivate the formation of consortia (+) Link between the roadmap and future financing from the EU Structural Funds (-) Cross-border access to the infrastructure not actively promoted
7	**SME Involvement**	(+) Co-funding Polish participation in Eureka / Eurostars by NCBiR (+) Availability of funds earmarked for participation of Polish research teams and SMEs in internationally coordinated R&I initiatives, with co-funding distributed by MNiSW and PARP based on regular, open competitions	(+) Availability of co-funding for SMEs involved in EU R&I programs (+) Dedicated financial and organisational support for Polish participants of selected programs
11	**Venture Capital Funds**	(+) Availability of subsidies for VCs, business angels and seed investors from the EU Structural Funds (+) Availability of public co-funding for VCs from KRK	(+) Availability of public funds for VCs and business angels, which supported the launch of numerous organisations (+) Innovative approach to VC involvement in BRIdge VC by NCBiR (+) Use of loans to support innovative

	IU Commitment	Main changes	Brief assessment of progress / achievements
		(+) Establishment of sovereign investment fund PIR (2013) (+) Continuation of VC support from the EU Structural Funds planned for 2014-2020 (+) NCBiR experimenting with VC involvement through public-private partnership in BRIdge VC program (2013) (+) PARP establishing the Loan Fund Supporting Innovations with 41.6m PLN (2013) (+) Existence of New Connect stock exchange market for innovative ventures facilitates access to capital without the need to use business angels or VCs (-) Lack of dedicated tax incentives for VCs, business angels or seed investors (-) No information available about applications for EU VC fund passports	activities by PARP as a useful supplement to subsidies (+) New Connect market popular among innovative SMEs from Poland and other countries (-) Public support through subsidies significantly reduces risk of private investors, but might also be crowding out private capital and cause excessive reliance on public funding (-) KPK investments mostly ICT-oriented (-) PIR most likely to focus on infrastructure investments not innovative ventures (-) Lack of other financial instruments for VCs, such as tax deductions or revolving assistance (-) Lack of systemic approach, which would stimulate larger scale private investments, corporate venturing or crowd-funding
13	**Review of the State Aid Framework**	(+) Country-wide support instrument for innovation clusters: POIG 5.1 sub-measure (+) Widening the scope of the measure in 2011 by including support for R&D projects (+) Regional support instruments for clusters in ROPs (+) Inclusion of dedicated support for innovation clusters in POIR (2014-2020), focusing on key clusters	(+) Public support promoted the development of numerous innovation clusters in recent years (+) Popularity of cluster initiatives, also without direct public support (-) Many initiatives will not continue when no longer supported by public co-funding
14	**EU Patent**	(-) Polish government did not sign the Agreement on a Unified Patent Court	(-) Poland decided against joining the unitary patent system based on results of impact analysis, which revealed that Polish business enterprises would incur substantial costs (-) Strong public opposition against participation in the system, including all major industry associations
15	**Screening of Regulatory Framework**	(+) Compulsory ex-ante screening of regulations, which have impact on entrepreneurship and innovativeness (every new relevant act requires consultations with PARP; detailed rules elaborated by the Ministry of Economy in 2006, comp. MG (2006))	(+) Ex-ante screening is a standard element of the legal framework (+) Ex-post screening by a legislative committee resulted in legal improvements (-) Ex-ante screening and impact analyses are standardized and in some cases might be perceived as unnecessary burdens, without real, in-depth analyses

	IU Commitment	Main changes	Brief assessment of progress / achievements
		(+) Legal obligation to prepare formal impact analysis and distribute each proposed legal act for inter-ministerial and public consultations (+) Since 2007, on-going work intended to identify excessive burdens on entrepreneurs, which reduce the innovativeness – the process resulted in multiple amendments of laws in recent years	
17	**Public Procurement**	(+) Proposed amendments to the Act on public procurement, relaxing procurement procedures related to R&D (2013) (+) Pilot projects related to pre-competitive procurement by NCBiR, intended to encourage other public institutions (2013)	(+) New, important changes to the legal framework (+) Government R&D agency setting a good example by launching tenders including innovative criteria (-) Conservative attitudes of PHEIs and PROs, resulting from past experiences with invasive oversights of public procurement procedures (unwillingness to experiment with new approaches) (-) Lack of national targets related to public procurement of innovative goods and services
20	**Open Access**	(+) Draft guidelines of the Act on open public resources published (2012) (+) NCBiR-funded project SYNAT to establish an open repository of scientific publications and data (+) Virtual Library of Science available to all scientists in Poland (free, government-sponsored access to international databases of scientific publications) (+) Dedicated funding instrument "Index Plus" supports among others electronic publications of scientific research (+) Numerous bottom-up initiatives by scientific institutions, establishing open access repositories	(+) Strong social support for open access, revealed during protests against ACTA agreement (2012) (+) Involvement of R&C community in open access efforts (-) Slow progress of the legislative procedures, as the draft guidelines have not been turned into a proposed legal act yet (-) IPRs to results of publicly-funded projects usually assigned to R&D performers, so granting open access to the results is complicated from the legal point of view
21	**Knowledge Transfer**	(+) Institutional assessment of PHEIs and PROS involves criteria related to industry co-operation (+) BRIdge programs, stimulating technology transfer	(+) Extensive portfolio of support measures, facilitating knowledge transfer and science-industry collaboration, including legal and financial measures (+) Observed changes at PHEIs and PROS, partly orienting its activities to serve the

	IU Commitment	Main changes	Brief assessment of progress / achievements
		and commercialisation of research results (NCBiR) (+) Amendments to the Act on higher education (2011) obliging PHEIs to establish special purpose companies tasked with technology transfer (+) SPIN-TECH (NCBiR) financially supporting the start-up phases of the special purpose companies (+) BRIdge Mentor - mentoring for scientists, provided by consultants (NCBiR) (+) Innovation Brokers (MNiSW) - program supporting the employment of professional brokers at PHEIs to support the commercialisation of research results (+) Top 1000 Innovators - international training in KT for outstanding scientists (+) PATENT PLUS program supporting patenting of inventions at PHEIs and PROs (+) Contents of model agreements, assigning IPRs to R&D performers (NCBiR) (+) R&D funding for consortia involving science and industry (most measures by NCBiR) (+) R&D support measures co-funded by business (NCBiR) (+) Tax exemptions for purchases/licensing of technologies (+) "Large innovation voucher" for SMEs covering the cost of development of new products or technologies by scientific institutions (PARP) (+) Regional programs supporting cross-employment of scientists by business enterprises	needs of the knowledge market participants
22	**European Knowledge Market for Patents and Licensing**	(+) Support for first implementations of inventions (PARP, 2012) and demonstration of R&D results (NCBiR, 2013) (+) Programs "Innovation brokers" (MNiSW, 2013) and	(+) Availability of public funds for IPR protection, including international patenting (+) Innovative support measures targeting industry-science cooperation related to IPR (-)Limited availability of publicly-supported

	IU Commitment	Main changes	Brief assessment of progress / achievements
		SPIN-TECH (NCBiR, 2013), supporting the commercialisation of academic IPR (+) PATENT PLUS program by NCBiR, co-funding IPR protection of academic inventions (2012) and a corresponding measure for SMEs, offered by PARP and funded from POIG (+) Proposed amendment to the Act on higher education, assigning the ownership of patents to inventors to facilitate the licensing and sales transactions (2013) (+) Agreements establishing fast track patenting with Japan (JPO) and China (SIPO) (2013) (+) Government support for participation in international trade fairs, exhibitions and roadshows (+) Planned instruments supporting IPR protection in the next perspective of the EU Structural Funds, 2014-2020 (+) IPR assigned to R&D performers for most of the publicly funded programs	IPR consulting services other than patenting
23	**Safeguarding Intellectual Property Rights**	(-)	(-) Lack of national legislation implementing the Guidelines on Horizontal Cooperation Agreements in respect to standard-setting agreements
24	**Structural Funds and Smart Specialisation**	(+) National S3 document (KSIS) will be published for consultations in October 2013, will determine the eligibility of R&D projects for funding from POIR (2014-2020) (+) Regional S3 prepared as a pre-condition for accepting ROPs	(+) Strong government commitment to the process of identifying and implementing smart specialisations on regional and national levels (+) Legal and financial measures enforcing orientation towards the identified specialisations (-) Imperfect methods for selecting the specialisations, particularly on the regional level (-) KSIS might be "watered-down" in the process of public consultations, as the proposed specialisations might not satisfy many interest groups
25	**Post 2013 Structural Fund Programmes**	(+) Advanced progress on developing and approving the operational programs for 2014-2020 on both national and	(+) Evidence-based development process, using results of evaluations and involving numerous stakeholders (+) Ministry of Infrastructure and

	IU Commitment	Main changes	Brief assessment of progress / achievements
		regional levels	Development imposed rigorous methodological standards and pre-conditions (including compliance with S3) (+) Preparation of the operational programs was probably the most extensive and in-depth public debate concerning the R&I policy in Poland's history
26	**European Social Innovation pilot**	(+) Dedicated funding program for social innovations launched by NCBiR (2013) (+) Establishment of living labs in several cities (in publicly co-funded technological parks or entrepreneurship centres)	(+) Public efforts to encourage social innovations and allocated funding (-) Limited scale of relevant activities and lack of public awareness
27	**Public Sector Innovation**	(+) Active role of KSAP (government-owned National School of Public Administration), promoting public sector innovation through trainings and other initiatives (+) Draft guidelines of the Act on open public resources published (2012)	(+) Sharing of best practices and knowledge transfer by KSAP (+) Plans to facilitate access to government-owned data (-) Lack of government-sponsored prizes for innovators in public sector (-) Slow progress in open access legislation
29	**European Innovation Partnerships**	(+) Participation in several EIPs and membership in the expert group evaluating the effectiveness of EIPs	(+) Involvement in EIPs perceived as important for the national innovation system (-) R&D institutions might not clearly understand the differences between EIPs and other EU-coordinated efforts
30	**Integrated Policies to Attract the Best Researchers**	(+) Legal framework ensuring open and transparent recruitment procedures in science sector (2010-2011) (+) Active promotion of Poland as a potential R&D destination – EURAXESS portal and service network, publishing English-language job offers (+) Regulations allowing foreigners without Polish postdoctoral degrees to be awarded the titles of professors (2011) (+) Participation in the EU Scientific Visa package (+) Dedicated funding programs "WELCOME" and "HOME PLUS", managed by Polish Science Foundation, attracting experienced researchers from abroad (+) Planned support for establishing International	(+) Efforts to attract foreign researchers by introduction of needed changes to the legal frameworks for employing researchers (-) Limited attractiveness of Poland as destination for foreign researchers due to uncompetitive salaries in R&D sector

	IU Commitment	Main changes	Brief assessment of progress / achievements
		Research Agendas, attracting best foreign researchers, to be funded from POIR, 2014-2020 (-) Low salaries for researchers at PHEIs and PROs, discouraging foreign experts	
31	**Scientific Cooperation with Third Countries**	(+) Bilateral co-operation programs with selected countries managed by NCBiR (+) Funding for Polish researchers and SMEs participation in international R&D consortia, or conducting projects abroad (+) Introduction of fast-track patenting with China and Japan (2013) (+) Active membership in ICSTI (International Centre for Scientific and Technical Information)	(+) Support for Polish researchers interested in R&D activities abroad (-) Limited financial support for foreign research teams (-) Lack of clear geographical focus or thematic priorities for international cooperation
32	**Global Research Infrastructures**	(+) Participation in ESA (European Space Agency), CERN,FAIR (Facility for Antiproton and Ion Research) and XFEL (X-ray Free Electron Laser) (+) Availability of standard co-funding instruments for Polish applicants interested in joining international consortia (+) Development of RI roadmap (PMDIB), compliant with ESFRI	(+) Importance of RI roadmap to ensure the complementarity of Polish RI efforts (+) Involvement in several, selected RI initiatives (-) Limited budgets to fund international RI
33	**National Reform Programmes**	(+) Adequately identified challenges and corresponding measures (+) R&I policies featured as an important part of NRP	(+) NRP addressing some of the most important challenges of R&I policies (-) Some of the planned measures (R&D tax deductions) dependent on budgetary situation, i.e. unlikely to be implemented

ANNEX 3. NATIONAL PROGRESS TOWARDS REALISATION OF ERA

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
1. More effective national research systems	Action 1: Introduce or enhance competitive funding through calls for proposals and institutional assessments	Annual increases of the share of science budget distributed through competitive calls for proposals First institutional assessment of PHEIs and PROs based on the new regulations carried out in 2013	(+) Substantial share of science budget distributed as competitive funding (+) Institutional funding linked to the results of regular evaluations, taking into account research excellence and bibliometric indicators (+) Multiple targeted R&D funding programs established, increasing the competitiveness of funds distribution
	Action 2: Ensure that all public bodies responsible for allocating research funds apply the core principles of international peer review	All new funding programs launched by NCN and NCBiR use external peer-reviews, complying with international standards NCN's and NCBiR's bylaws facilitate the possibility of using foreign experts as reviewers	(+) All competitive R&D funding programs (MNiSW, NCN, NCBiR) use external peer-reviews (+) Applicants in most NCN and NCBiR programs required to submit applications both in Polish and English to facilitate international peer-reviews (-) Limited use of international experts by NCN and NCBiR, as compensation for peer-reviewers is relatively low, thus discouraging foreign specialists
2. Optimal transnational co-operation and competition	Action 1: Step up efforts to implement joint research agendas addressing grand challenges, sharing information about activities in agreed priority areas, ensuring that adequate national funding is committed and strategically aligned at European level in these areas	KIS (National Smart Specialisations) directly addressing major societal challenges New funding programs launched by NCBiR in 2012-2013, responding to specific major challenges and co-funding participation in trans-national initiatives Poland joining ESA in 2012 Involvement of Polish researchers in trans-national projects and projects addressing grand challenges	(+) Policy documents KPB (National Research Program) and KIS (National Smart Specialisations) address major societal challenges, which are subsequently supported by dedicated R&D funding programs (+) Multiple dedicated funding programs from NCBiR, corresponding to the grand challenges (+) Polish participation in ESA (+) Polish participation in

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
		is highly prioritized in POIR (2014-2020)	joint-programming (JPIs, ERA-NETs, bilateral programs) (+) Public co-funding for Polish researchers participating in trans-nationally co-ordinated projects (MNiSW, NCN, NCBiR) (+) Program IDEAS PLUS support the participants of the ERC competition, whose applications were positively evaluated but not funded (+) Trans-national research will be supported from the EU Structural Funds in 2014-2020 (POIR) (-) Polish involvement in trans-national initiatives is relatively limited due to easy availability of R&D funding for projects on the national level
	Action 2: Ensure mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions	Multiple public funding programs, supporting Polish participation in trans-national initiatives and recognizing the outcomes of application evaluations POIR will be complementary to Horizon 2020 and intends to use criteria/evaluation results of H2020 in some of R&D support measures	(+) Existence of legal framework facilitating the use of international peer-reviews in national funding decisions (+) Selected funding programs benefits from the outcomes of international peer-review process, e.g. IDEAS PLUS, benefiting from evaluations of applications, previously carried out by ERC (+) Public co-funding for Polish researchers participating in trans-national projects relies on the results of previous international peer-reviews of their applications (e.g. in FP7, CIP) (+) POIR will include dedicated funding for Polish researchers involved in trans-national projects, relying on external evaluations (in particular, offering complementarity to Horizon 2020 and

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
			COSME) (-) Current use of evaluations carried out by other institutions in national funding decisions is limited
	Action 3: Remove legal and other barriers to the cross-border interoperability of national programmes to permit joint financing of actions including cooperation with non-EU countries where relevant	Multiple joint financing initiatives launched by NCN and NCBiR in 2012-2013	(+) Act on science financing from 2010 facilitates the joint financing (+) Multiple joint financing initiatives, including bilateral co-operation, launched by NCBiR and NCN in 2012-2013 (-) Lack of strategic framework / clear policy directions related to the pursuit of international initiatives, which currently seem to be carried out in an ad hoc manner (-) Poland does not offer portability of national R&D grants to other countries
	Action 4: Confirm financial commitments for the construction and operation of ESFRI, global, national and regional RIs of pan-European interest, particularly when developing national roadmaps and the next SF programmes		(+) RI roadmap (PMDIB) established in 2011 and updated in 2013 (+) Funding for PMDIB secured in the 2014-2020 financial perspective (POIR) (+) PMDIB development taking into account complementarity of existing RIs on national and international levels, addressing smart specialisations, and facilitating external access to the financed RIs (+) Impressive scale of RI investments in Poland in recent years
	Action 5: Remove legal and other barriers to cross-border access to RIs	Legal interpretations promoting the availability of publicly-funded RIs published by NCBiR MNiSW published online map of RIs, searched by specialist keywords, and works on similar	(+) NCBiR facilitated commercial uses of publicly funded RIs by publishing legal interpretations and model agreements for PHEIs and PROs (+) Funding for RIs under PMDIB/POIR will require

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
		functionality in a more extensive online system called POLON POIR introduces strict RI funding criteria, requiring applicants to demonstrate the commercial feasibility of their applications and guarantee external access to the RIs	submission of draft access rules and service pricing models, to ensure the availability of RIs to external clients, including international research organisations (+) MNiSW published online searchable map of all RIs co-funded from public sources, facilitating the identification of the needed laboratories and equipment, and similar functionality will be offered by a more extensive system POLON (-) RIs are under-utilized, as many PHEIs and PROs are still afraid of using publicly funded RIs for commercial purposes or making them available to external clients
ERA priority 3: An open labour market for researchers	Action 1: Remove legal and other barriers to the application of open, transparent and merit based recruitment of researchers	Amendments of legal acts, establishing merit-based recruitment and promotion system at PHEIs and PROs Amended Act on scientific degrees and scientific title (2011) enables foreign researchers to be promoted to professors in Poland without the need to satisfy all local requirements	(+) Hard laws enforce merit-based recruitment and promotion of researchers (+) Job offers at PHEIs published online at MNiSW website and EURAXESS (-) PHEIs and PROS not obliged to clearly specify eligibility criteria for advertised positions or publish details of the selection process (-) Modalities for selection procedures defined by individual institutions, usually no involvement of international experts in selection panels (-) Recruitment procedures usually involve the submission of Polish-language documents (-) PHEIs tend to implicitly prefer own graduates in recruitment procedures (-) Low salaries for researchers discourage foreign experts

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
	Action 2: Remove legal and other barriers which hamper cross-border access to and portability of national grants		(+) Grants applied for by natural persons, having certain flexibility in looking for future employment at selected PHEIs and PROs (+) Most grants are available to foreigners if the beneficiary institution is in Poland (-) No cross-border portability of national grants (with the exception of dedicated funding programs, supporting international projects)
	Action 3: Support implementation of the Declaration of Commitment to provide coordinated personalised information and services to researchers through the pan-European EURAXESS3 network	Amended Act on scientific degrees and scientific title (2011) enables foreign researchers to be promoted to professors in Poland without the need to satisfy all local requirements	(+) Active involvement in EURAXESS, with English-language online services, contact points in 10 cities, and publications for foreign researchers (+) Legal framework facilitates the employment of experiences foreign researchers, who do not satisfy the local requirements of post-doctoral titles (habilitation, professor title) (-) Language barriers discourage many foreign researchers (-) Small share of R&D jobs advertised through EURAXESS compared with the researcher population (-) Uncompetitive salary levels
	Action 4: Support the setting up and running of structured innovative doctoral training programmes applying the Principles for Innovative Doctoral Training.	Modifications of doctoral study programs at PHEIs and PROs, including definition of learning outcomes, involvement of stakeholders and introduction of quality assurance procedures Evaluations of doctoral study programs conducted by the Polish Accreditation Committee from 2012 on Public funding for	(+) Higher education reform from 2011 promotes the excellence in doctoral training (including definition of learning outcomes and quality assurance) and transparent procedures for awarding the Ph.D. titles (+) Doctoral studies are accredited by the Polish Accreditation Committee based on regular evaluations

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
		launching innovative, internationally competitive doctoral study programs	of study programs (+) Availability of funding for launching internationally competitive doctoral study programs (-) Slow pace of changes at some PHEIs and PROs, which merely introduced minor formal changes to their programs in response to the reform
	Action 5: Create an enabling framework for the implementation of the HR Strategy for Researchers incorporating the Charter & Code		(+) Charted & Code endorsed by the Conference of Rectors of Academic Schools in Poland (KRASP), the Polish Academy of Sciences (PAN) and the Foundation for Polish Science (FNP) (+) National regulations are consistent with the Charter & Code (-) Most PHEIs and PROs did not define own, formal HR strategies, carry out self-assessments or prepare action plans
ERA priority 4: Gender equality and gender mainstreaming in research	Action 1: Create a legal and policy environment and provide incentives		(+) Anti-discrimination regulations in Polish hard laws (+) NCN and NCBiR bylaws facilitate maternity leaves and leaves to take care of children for project applicants (+) Length of doctoral studies can be extended in the case of pregnancy (-) Doctoral candidates not benefiting from nation-wide employment regulations due to their student status (-) Only few gender mainstreaming actions – the legal framework focuses on gender equality
	Action 2: Engage in partnerships with funding agencies, research organisations and universities to foster cultural and institutional		(+) Several funding programs, supporting female researchers (MNiSW awards "Girls of the future, program of the Conference of Rectors of Polish

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
	change on gender		Technical Universities "Girls on technical universities", L'Oréal-UNESCO scholarship for female researchers, Foundation for Polish Science BRIDGE program for researchers who are young parents) (-) Limited scope and availability of the above-listed initiatives (+) National Statistical Office regularly monitors gender balance in R&D sector (including data on employment and remuneration)
	Action 3: Ensure that at least 40% of the under-represented sex participate in committees involved in recruitment/career progression and in establishing and evaluating		(+) Hard laws stipulate that 30% of members of the Polish Accreditation Committee are women, and the composition of the Main Council of Science and Higher Education attempts to ensure gender balance (-) PHEIs and PROs are autonomous in recruitment and promotion procedures, so no national regulations enforce the shares of the under-represented sex in committees (-) No evidence for gender mainstreaming actions found at PROs and PHEIs with regards to the composition of committees (-) Empirical data demonstrate under-representation of women in scientific committees on the national level
ERA priority 5: Optimal circulation, access to and transfer of scientific knowledge including via digital ERA	Action 1: Define and coordinate their policies on access to and preservation of scientific information	Multiple bottom-up initiatives by scientific institutions and individual researchers, related to open access Draft guidelines of the Act on open public resources published in 2012, with no follow-up activities in 2013	(+) Virtual Library of Science, consisting of major commercial databases of scientific publications, licensed by MNiSW and freely available to researchers and students (+) Legal regulations support the free use of patented inventions for

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
			scientific research purposes (+) Multiple open access initiatives, carried out by institutions and researchers (Federation of Digital Libraries, Centre of Open Science CEON, SYNAT platform, commercial Index Copernicus bibliographic database with some open access functionality) (+) MNiSW subsidizing open access publications in Springer's journals (gold open access model) and offers other funding opportunities for electronic open access publications (+) Ministry of Administration and Digitization prepared draft guidelines of the Act on open public resources in 2012 (-) No follow-up in 2013 – lack of open access regulations, including modalities for accessing resources generated by the public sector
	Action 2: Ensure that public research contributes to Open Innovation and foster knowledge transfer between public and private sectors through national knowledge transfer strategies	High-level policy documents (SIEG, PRP, POIR) emphasizing the importance of private-public R&D collaboration Proposed amendments of the Act on higher education assign IPRs to individual scientists New support measures facilitating technology transfer from PHEIs and PROs (MNiSW, NCBiR) Further support measures planned for the financial perspective 2014-2020 (POIR)	(+) Importance of the private-public R&D collaboration in national policy documents (SIEG, PRP, POIR) (+) Multiple support measures promoting science-industry cooperation (+) Proposed amendments to the Act on higher education, transferring academic inventions' IPRs to their inventors to facilitate their co-operation with business enterprises (+) Intensive science-industry collaboration expected in the financial perspective 2014-2020, as POIR requires formation of consortia for many funding instruments

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
			(+) Intensive public support for PHEIs and PROs interested in commercialisation of research results (+) Innovation vouchers for business enterprises, contracting R&D projects to scientific institutions (+) Public financial support for innovation brokers–agents, selling or licensing PHEIs technologies (+) MNiSW sending altogether 500 young researchers and employees of university technology transfer centres for specialist commercialisation trainings in Silicon Valley in "Top 500 Innovators" program (-) Limited effectiveness of past interventions, as many PHEIs and PROs have no tangible successes of technology transfer activities
	Action 3: Harmonise access and usage policies for research and education-related public e-infrastructures and for associated digital research services enabling consortia of different types of public and private partners		(+) Virtual Library of Science as the main ICT platform supporting access to scientific publications at PHEIs and PROs, based on commercial databases licensed by government for Polish researchers (+) SYNAT project, funded by NCBiR, intended to establish an open repository of scientific publications and data (-) Researchers working for business enterprises cannot benefit from the Virtual Library of Science, but could co-operate with academic partners to benefit from these resources
	Action 4: Adopt and implement national strategies for electronic identity for researchers giving them transnational access to digital research		(+) Electronic identity of researchers partly implemented by the Virtual Library of Science (+) IT system POLON,

ERA Priority	ERA Action	Recent changes	Assessment of progress in delivering ERA
	services		developed by MNiSW, will establish a register of researchers, facilitating the introduction of e-identity services (+) Many PHEIs and PROs participate in Eduroam network (-) No nation-wide strategy or policy documents related to the Action, in particular: non expressed interests in offering trans-national access

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LIST OF ABBREVIATIONS

ACTA	Anti-Counterfeiting Trade Agreement
ARP	Industrial Development Agency (Agencja Rozwoju Przemysłu)
BERD	Business Expenditures for Research and Development
BGK	Bank Gospodarstwa Krajowego
BPO	Business Process Outsourcing
CSR	Country specific Recommendations
EC	European Commission
ERA	European Research Area
EPO	European Patent Office
ERA-NET	European Research Area Network
ESA	European space Agency
ETV	European Union's Environmental Technology Verification
EU	European Union
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investment
FNP	Foundation for Polish Science (Fundacja Nauki Polskiej)
FP7	7th Framework Programme
FTE	Full-time equivalent
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
HEI	Higher Education Institutions
HERD	Higher Education Expenditure on R&D
HRST	Human Resources for Science and Technology
ICT	Information & Communication Technologies
ISCED	International Standard Classification of Education
IU	Innovation Union
KEJN	Committee for Evaluation of Scientific Research Institutions (Komitet Ewaluacji Jednostek Naukowych)
KFK	National Capital Fund (Krajowy Fundusz Kapitałowy)
KIS	National Smart Specialisations (Krajowe Inteligentne Specjalizacje)
KNOW	National Scientific Leading Centre (Krajowy Naukowy Ośrodek Wiodący)
KPB	National Research Programme (Krajowy Program Badań)
KPK	National Contact Point for Research Programmes of the European Union (Krajowy Punkt Kontaktowy Programów Badawczych UE)
KPN	Committee for Science Policy (Komitet Polityki Naukowej)
KRASP	Conference of Rectors of Academic Schools in Poland (Konferencja Rektorów Akademickich Szkół Polskich)
KSU	National Service System for Small and Medium-Sized Enterprises (Krajowy System Usług)
MF	Ministry of Finance (Ministerstwo Finansów)
MG	Ministry of Economy (Ministerstwo Gospodarki)
MNiSW	Ministry of Science and Higher Education (Ministerstwo Nauki i Szkolnictwa Wyższego)
MIR	Ministry of Infrastructure and Development (Ministerstwo Infrastruktury i Rozwoju)
NCBiR	National R&D Centre (Narodowe Centrum Badań i Rozwoju)

NCN	National Science Centre (Narodowe Centrum Nauki)
NFOŚiGW	National Fund for Environmental Protection and Water Management (Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej)
NIK	Supreme Audit Office (Naczelna Izba Kontroli)
PAN	Polish Academy of Sciences (Polska Akademia Nauk)
PAIZ	Polish Information and Foreign Investment Agency (Polska Agencja Informacji i Inwestycji Zagranicznych)
PARP	Polish Agency for Enterprise Development (Polska Agencja Rozwoju Przedsiębiorczości)
PCT	Patent Co-operation Treaty
PHEI	Public Higher Education Institution
PIR	Polish Development Investments (Polskie Inwestycje Rozwojowe)
PKA	Polish Accreditation Committee (Polska Komisja Akredytacyjna)
PLN	Polish zloty
PMDIB	Polish Roadmap of Research Infrastructure (Polska Mapa Drogowa Infrastruktury Badawczej)
PO	Civic Platform (Platforma Obywatelska)
POIG	Operational Programme Innovative Economy (Program Operacyjny Innowacyjna Gospodarka)
POIR	Operational Programme Smart Growth (Program Operacyjny Inteligentny Rozwój)
PRO	Public Research Organization
PRP	Enterprise Development Program (Program Rozwoju Przedsiębiorstw)
PSL	Polish People's Party (Polskie Stronnictwo Ludowe)
R&D	Research and development
RGIB	Main Council of the Research Institutes (Rada Główna Instytutów Badawczych)
RGNiSW	Main Council of Science and Higher Education (Rada Główna Nauki i Szkolnictwa Wyższego)
RI	Research Infrastructure
R&I	Research and innovation
RDI	Research and development and innovation
RIS3	Research and Innovation Strategies on Smart Specialisation
RPO	Regional Operational Programme (Regionalny Program Operacyjny)
S3	Smart Specialisation Strategy
S&E	Science and engineering
S&T	Science and technology
SF	Structural Funds
SIEG	Strategy for the Innovation and Efficiency of the Economy (Strategia Innowacyjności i Efektywności Gospodarki)
SME	Small and Medium-sized Enterprise
SSE	Special Economic Zone
VC	Venture Capital

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