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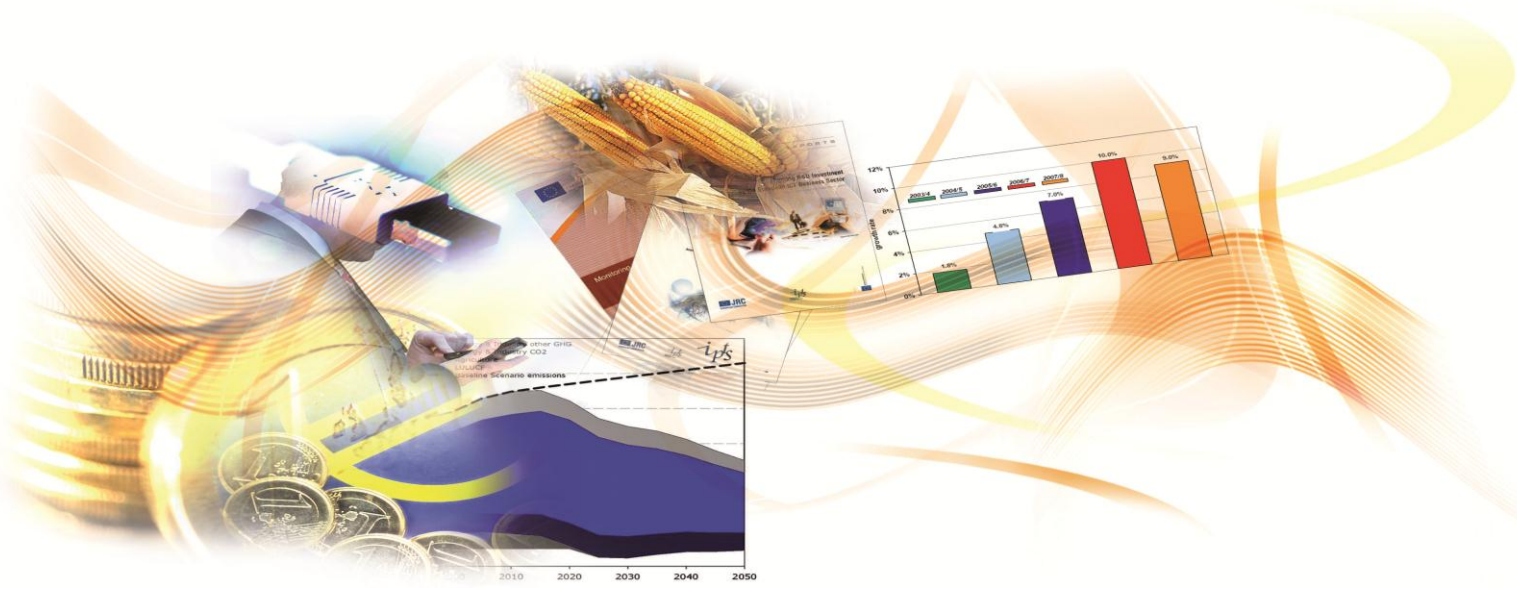

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Abstract

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.

ACKNOWLEDGMENTS 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 December 2013 and was focused on developments taking place in the previous twelve months. In particular, it has benefitted from the comments and suggestions made by Dr. Jörg Zimmermann from JRC-IPTS. The contributions and comments from DG-RTD are also gratefully acknowledged.

The report is currently only published in electronic format and is 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

In Germany, R&D and innovation policy is among the top priority areas of both federal and state governments (*Bund* and *Länder*) without significant changes in perspective and/or policy approach over the last couple of years. Also among the group of main policy actors and institutions involved within the governance of the research system, lately there have been no major changes. The same holds for the set of policy instruments in place. In fact, R&D and innovation policy in Germany is quite persistent and straightforward.

Nevertheless, some shifts in priority settings and individual policy initiatives have occurred, mainly towards rather mission-oriented approaches in technology policy (see e.g. the setup of future-oriented projects as part of the HTS-2020' Action Plan[1]). In general, structural reforms with regard to the German R&D and innovation system were continued in course of 2012 and 2013, especially the *'Excellenzinitiative'* (outlook: continue as before) and *'Pakt für Forschung und Innovation'* (outlook: further expanding). However, both initiatives formally expire in course of the legislative period that has just started (Please note: The new government just took office in 12/2013). In other words, both initiatives (as well as others such as '*Hochschulpakt*' and *'Qualitätspakt Lehre'*) need to be formally prolonged by the new government, which is commonly assumed to happen. Moreover, the discussion concerning a possible amendment of the German Basic Law (*Grundgesetz*, Artikel 91b), which ultimately points to a change in the current regulation concerning general financing of universities (in particular joint initiatives of federal and state level), may finally gain momentum as the new federal government has strong majorities in both chambers, which provides possibly the historical chance to realise such a systemic change.

Further relevant changes that occurred in course of 2013 are, for instance, the release of the new National Research Strategy BioEconomy 2030, which aims at reducing Germany's oil dependence by stronger use of renewable resources. Moreover, a National Research Infrastructure Roadmap was presented, which is meant to support and guide political decisions in terms of research infrastructures (i.e. for instance large scale research infrastructures of national / European importance, comprehensive experiments, etc.). Finally, a number of further initiatives are on the way as e.g. concerning smart specialisation by strengthening co-operations between businesses and research institutes as well as business driven innovation clusters and enabling them to emerge as excellence centres recognised at regional and European level. In this light, a new competence centre for procurers opened 2013 and seeks to stimulate the demand for innovations. Regional smart specialisation strategies are due to be developed but remain so far still widely in the making. Evidence in this regard suggests that the corresponding ex-ante conditionality of the EU structural funds pushes some regions (more than others) to advance their RIS3 concepts. However, concerns remain with regard to the compatibility of the individually developed RIS3 concepts (at *Länder* level) and whether/to what extent they will be mutually reinforcing each other (i.e. in a smart way complementing their individual strengths).

Key priorities of Germany's R&D and innovation policy continue to be: (i) keeping pace with global technology trends, (ii) ensuring/providing sufficient funds for public and private R&D and thus keeping research excellence at a top international level, (iii) maintaining and further improving the industry-science link (i.e. enabling knowledge flows at the public~private nexus), and

[1] The general aim is to bundle the innovation relevant policies and initiatives of all federal resorts and also to bring together the efforts made at HEI/PRO and business sector, particularly in the fields of climate/energy, health/healthy food, mobility, communication, and security

(iv) strengthening the education sector (at all levels) in order to stimulate knowledge creation, capability building, absorptive capacities and ultimately the formation of a qualified workforce.

The main challenges that Germany is confronted with in the area of research and innovation are the expansion of research in cutting-edge technologies, the provision of sufficient funding for R&D, the commercial exploitation of scientific knowledge (i.e. 'from ideas to market'), the provision of an appropriately qualified workforce, and (newly) 'greening the economy',[2] i.e. responding to the new energy concept and coordinating climate, energy and R&I policies. The current policy mix addresses these challenges through a broad range of measures, in particular by:

- Keeping pace with global technology trends by expanding research in cutting-edge technologies (e.g. by means of thematic R&D programmes and innovation alliances; all embedded in the HTS-2020) as well as by supporting its adaptation. Moreover, stimulating the creation of lead markets is another (recent) approach to address societal challenges and to gear increasingly towards high-tech sectors, which are expect to have significant growth potential.
- Ensuring sufficient funds for public and private R&D and thus keeping research excellence and innovativeness at a top international level. In fact, access to finance for R&D and innovation in Germany is still limited and appears to be a barrier especially for the business sector (SMEs, NTBF, small/young innovators, etc.). The HTS-2020 recognises this challenge and a number of measures seek to address this issue, such as e.g. the increased focus on SMEs in public R&D programmes (*'SME innovative'*, 'ZIM', etc.) and the expansion of the provision of VC through 'High-tech Start-up Fund II'. A new instrument to support venture capital *'Investitionszuschuss Wagniskapital'* was launched in 05/2013.
- Maintaining and further improving industry-science links and by that means stimulating the commercial exploitation of scientific knowledge. This is one of the core points within the HTS-2020, implemented e.g. by the initiatives *'VIP–Programm'* (validation of innovation potentials of scientific research), the *'Spitzencluster-Wettbewerb'* (leading edge cluster competition) and '*Forschungscampus*'. By means of these measures, inter alia, the evolvement of high-tech sectors in Germany is due to be facilitated.
- Strengthening the education sector at all levels in order to stimulate knowledge creation, capability building, absorptive capacities, and thus ensuring the provision of a qualified workforce. In fact, the German education system still exhibits a number of challenges (performance lacking behind compared to other leading EU/OECD countries) and is constraint by too complex policy coordination. Moreover, existing/potential resources need to be mobilised to a larger extent (women, foreign-born residents, immigrants). A number of initiatives are launched to address these points, such as e.g. *'Pakt für Forschung und Innovation'*, '*Hochschulpakt* (including *'Qualitätspakt Lehre'*), and '*Exzellenzinitiative*'.
- Fostering research and innovation in 'green technologies' – thus responding to the new paradigm of 'greening the economy' – and in this regard especially the new energy concept and the challenge of coordinating climate, energy and R&I policies in the light of expanding R&D and innovation activities (especially in terms of renewable electricity production). The latter is par-

[2] Germany has been proactive in developing ambitious environmental policies during the last decades, both nationally and internationally. The country's strong environmental framework makes it not only a pioneer in environmental protection and sustainable development, but also constitutes a good example on how a cleaner low-carbon economy is compatible with growth. For instance, in 2002, Germany adopted its National Strategy for Sustainable Development, making sustainability a guiding principle for national policies. The Strategy is underpinned by concrete targets and sustainability indicators, which are evaluated in regular progress reports. Germany also launched major cross-cutting initiatives on biodiversity, climate change, energy, and resource efficiency. In fact, **'greening the economy'** has turned to be a mainstream movement in Germany (with or without being explicitly labelled in this way). <link>

ticularly needed to compensate the recently decided nuclear phase-out until 2022 and to secure the energy supply afterwards (for an affordable price). The federal government is aware of this challenge and launched already in 2007 a comprehensive package of energy and climate policy measures: 'Integrated Energy and Climate Programme', (IEKP). Future-oriented projects are included in the HTS-2020's Action Plan. Supporting instruments of various ministries have environmental aspects as a cross cutting issue. Corresponding policies and activities are coordinated by the BMWi's 'Coordination Platform for Energy Research Policy'.

Overall, there is a good match of the national policy objectives as outlined above and the identified structural challenges. Strategies and the applied measures seem to be well targeted and widely appropriate to address the challenges for Germany in general and for the RIS in particular. Nevertheless, further structural reforms of the education, research and innovation system are required. In fact, with a view to the demographic development in Germany, a particular focus on the quality of human resources is necessary and further incentives for excellence and internationalisation are needed. There is room for more public-private cooperation and for implementing targeted supply-side and demand-side measures to foster innovation and fast-growing innovative firms in Germany. Such measures should be targeted, in particular, at high-tech sectors such as ICT, biotechnology and medical technologies. A weak point of German R&D is the currently relatively low level of spending in high-tech areas such as ICT. In fact, while the German economy is still strongly based on medium-high technology sectors (such as automobiles, electrotechnical products, machinery, and chemical products), over the last decade it has lost its strong market position in pharmaceuticals and in optical industries. In turn, compared to e.g. the US, in the recent past, Germany has only produced a few successful new players in high-tech industries. The development of biotechnology and advanced computer science remains below potential. There is also still underexploited growth potential as regards innovative and knowledge-intensive service economy sectors (see in this regard IU Progress report 2013, p. 108ff).

In sum, Germany has come through the current economic crisis relatively well, partly as a result of a strong export sector. However, the German market position as regards medium-high-tech products may be challenged in the future by new players such as the BRIC countries and also due to a potential tapping into a specialisation trap (i.e. missing to explore/enter new technological fields). An ageing population and fewer young people represent further challenges for the German economy.

Although there is still no explicit strategy with regard to ERA, Germany has developed over the recent years a strategic thinking and action towards ERA. There is a strong involvement of national policy makers in the five ERA-Initiatives and other European issues. EU level instruments are being used for national goals, and there are attempts to influence the European level policy with core ideas as set out in the Internationalisation Strategy and the High Tech-Strategy 2020. Triggered by a broadening of R&D policy and innovation policy at EU level, there have been steps towards a more functional 'horizontalisation' at national level, i.e. European involvement is becoming part of the strategic thinking and there is a stronger awareness of European issues across all ministries (e.g. visible in ERA-Net participations). However, there remain several challenges when it comes to maximise the benefits of the ERA development for Germany and contributing to an optimised ERA development. Not all of them can be addressed by the German federal government, which, however, can take a leading or at least supporting role. In fact, the German Expert Commission on Research & Innovation points out that the federal government could intensify its role in the European coordination process and take a lead in the area of research and innovation in order to shape the ERA (EFI, 2011; re-emphasised in EFI, 2012).

TABLE OF CONTENTS

1 BASIC CHARACTERISATION OF THE RESEARCH AND INNOVATION SYSTEM

In terms of both population and GDP, Germany is the biggest country within the EU. With 80.6 million inhabitants in 2013, 15.9% of the EU-28 total population of 506 million lived in Germany. According to the official EUROSTAT Gross Domestic Product (GDP) forecasts for 2013 (€2,737b and €13,163b for Germany and the EU-27, respectively), Germany stands for about 20.8% of the total EU-28 GDP in 2013. Furthermore, Germany's GDP per capita for 2013 is estimated to be about 30% above the EU-27 average.[3]

Over the recent years, like in many other industrial economies in the world, the economic figures for Germany were affected by the economic and financial crisis. While in 2008 a moderate increase in real GDP could still be realised (+1.1%), in 2009 it sharply declined (-5.1%). However, Germany recovered rapidly from the crisis and returned to growth, realising an increase of 4% in 2010 and 3.3% in 2011, and thus surpassed already the pre-crisis level. Nevertheless, in the light of the global economic slowdown and the uncertainties concerning the Euro, the growth figures for 2012 dropped to just 0.7% and forecasts for 2013 assume ca. 0.5%. However, GDP growth figures remain still well above the forecasted zero growth of the EU-28 for 2013 and, moreover, are expected to increase again in 2014 and 2015 (1.7% and 1.9%, respectively).

Germany also has the largest research system in the EU (measured in terms of gross R&D expenditure (GERD)). Germany's GERD was about €67.0b in 2009 and further increased to €69.9b in 2010, €75.5b in 2011, and about €77.8b in 2012. Germany thus contributed 29.2% to the overall EU-27 R&D expenditure in 2012 (i.e. the share increased by 0.5 percent points compared to 2011). It is remarkable that public funding of R&D was not decreased during the years of crisis and economic downturn. In fact, the GBAORD even rose between 2008 and 2010 by about 12% (to €22b in 2010) and continued to grow by another 12% between 2010 and 2012 to a total spending of €24.6b in 2012. The increase in public R&D funding offset the slight decline in R&D activities funded by the business sector in 2009 (BERD: -1.7%). In 2010, BERD begun to rise again by 3.7% (total BERD €46.9b), followed by an increase of even 8.8% in 2011 (total €51.1b) and another 2.0% in 2012 (€52.1b). The share of private R&D/GDP lately remained about constant at 1.95% and the business enterprise sector performs about two-thirds of total R&D in Germany (66.9% in 2012 compared to 67.7% in 2011). Finally, the total turnover from innovation in Germany, in 2010, was at 15.5% and thus above EU-27 level (13.3%).[4]

According to the Innovation Union Scoreboard (IUS), which measures and compares the innovation performance across the EU-27, Germany is among the 'Innovation Leaders' in Europe (together with Sweden, Denmark and Finland), ranked overall at 2nd position just behind Sweden and is thus well above the EU-27 average (see IUS-2013, p. 5). Intellectual assets and innovators are particular strengths of the German system, while relative weaknesses were found especially concerning 'open, excellent and attractive research systems'.

In general, science and research in Germany are characterized by a multi-faceted infrastructure, a wide variety of disciplines, well-equipped research facilities and competent staff. Germany has various types of research locations: universities, universities of applied sciences, non-university

3 If not referenced otherwise, **all quantitative indicators are based on EUROSTAT data**.

4 This figure refers to the ratio of turnover (industry and services) from products new to the enterprise and new to the market as a per cent of total turnover (Eurostat Table code: tsdec340). It is based on the Community Innovation Survey and covers at least all enterprises with 10 or more employees. An innovation is a new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process. Please note that the most recent figures currently available from Eurostat are those from 2010.

institutes, companies and federal as well as *Länder* institutions. All in all, there are more than 800 publicly-funded research institutions in Germany, as well as research and development centers run by industrial corporations. In selected fields or regions, these industrial and academic institutions pool their research and development activities in networks and clusters (<more info>). Moreover, there are also a series of innovation centers and forward-thinking institutions (Innovation Agencies), which provide information and support in a variety of areas, including innovation management and business planning, technology transfer and commercialization of patents, innovation marketing, and technology assessment. Located in every German state, these institutions and portals represent core strengths and services of Germany's dynamic innovation landscape <centres of innovation in Germany>. Moreover, Germany's research and innovation system is also grounded in a well-established university system and a large and unique non-university public research system. The latter is mainly based on the four large research organisations: Max Planck Society (MPG), Fraunhofer Society (FhG), Helmholtz Association (HGF), and Leibniz Association (WGL). The industrial innovation system is characterized by a strong specialisation on medium-/high-tech manufacturing, such as automotive, mechanical engineering and chemicals. German enterprises are strongly oriented towards an innovation-based competitive strategy, revealed by a high share of innovating enterprises (2010: 48%) and a high share of firms that conduct in-house R&D (23%; see: Rammer et al., 2012).

Due to the federal structure, both the federal government (*Bund*) and the 16 federal states' ('*Bundesländer*' or just '*Länder*') governments are important players in terms of Germany's research and innovation policy. The federal government takes up a variety of activities in research and innovation policy and may be regarded as the main state actor in the German system. The Federal Ministry of Education and Research (BMBF) has the nationwide responsibility for research policy. The Federal Ministry of Economics and Technology (BMWi) is responsible for innovation and technology policy as well as for some areas of R&D policy. In addition, several other ministries maintain their own research institutes in order to fulfil their demands for evidence based governance ('*Ressortforschungseinrichtungen*'). In turn, education policy lies almost exclusively within the responsibility of the individual *Länder*. The *Länder* governments' main activity in research is to fund universities and co-fund the four large research organisations. In addition, they are involved in science-industry linkages and innovation programmes. Finally, there are also a number of joint activities of the federal and state governments, e.g. joint institutional funding of the four main research organisations and the programme for the Academies of Sciences. The Joint Science Conference (GWK) is the main body that coordinates research policies between the federal government and the state governments. Most publicly funded R&D programmes are administered and managed by a range of implementation agencies (*Projektträger*), with some of them located within the mentioned large research centres (PROs).

The German Science Foundation (DFG) is the self-governing organisation for science and research in Germany and serves all branches of science and the humanities. The chief task of the DFG is to select the best research projects by scientists and academics at universities and research institutions on a competitive basis and to finance these projects. The German Federation of Industrial Research Associations "Otto von Guericke" (AiF) deals with the promotion of applied R&D for the benefit of small and medium-sized enterprises (SMEs).

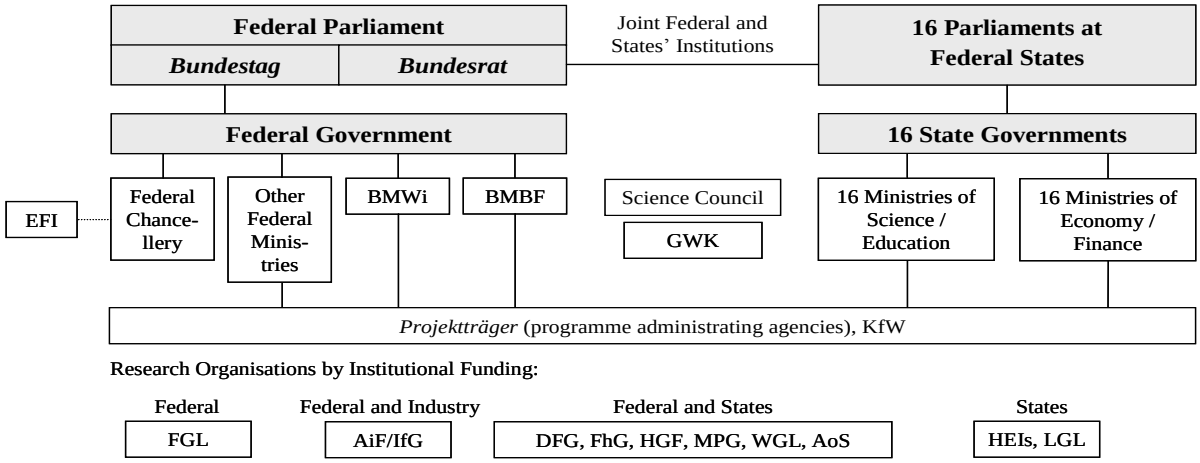
With regard to the governance of the research system in Germany, there have been no major changes in recent years among the group of main policy actors and involved institutions. However, significant efforts have been made to increase interconnections between the institutions. In general, research in Germany is conducted by a diverse spectrum of performers. Measured by international standards, the business enterprise sector is a comparably strong R&D performer (stands for about 2/3 of Germany's total R&D expenditures). Large enterprises play a particularly important role. Companies with more than 500 employees account for around 84% of intra-

mural R&D investments of the business sector (BERD; Stifterverband, 2011).[5] In turn, the ~400 Higher Education Institutions (HEIs) in Germany performed in 2012 about 18.3% of total R&D expenditure (GERD). A unique feature in Germany is a wide range of Public Research Organisations such as MPG, FhG, HGF and WGL with a large number of institutes, covering the whole spectrum from fundamental and applied research to research services. Their quantitative significance in the German research system is almost comparable to that of universities. The special role of PROs in the German research and science system is to provide long-term oriented research based on large research infrastructures (covering technical, data and information infrastructures) and to offer top scientists space for concentrating on research. Another relevant block of public research performers consists of governmental research agencies and institutes ('*Ressortforschungseinrichtungen*'). These institutions provide ministries with scientific knowledge and administer sovereign tasks such as the compliance of quality and safety standards.

Despite the clear separation in statistics between HEIs on the one hand and PROs on the other, both sectors are closely interlinked in practice. For instance, in all MPG institutes and the vast majority of FhG, HGF and WGL institutes, the institutes' directors are at the same time full professors at universities and hold university chairs. All four large PROs are actively engaged in graduate and post-graduate education.

See below a chart illustrating the structure of the German research system (Figure 1).

Figure 1 : Organisational chart of institutions in the field of research and innovation in Germany



BMWi:	Federal Ministry of Economics and Technology	DFG:	German Research Foundation
BMBF:	Federal Ministry of Education and Research	AiF:	Association of Industrial Research Institutes
FhG:	Fraunhofer Society	IfG :	Institutes of Co-operative Industrial Research
MPG:	Max Planck Society	KfW:	KfW Banking Group - State-owned bank (80 % Federal Government, 20 % States)
WGL:	Leibniz Association	GWK:	Joint Science Conference of the Federal Government and the Federal States
AoS:	Academies of Sciences	LGL:	Länder Government Research Organisations
HEIs:	Higher Education Institutions		(State Agencies, other research institutions funded through)
FGL:	Federal Government Research Organisations		State governments)
	(Federal Agencies)	EFI:	Expert Commission on Research and Innovation

Source: Pro-INNO Mini Country Report – Germany 2011.

In Germany several comprehensive programmes have been implemented that aim at stimulating and further strengthening Germany as a location for research and innovation and its successful commercial use. For instance, over the recent years, three main reform initiatives with multi-annual planning were launched jointly by federal and regional governments, namely the '*Hochschulpakt*' (including *'Qualitätspakt Lehre'*), the '*Exzellenzinitiative*' and the *'Pakt für Forschung und Innovation'*, and it is common understanding that all these initiatives will be continued in fu-

[5] For more detailed information concerning company level investment trends in R&D see, for instance, the EU Industrial R&D Investment Scoreboard <link>, most recent version released on Nov 18th 2013.

ture. In fact, developing the research and innovation system in Germany further is among the highest political priorities across the board. Moreover, federal governments seek to amend Art. 91b GG (*'Grundgesetz'*) with the view to open up the legal possibilities federal and regional governments currently have in terms of research and education funding.

2 RECENT DEVELOPMENTS OF THE RESEARCH AND INNOVATION POLICY AND SYSTEM

The financial and economic crisis, across countries and stakeholders, has widely reinforced the consensus that innovation as well as investment in the capacity to innovate is central for economic recovery, persistence of growth, and thus for the achievement of a number of socio-economic goals. Moreover, there is now indeed a greater recognition of the need to move towards new, more inclusive and environmentally sustainable models of growth; in the EU and in Germany alike. However, notable changes in terms of vision of R&D and innovation policy and even more in the established R&I system take time and commonly evolve rather gradually than ad hoc. Accordingly, when reflecting developments of the corresponding policies and trends that are possibly pointing towards a system change, one has to consider a wider time span than just 12 months. Hence, in this section, the most recent developments shall be considered in the context of the changes that occurred during the last couple of years, thus seeking to understand where political emphasis is enforced or removed, what are adjustments of existing instruments, and where eventually a new line and/or a new direction of efforts emerges. However, please see also the previous ERAWATCH Country Reports on Germany for further context information.

2.1 National economic and political context

To date, the German economy has proved encouragingly resilient in a difficult international environment. Employment and prosperity have risen over the past few years and government forecasts assume continued economic growth for 2013 (and beyond). The German government is therefore dedicated to further enhancing the economy's competitiveness in order to safeguard growth and employment in the long term. This approach is at the heart of the government's economic policy strategy (see: Federal Government's Annual Economic Report 2013) and, moreover, an essential contribution to strengthening Europe's economy as part of the Europe 2020 strategy for smart, sustainable and inclusive growth. In this regard, sustainable commercial activity means aligning economic efficiency with ecological and social responsibility.

In the light of the Annual Growth Survey (published 28 Nov 2012) and according to the National Reform Programme (NRP), the priorities defined in the previous year are reiterated for 2013:

- Pursuing differentiated, growth-friendly fiscal consolidation
- Restoring normal lending to the economy
- Promoting growth and competitiveness for today and tomorrow
- Tackling unemployment and the social consequences of the crisis
- Modernising public administration

These priorities reflect the Europe 2020 targets and the related Integrated Guidelines. They are also in line with the Country-Specific Recommendations issued by the Council of the European Union on 10 July 2012[6] and the Compact for Growth and Jobs.[7]

6 Official Journal of the European Union, published on 24 July 2012 C 219/35.

Beyond the priorities set out and refined in the NRP 2013 and thus especially in the light of the efforts concerning budgetary consolidation, the federal government is continuing to make targeted investments in education and research. In 2012, the budget of the Federal Ministry of Education and Research (BMBF) increased by 11% (<link>) and the provisions for 2013 grew by 6.3% compared to 2012 (totalling about €13.75b). Moreover, the draft for the 2014 federal budget provides for a further increase in the 2014 budget for BMBF of about €224 million, up to a total of some €14 billion. <link> For details on the general macro-economic context 2012 – 2013 for Germany and the economic outlook for 2013 (as outlined by the German government) see e.g. the NRP 2013 <link>, especially chapter I, p.4 ff.

With a look at company level, according to a study released by the *Stifterverband* based on surveying annual reports of about 100 globally operating German companies (press release: 07 Sep 2013), evidence suggests that in course of 2012 the German industry has increased substantially its investments in R&D. Accordingly, in 2012 global spending of German firms on R&D in Germany and elsewhere rose by 8.4%. However, when looking at the figures firm by firm, the image turns to be more heterogeneous: about 1/3 of the companies have reported an increase in R&D spending of more than 10% compared to 2011. But, more than 20% of the companies reported decreasing R&D spending. And there are also notable sector differences. The most striking increases (in average across companies) were found for the R&D spending in automotive industries (+9.2%), machinery (+9.4%), chemical industries (7.7%), electric equipment (7.2%), and pharmaceuticals (5.4%). This overall rather mixed evidence should be kept in mind when looking at the recently released BERD figures for Germany at aggregated terms. In fact, BERD increased by about 2% from 2011 till 2012 (+15% since 2009) and the BERD/GDP ratio lately remained about constant at 0.0195. For more details on this please see the following chapters.

Overall, the German R&I system has a good standing in an international comparison and this positioning has been maintained in course of 2012 and 2013 and lately eventually even improved (if benchmarked e.g. against countries which in the light of anti-crisis and austerity measures had to cut down the spending on R&D, HES and related infrastructures). In fact, in its 2013 monitoring report on the German research and innovation landscape, the GWK concluded that the German science system 'holds its good international position' and that the increased investments in science and research[8] evidently pay off as they are proven to be a driver for growth, competitiveness and welfare. It is worth mentioning in this context that Germany remained to be globally top in terms of trading R&D-intensive/high-tech commodities (share in global trade: 12.1%), and, according to the IUS 2013, within Europe, Germany is ranked second just after Sweden in terms of innovativeness (BMBF, 2013: <link>).

2.2 Funding trends

In general, public and private sector R&D spending figures in Germany lately were both rising. In fact, the federal government continued to make targeted investments in education and research even in times of budgetary consolidation. In 2012, the budget of the Federal Ministry of Education and Research (BMBF) increased by 11% (<link>); the provisions for 2013 grew by 6.3% compared to 2012 (totalling about €13.75b) and the draft for the 2014 federal budget provides for a further increase in the 2014 BMBF budget of about €224 million, up to a total of

7 European Council Conclusions, 28/29 June 2012, document EUCO 76/2/12. See also: <link>

8 The GWK points in this context especially to the efforts related to the Pact for Research and Innovation which was launched in 2005 initially for the period 2006 – 2010, but has been prolonged meanwhile until 2015. Federal and *Länder* governments have thus committed themselves to increase the budgets for the main PROs (Fraunhofer, Helmholtz, Max-Planck, Leibniz-foundation, and the DFG) until 2010 by annually 3% and since 2011 by even 5% annually.

some €14 billion <link>. Moreover, similar trends can be seen also in the private sector. For instance, as outlined above in chapter 2.1, the *Stifterverband* found in a recent study (released 09/2013) some empirical evidence suggesting that German firms have increased substantially their investment in R&D (although there was also evidence of sector specifics and notable heterogeneity in this regard). And evidence from the 2013 edition of the EU Industrial R&D Investment Scoreboard points into the same direction. Actually, in the 2013 SB edition, overall 224 German companies have been listed among the top 1,000 European R&D performing companies. Looking at the figures of these companies reveals, in average, a remarkable increase in corporate R&D spending during 2012. In fact, the average growth in R&D spending between 2011 and 2012 (across the 224 German SB companies) was estimated to be at 6.0%; but over the last 3 years just at 6.4% in total. In other words, after several years of self-effacement and a rather cautious attitude in the light of the Euro-crisis, during 2012 German top R&D performing companies apparently returned to invest significantly (more) in R&D activities, which certainly can be taken as a promising signal also for the trends in the rest of the economy.

2.2.1 Funding flows

Germany has set out a target of 3% GDP to be invested in R&D, of which two thirds shall be funded by the private sector and one third by the public. Moreover, by 2015, 10% of GDP should be spent on education and research. As Table 1 below illustrates, currently the total R&D expenditures in Germany correspond to about 2.9% of GDP (2012), and thus remained about constant since 2011, i.e. total volume is close to the overall national target. Moreover, roughly about 2/3 of the total R&D activities is funded by the private sector and 1/3 originates from public budgets, just as set out for the EU-wide indicator. In other words, the R&D investment target for Germany is about to be achieved, which in turn raises the question whether the target has been ambitious enough given the importance of R&D and innovation generally have for the German economy. By the same token, the spending on education, training and research added up to about 9.5% of GDP already in 2010 (according to the German NRP 2013, p.17).[9] Exact figures for later years are not yet available. However, given the fact that the budgets for both research and education have been rising since, one can assume that also this figure meanwhile is getting even closer to the national target originally set out. In the light of the challenges Germany is facing with ensuring an adequately skilled workforce and also with a view to the general education level of the population (which is commonly seen as a rather weak point, see IUS-2013), also with regard to the combined investment target on research and education the question emerges whether Germany should have been more ambitious in terms of setting national targets.

Table 1: Basic indicators for R&D investments

	2009	2010	2011	2012	EU-27 (2012)
GDP growth rate	-5.1	4.0	3.3	0.7	-0.4
GERD (% of GDP)	2.82	2.80	2.89	2.92	2.06e
GERD (€ per capita)	817.2	855.1	923.5	951	529.6
GBAORD - Total R&D appropriations (€ million)	20,348	22,011	23,381	24,604	95,125
R&D funded by Business Enterprise Sector (% of GDP)	1.91	1.88	1.96	1.95p	1.3
R&D performed by HEIs (% of GERD)	17.6	18.1	17.8	18.3	23.8
R&D performed by Government Sector (% of GERD)	14.8	13.7	14.5	14.8	12.4
R&D performed by Business Enterprise Sector (% of GERD)	67.6	67.1	67.7	66.9	63.0

[9] Please note: Comparable figures from EUROSTAT need to be calculated from several different tables (total public and private expenditures on education and training). For 2010, this adds up to about 8.6% of GDP. More recent figures are not available (neither from national statistics nor from EUROSTAT; state: 12/2013).

Share of competitive vs. institutional public funding for R&D*, #, DE	46.2 vs. 44.2	49.5 vs. 41.6	51.4 vs. 40.6	49.6 vs. 42.5	n.a.
Venture Capital as % of GDP (*Eurostat table code tin00141)*	0.030	0.030	0.030	0.021	0.025 (EU-15)
Turnover from Innovation as % of total turnover (*tsdec340*)	:	15.5	:	:	:

Source: EUROSTAT: <link>, data retrieved 02/2014; DE: data according to German Statistical Office <link>, 01/2014; and BMBF (data on institutional funding, <link>)

Notes: p = provisional, e = estimate, d = definition differs, DE = BMBF data, c = own calculations, : = not available

* Please note that the first figure provided for each year in this line corresponds to competitive public funding for R&D (financed by federal government) as a share of total government funding for R&D, while the second figure provides the share of institutional funding for R&D as percent of total (federal) R&D funding. The remaining shares (difference to 100) comprise of the contributions made to international scientific organisations and multinational research centres and, moreover, the funding for R&D at HEIs that is financed by the federal government (which is counted neither as institutional nor competitive funding according to BMBF (2012) – '*Bundesbericht für Forschung und Innovation*', pp. 430ff, <link>). Please note as well that among the share labelled as 'institutional funding', inter alia, there is the block funding of large German PROs (*Resortforschungszentren*, etc.). As the latter may allocate the received funds internally based on a competitive funding mechanism, the provided figures likely underestimate the total share of funds ultimately allocated in a competitive way. In other words, due to the multilayer structure of the German R&I funding system it is impossible to arrive to exact estimates. Accordingly, the provided figures should be treated with caution and rather illustrate the order of magnitude, i.e. not be seen as exact budget shares.

As outlined above in chapter 2.2 with regard to Funding Trends, the budgets earmarked for research and innovation in Germany have expanded remarkably over the past four years (looking at both the public as well as private sector figures). The total expenditures on R&D (GERD) rose steadily from roughly €67b in 2009 to €78b in 2012 (+16.1%), with a 3.1% y-to-y growth between 2011 and 2012. Thus, public support (budget provisions for R&D) and private investments in R&D increased at relative similar pace: GBAORD +20.9% between 2009 and 2012 and on a y-to-y growth basis between 2011 and 2012 +5.2%; BERD +15% between 2009 and 2012 and +2.0% (since 2011). The increase in the public spending was mainly triggered by the HTS-2020[10], which was accompanied by an additional €6b funding effort for the period 2010 – 2013.[11] Moreover, in 2009 and 2010, a series of economic stimulus packages also contributed to higher research and innovation budgets. In turn, economic recovery from the years of crisis (in Germany mainly 2008 and 2009) and lately an improved economic outlook and thus more favourable investment climate for businesses altogether have stimulated the recovery and expansion of business sector R&D (meanwhile well beyond pre-crisis levels).

At the side of the *Länder*, research and innovation budgets were mostly stable or lately slightly rising as the reform of higher education curricula (bachelor and master studies), the increase in the number of students due to a shortening of secondary school time, and an expected further rise due to the abolition of compulsory military service in 2011 have urged state governments to increase funding for HEI.[12] Over recent years, no substantial shifts in the shares of R&D fund-

10 In 2013, the support to projects tackling the grand societal challenges as provided by the Hightech-Strategie HTS-2020 will increase to €2,3b, which is equivalent to +24% compared to 2009 and even + 90% compared to 2005.

11 Source: Bildung und Forschung in Zahlen, p. 14 (Table 9). Note that the federal government decided to increase the budget earmarked for R&D, innovation and education over the current legislation period 2010 – 2013 by €12b (of which €6b were allocated to R&D and innovation related activities as specified in the jointly released new HTS-2020).

12 Based on the *Qualitätspakt Lehre*, in year 2013, an extra of €200m is foreseen to be invested by the BMBF into the improvement of framework conditions and the general quality of higher education. Moreover, as part of the *Hochschulpakt 2020, the Länder* will receive €1.85b for creating extra student places in 2013. BMBF resources for *Exzellenzinitiative* and the *Programmpauschalen* add up in 2013 to a total of €680m (means meant to improve research at universities). In the same regard, the funding provided to HEI as part of the *Pakt für Forschung und Innovation* is due to be increased by 5% annually (i.e. also in 2013). Further points addressed by the BMBF are vocational training with a special focus on disadvantaged kids and youth (increase in spending in 2013 of 16%, i.e. €214m) and long life learning (+26.5%).

ing provided by different funding sources in Germany appear evident (like e.g. abolishing certain programmes, freezing R&D budgets, etc. in the light of anti-crisis measures, ad hoc efforts of budget consolidation and austerity measures as happened in some other EU countries).

The main challenge for the next years will be to maintain the growth path in research and innovation budgets. In the past years, HEIs and PROs primarily profited from increased funding. In the years to come, budgets need to be reallocated in some way to allow for an increased funding of enterprises and cooperative projects, too, especially in those fields of technology where the need for technical progress is particularly high (e.g. energy technologies, E-mobility, health, resource efficiency). See chapter 2.3 below for a discussion of R&I relevant policy challenges. However, as the general economic perspectives appear to be brightening up, which could help unleashing the investments in Germany, additional stimulus for R&D funding might be expected from the business sector in the years to come.

2.2.2 Funding mechanisms

The German system of public R&D funding is based on two pillars: institutional (block) funding and project funding (i.e. competitive allocation of funding). While institutional funding is provided to cover the basic financial demands e.g. of PROs and HEIs as well as the costs of R&D in areas with low significance of third-party funding (fundamental research), project funding is target-oriented and has a rather short to medium-term focus (see BMBF, 2012 – *'Bundesbericht für Forschung und Innovation 2012*', pp. 53ff for details on 'how R&D funding in Germany works').

The legislative base for national allocation of research funding is set by the 'Freedom for Science'-Article 5(3), constitutional law; the joint funding by federal and state governments (Article 91b, constitutional law); and the Federal Budget Code (*Bundeshaushaltsordnung*, BHO).

As outlined above in chapter I, the German Research Foundation (*Deutsche Forschungsgemeinschaft*, DFG) plays a central role in the funding of basic research in Germany, complementing the institutional funding for basic research with project-type funding. DFG thus selects the best research projects by scientists and academics at universities and research institutions on a competitive basis and finances these projects. Funding is commonly awarded on the bottom-up principle based on peer review. In contrast, R&D programmes by ministries are administered and managed by a range of implementation agencies (*Projektträger*), which are mostly located in large research centres. Commonly these programmes provide project funding on a competitive basis. Furthermore, there are several public and private foundations that finance research such as the Alexander von Humboldt Foundation (AvH), Volkswagen Stiftung, Federal Foundation for the Environment, or Fritz Thyssen Foundation. Finally, there is R&D performed in the higher education sector, which is generally financed by institutional funding, public project funding (e.g. Initiative of Excellence, R&D thematic programmes by BMBF) and contract research conducted for industry. See Aschhoff (2013) for further details on the Germany R&I system and a comprehensive analysis of the ERA state-of-play in Germany.

2.2.2.1 Competitive vs. institutional public funding

Given the rather complex landscape of research funding bodies and links among them in Germany, it is difficult to obtain exact figures concerning the total volumes and corresponding shares of competitive vs. institutional (block) funding of R&D.[13] In general, the German gov-

[13] *Block funding* refers to funds which are allocated directly to institutions according to particular formulae or budget negotiations among actors. Such funding is provided through various distribution algorithms, which may include a share based on institutional performance assessments. *Project funding* is broadly defined as money attributed through an open and competitive process to a centre, group, or individual to perform a research activity limited in scope, budget and time.

ernment envisages to increase the share of competitive funding versus institutional i.e. block funding of R&D (insensitive to research performance) basically in all publicly (co-)financed research activities as a mean to leverage the general effectiveness of R&D activities. It is thus assumed that 'competitive money' – including public, private, foreign, EU sources, etc. which are commonly referred to as '*Drittmittel*' – is generally awarded according to stringent quality criteria and subject to a throughout evaluation. Accordingly, a higher share of such *'Drittmittel'* is generally seen as a sign of excellence in terms of R&D. For instance, research institutes receiving public funding for R&D are regularly evaluated and benchmarked in this regard. In this light, also the allocation of public R&D funding increasingly is done based on research performance criteria.

Evidence from the figures allowing to disentangle competitive vs. institutional funding suggest that over the last 10 years a general shift in terms of research funding has taken place already (see in the context the 'JOREP Report' on Joint and Open Research Programs in Germany, 2011). Apparently, a significant share of public R&D funding is distributed in a competitive way rather than by means of institutional funding (see in this regard Table 1, above). However, as far as corresponding data is available, some differences seem to emerge when comparing public funding of research at HEI vs. PROs. Apart from the fact that the corresponding funding bodies differ (*Länder* vs. *Bund*), this is likely due to differences in the main subject of research; i.e. emphasis rather on applied vs. fundamental research. In this regard, it has to be mentioned that the share of competitive funding also seems to vary significantly within each category (HEI vs. PRO). For instance, it is much higher for institutes of the Fraunhofer Association since performing applied science with rather close links to businesses is part of the institutes' missions. Actually, the share of institutional public funding in FhG is at ca. 30%; and a high share of competitive money is even required as part of the institutes' missions (<link>).

In sum, any research performer in Germany who receives public funding for R&D is generally expected to exploit (i.e. tap the full potential) of third-party funding. Strict targets are usually not set out, but individual institutes are regularly benchmarked against their peers and a higher share of *'Drittmittel'* is considered to be an indicator of excellence, which in turn is a criterion for allocating institutional (block) funding in future periods. Admittedly, for some R&D performers it might be obviously easier to receive third-party funding than for others due to thematic subjects of research, e.g. fundamental vs. applied research. However, further leveraging the share of total funds for R&D that are allocated in a competitive way rather than ad hoc by block funding seems to be feasible and also promising with a view to research effectiveness (and finally also the potential commercial use of the research results). But, it has to be mentioned here that for some thematic areas this has also obvious limits. Moreover, the perpetual evaluations, which come along with the competitive allocation of (public) funds, come at certain costs and it is important to keep an eye on the relation of these costs and the potential (marginal) gains in research effectiveness which is expected to be due to the competitive way of allocating the funds. In a recent note (No. 28/2013), the German General Accounting Office (*'Bundesrechnungshof'*) also pointed in this direction by raising the question whether it makes sense to open certain programmes and funding tools to research performers such as HEIs & PROs (esp. WGL), which already receive comprehensive institutional funds; thus eventually crowding out others which rely on project funding only. In sum, while undertaking further efforts to increase the competitive allocation of public funds and also the share of third-party funding of publicly co-financed research in general, it is evident that both pillars of funding – block and project based – will remain to be equally important for the research system as a whole (irrespective of its ratio).

2.2.2.2 Government direct vs. indirect R&D funding14

Governments can choose among various tools to stimulate private-sector R&D. They can offer firms direct support e.g. via grants or procurement or they can use (more or less indirect) fiscal incentives, such as e.g. R&D tax incentives. In Germany, most of these tools are used without remarkable changes in the corresponding legislation over the recent years. For instance, strong efforts are undertaken to stimulate the public~private nexus in terms of R&D collaborations (i.e. carrying out parts of corporate research projects jointly or cooperatively at PROs or HEI). Further examples for direct support measures are awarding grants, co-financing private research activities, and 'innovation-friendly' public procurement. With regard to the latter, a number of German Ministries have committed themselves to apply increasingly procurement standards favouring innovative products and services. However, further increase in volume and enlarging the thematic fields and subjects for the corresponding type of procurement would be desirable.[15]

Besides, there are measures that certainly influence R&D funding (especially in the private sector), which by nature are neither financial incentives nor directly targeting the spending on R&D, such as e.g. promoting excellence in education and skills development, facilitating quality and access to research infrastructures and generally the access to sources of finance, protecting and enhancing the value of intellectual property, and boosting creativity. Measures tackling these issues are at the top of the policy agenda in Germany.

Finally, with regard to financial incentives for performing (corporate) R&D in Germany, subsidized loans and loan guaranties for R&D projects are vital. However, there are no tax credits for R&D activities although the introduction of R&D tax credits and also improved conditions for venture capital (VC) had been enshrined in the federal government's coalition agreement (2009 – 2013). In fact, these measures have not been implemented yet. Nevertheless, as in many other countries, in their fiscal reporting, businesses can either treat R&D as immediate costs and correspondingly reduce their taxable income in the period when the R&D expenditures occurred or chose to capitalise R&D activities (which are then to be depreciated over a longer time span).

Overall, it can be stated that the main emphasis of the German government lies rather on indirect incentives to stimulate R&D funding, but thus less on fiscal incentives rather than on creating, in general, an R&D and innovation friendly environment. And this has not changed over the recent past. A persisting challenge remains to be ensuring appropriate forms of access to finance for R&D (and thus sufficient volume), i.e. especially in terms of Venture Capital (VC) and seed funds. The German position in this regard is remarkably weak and trend figures even appear to be negative (see IUS 2013, p. 32 and also Table 1, above).[16] A lot of efforts have been done in this regard by the German government. However, so far without evident success.

In contrast, there are some examples of successful implementation of programmes that incorporate funding streams covering the entire value creation chain from fundamental research through to market innovation. For instance, among several streams of the 'EXIST' programme, there is the 'EXIST Start up from Science' scheme <link>, which aims at improving the entrepreneurial environment at universities and research institutions and at increasing the number of technology and knowledge based business start-ups.[17] Ultimate goal is facilitating start-ups and thus especial-

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14 *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.

15 See chapter 4.2 for more details on innovation-friendly public procurement in Germany.

16 According to the IUS 2013, p. 32, Germany just achieves about 61% of the EU-27 average in terms of VC investments.

17 The EXIST program is part of the German High-Tech Strategy and is co-financed by the European Social Fund (ESF).

ly spin offs from universities and research institutes (i.e. going from science to market). Another example is the 'Validation of Innovation Potential' initiative, which is also part of the High-Tech Strategy and seeks to stimulate knowledge transfer. It is targeted at public research organisations to improve their transfer abilities and raise their relevance for the regional firm population and by that means facilitates the transfer of results from academic research into marketable products

2.2.3 Thematic versus generic funding

Table 2 below illustrates the distribution of public funding for R&D among thematic fields of research as well as those among the main scientific disciplines. It is thus assumed that 'share of funding' in terms of total GBAORD mirrors thematic priorities. Accordingly, public spending on R&D in the field of industrial production and technology stands out as the main priority (highest share), which corresponds to Germany's economic orientation towards manufacturing. However, what appears striking in this regard is the fact that the funding earmarked for research on environment, energy and health are comparably low and in 2012 not even together add up to the budget allocated to R&D on industrial subjects. In this light, research concerning the corresponding grand challenges may seem to be underfinanced. The same could be said about research on agriculture (given the global challenge of ensuring food security in times of a rising overall population, although the German population in parallel is assumed to be declining) and also with regard to education. Both together just receive the same funding share as defense.

Table 2: R&D funding by thematic field of research as percent of GBAORD

	2005	2006	2007	2008	2009	2010	2011	2012
Exploration and exploitation of the earth	1.8*(d)*	1.8*(d)*	1.7*(d)*	1.9*(d)*	1.8*(d)*	1.7*(d)*	1.8*(d)*	1.6*(dp)*
Environment	3.4*(d)*	3.1*(d)*	3.2*(d)*	3*(d)*	2.9*(d)*	2.8*(d)*	2.7*(d)*	2.9*(dp)*
Exploration and exploitation of the space	4.9*(d)*	4.9*(d)*	4.8*(d)*	4.9*(d)*	4.9*(d)*	4.7*(d)*	4.7*(d)*	4.7*(dp)*
Transportation, telecom and other infrastructure	1.8*(d)*	1.8*(d)*	1.8*(d)*	1.7*(d)*	1.7*(d)*	1.6*(d)*	1.4*(d)*	1.4*(dp)*
Energy	2.8*(d)*	2.9*(d)*	3.5*(d)*	3.7*(d)*	4*(d)*	3.8*(d)*	3.8*(d)*	4.2*(dp)*
Industrial production and technology	12.6*(d)*	12.6*(d)*	12.1*(d)*	11.8*(d)*	12.7*(d)*	14.5*(d)*	15.3*(d)*	13.2*(dp)*
Health	4.3*(d)*	4.5*(d)*	4.7*(d)*	4.4*(d)*	4.6*(d)*	4.3*(d)*	4.7*(d)*	5*(dp)*
Agriculture	1.8*(d)*	2.3*(d)*	2.6*(d)*	2.8*(d)*	3.1*(d)*	3.3*(d)*	2.9*(d)*	2.9*(dp)*
Education	3.9*(d)*	3.5*(d)*	1*(d)*	0.9*(d)*	0.9*(d)*	1*(d)*	0.9*(d)*	1*(dp)*
Culture, recreation, region and mass media	3.9*(d)*	3.5*(d)*	1*(d)*	0.9*(d)*	0.9*(d)*	1*(d)*	0.9*(d)*	1*(dp)*
Political & social systems, structures & processes	:	:	1.7*(d)*	1.8*(d)*	1.8*(d)*	1.8*(d)*	1.3*(d)*	1.4*(dp)*
Defense	5.8*(d)*	6.5*(d)*	6*(d)*	6*(d)*	5.4*(d)*	5*(d)*	4*(d)*	3.9*(dp)*
General advancement of knowledge*	57.6*(d)*	56.2*(d)*	56.2*(d)*	56.5*(d)*	55.5*(d)*	54.8*(d)*	55.7*(d)*	57.1*(dp)*
R&D related to natural sciences*	:	:	25.4*(d)*	24.7*(d)*	23.8*(d)*	24*(d)*	24.1*(d)*	25*(dp)*
R&D related to Engineering Sciences*	:	:	7.5*(d)*	6.6*(d)*	6.9*(d)*	7.4*(d)*	7.2*(d)*	7.4*(dp)*
R&D related to Medical Sciences*	:	:	11.5*(d)*	12.2*(d)*	12.1*(d)*	11.2*(d)*	11.6*(d)*	11.5*(dp)*
R&D related to Agricultural Sciences*	:	:	1.4*(d)*	1.3*(d)*	1.4*(d)*	1.4*(d)*	1.4*(d)*	1.4*(dp)*
R&D related to Social Sciences*	:	:	4.9*(d)*	5.8*(d)*	5.4*(d)*	5.3*(d)*	5.3*(d)*	5.5*(dp)*
R&D related to Humanities*	:	:	5.7*(d)*	5.8*(d)*	5.9*(d)*	5.8*(d)*	6.1*(d)*	6.2*(dp)*

* Sum of R&D financed from General University Funds (GUF) and sources other than GUF
Source: EUROSTAT (table code: gba_nabsfin07)

A slightly different image emerges with a look at the distribution of GBAORD funding among the scientific disciplines. In fact, in this regard natural sciences and medicine appear to be the priority areas. It is thus remarkable that – given the corresponding time series as provided by EUROSTAT (i.e. the lower part of Table 2) – there is no evidence of any shifts in the distribution of funds among scientific disciplines. In fact, from 2007 until 2012, the distribution remains virtually unchanged. In other words, reallocation of funds was apparently done within the disci-

plines thus concentrating on certain thematic subjects/core areas, which gives some reason to assume a rather holistic approach towards research. Moreover, it can be assumed that the general distribution of resources and the corresponding trends as evident from the thematic subjects (not from disciplines!) point into the right direction in order to address the grand challenges, namely reducing funds earmarked for defense and in turn increasing especially R&D spending on energy, health and agriculture (see upper part of Table 2, above).

2.2.4 Innovation funding

In the light of the provisions set out by Horizon 2020, which covers the entire innovation chain from research to the market while the previous programme (FP7) was more research oriented, nowadays more and more governments across Europe are allocating funds to innovation activities, thus moving from purely R&D to R&I funding. In Germany, this has emerged already well before Horizon 2020. However, funding for research and innovation activities, in Germany, cannot be clearly disentangled as the corresponding measures are strongly interwoven. A good example is the Pact for Research and Innovation[18], which is set up to ensure funding for both R&D and innovation activities. The corresponding budget line is due to be increased by five per cent every year between 2011 and 2015. However, reliable figures concerning total public budgets earmarked for either research or mere innovation activities are not available, which is also due to the multilayer nature of the German R&I system and the numerous actors and funders in this field. Accordingly, assessing the balance between research funding and innovation funding is not trivial. Overall, as the early shift from targeting R&D towards R&I suggests, Germany seems to be on the right track in this regard. Good performances in terms of innovation indicators (such as patenting activities, etc.; see IUS-2013) support this hypothesis. In fact, the share of innovative companies in Germany, which received some public support for their innovation activities, was at 18% in 2012 and thus remained about constant compared to 2010. Nevertheless, this level is well above the 12% in 2006. As outlined by a comprehensive report on the German Innovation Survey (see: Rammer et al, 2014: <link>), this increase in terms of (companies') innovation funding was mainly due to efforts at federal level: BMWi and BMBF both increased significantly the number of companies benefiting from their corresponding support programmes. In 2012, about 13% of all companies actively innovating in Germany received funding from federal budgets, while the share of companies benefiting from *Länder* programmes was at 6% only. 4% received EU funding for innovation projects. In research-intensive industries, in Germany, even 42% of all companies received public support for innovation. In the remaining industries, this quota was at 20% and for knowledge-intensive services at 17%. Although all these figures appear quite promising, further efforts in this regard and especially in terms of linking the research activities at PROs and HEI with 'turning ideas into innovations' and developing these towards the markets – i.e. involving companies and entrepreneurs – appears to be desirable.[19]

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18 This pact is designed to give financial planning security to institutions that are jointly funded by *Bund* and *Länder* , such as Fraunhofer, Max Planck, Helmholtz and Leibniz institutes as well as the DFG (as a research funding organization).

19 In this light, as a one-stop shop for German research, science, and innovation, the German Centre for Research and Innovation (*Deutsche Wissenschafts- und Innovationshäuser;* DWIH) pools resources, ideas, and competencies. See more at: http://www.germaninnovation.org. Another relevant contact point for public R&D and innovation programmes is the Federal Funding Advisory Service on Research and Innovation, offering companies (in particular SMEs), HEIs and research institutions straightforward access to details on Federal, *Länder* and EU funding. These advisory and information services are especially designed to support and assist applicants for research and innovation funding.

Another way to assess innovation funding is looking at the regional dimension. In this regard, the BMBF Innovation Initiative Entrepreneurial Regions ('*Unternehmen Region*') stands for innovation-oriented regional alliances, which develop a region's identified core competences to clusters on a high level and with strict market orientation.[20] With this aim in mind, the BMBF has systematically developed a series of programmes for East Germany ('*Neue Bundesländer*') since 1999. The individual programme lines[21] seek to improve the conditions for innovations and set the course for the long-term success of regions ("clusters"). All programmes represent the basic principles of the BMBF innovation support policy and thus of 'Entrepreneurial Regions': lateral thinking, cooperation, strategic planning and entrepreneurial action. The most recent initiative is the 'Zwanzig20 – partnership for innovation' ('*Partnerschaft für Innovation*'), which was launched in 2012. In July 2013, the first 10 consortia were selected and received funding.[22] The BMBF has earmarked for this programme a total budget of €500m until 2019. <link>

2.3 Research and Innovation system changes

In general, no substantial system changes occurred in course of 2013 in Germany mainly as this period coincided with the pre-election period for the new *Bundestag*. The parliamentary elections took place on 22 Sep 2013 and brought that the former coalition of CDU and FDP couldn't be continued (FDP failed to receive 5% share of votes and therefore is not represented in the '18th Bundestag'). In other words, a new government needed to be formed, thus bringing together different political forces. The collation agreements have just been concluded and the new government took office mid Dec 2013, i.e. the vision and the provisions the new government will set out for the years to come still needs to be seen. However, it is rather likely that there will be no radical changes in the given R&D and innovation system as it has widely proven to be working fairly well. Nevertheless, the new government (coalition between the largest political parties CDU and SPD) has a strong majority (> 2/3 of MPs), which allows even for changing the constitution (something that is rather difficult otherwise). In this light, the formerly discussed reform of the German federalism and thus eventually redistributing the responsibilities for education (including HES) and research among regional and federal governments might become again an agenda point for the political debate. See in this regard e.g. the considerations concerning need for policy action as presented in the ERAWATCH Country Report for Germany 2012.

In an effort to reflect the development of the German research and innovation system over the last years, in its 2013 Report (<link>), the German expert commission on research and innovation ('e-fi') identified priority fields of action that should be addressed by the political stakeholders during the 18th legislative period (2013 – 2017). The EFI Expert Commission recommends:

- setting ambitious R&D and educational budget targets for the year 2020

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20 The programmes' aspirations are generally based on the fact that the most innovative products and applications are almost exclusively the result of highly specialized and integrative knowledge from many sources, minds and organizations of widely varying origins and orientation. In "Entrepreneurial Regions", this philosophy is closely tied to an entrepreneurial approach.

21 Innovative Regional Growth Cores (*Innovative regionale Wachstumskerne*, since 2001), with GC Potential (*WK Potenzial*, since 2007), Centres for Innovation Competence (*Zentren für Innovationskompetenz*, ZIK, since 2002), Innovation Forums (*Innovationsforen*, since 2001), InnoProfile (since 2005), ForMaT (since 2007), Twenty20 – Partnership for Innovation (German: Zwanzig20 - *Partnerschaft für Innovation*, since 2012), InnoRegio (1999-2006).

22 The consortia will carry out research on a wide spectrum of thematic subjects such as innovative materials for construction, new medicines and therapies, and affordable and clean energy.

- enabling participation of the federal government in institutional financing of university research and education
- applying a uniform financing key to non-university research institutions
- expanding the Freedom of Science Act to tertiary education institutions
- developing funding concepts for research following expiry of Higher Education Pact, Pact for Research & Innovation and Excellence Initiative
- supporting innovation financing via R&D tax credits for companies
- improving framework conditions for venture capital financing
- further modernizing patent and copyright systems
- developing and implementing a systematic approach for R&I policy evaluation
- focussing the High-Tech Strategy 2020
- improving coordination of climate, energy and innovation policies
- facilitating immigration of highly qualified foreigners
- taking more advantage of the potential of women in business and research

Further suggestions concern, for instance, the stimulation of 'Open Access' to research findings,[23] a further harmonization of the EU patent system and replacing the EPO bundle patent in the medium term with the unitary European patent,[24] exploiting the full potential of innovation-oriented public procurement, reinforcing the efforts that aim at improving the framework conditions for new/growing enterprises, and setting the ground for increased access to crowd-funding in Germany and harmonizing the corresponding regulatory framework at a European level.

In a similar attempt, also the German Science Council (*Wissenschaftsrat*, WR) discussed the perspectives of the German research system and outlined some recommendations for the 18th legislative period <link>. In particular, a bundle of measures is suggested that aim at realigning the packages which are due to expire in the coming four years (*Exzellenzinitiative, Hochschulpakt, and Pakt für Forschung und Innovation*). In this regard, the WR pointed out that – in order to keep and further improve the performance and dynamism of the German research system – it is of outmost importance to keep on earmarking the substantial financial resources currently spend on the mentioned packages by federal and regional governments for investment in the R&D system. Other recommendations tackle strategic co-operations, which are seen as essential for any fur-

23 Yet this should also include protecting the interests of researchers involved. The development and expansion of open access journals and repositories should be further supported via public funding, with the aim of making open access publishing appealing to researchers. In the design of new structures it should be ensured that these are viable in the long term and as efficient as possible. The EFI Commission, in its 2013 report, recommends in this regard integrating a contractually bound, indispensable second publication right into the Copyright Act for academic writers whose publications originate in research activities that were largely financed by public resources. This right shall take effect within a reasonable period of time after initial publication. If scientists hold the right to second publication, they should be obliged in the case of publicly funded projects to publish their research findings online and free of charge upon expiry of the term.

24 Fees should be designed attractively in order for the new system to be favoured over the old bundle patent system, while at the same time effectively limiting incentives for increased filing of low-quality patent applications. To maintain current high standards and to deal with an expected increase in the number of patent applications, the European Patent Office requires corresponding equipment and administrative support structures. The highest standards should be applied to the selection and specialised training of judges and to the ongoing support of patent courts, which are due to be established as part of the Central Division. Moreover, the expertise and current benefits of the German system need to be integrated into the new system.

ther improvement of capacity and performance of the German research and innovation system. In this regard, the WR recommends strengthening the existing measures that aim at intensifying cooperation between HES and PROs and to enable more individual independence in strategic decisions. Further suggestions concern the conditions for occupational careers in science and HES; for instance calling for a more systematic and more structured procedure in terms of doing a doctorate in Germany and, moreover, recommending to introduce additional categories of personnel (beside the professorship) in order to open up new and eventually more attractive development chances for scientific staff.

2.4 Recent Policy developments

In general, structural reforms with regard to the German R&D and innovation system were continued in course of 2012 and 2013, especially the '***Excellenzinitiative'*** (outlook: continue as before) and '***Pakt für Forschung und Innovation'*** (outlook: further expanding). However, both initiatives formally expire in course of the legislative period that has just started (new government just took office in Dec 2013). In other words, both initiatives need to be formally prolonged by the new government. Below, some (recent) policy developments are outlined in brief.

Raising budget of the Federal Ministry of Education and Research: The federal government is continuing to make targeted investments in education and research even in times of budgetary consolidation. In 2012, the budget of the Federal Ministry of Education and Research (BMBF) increased by 11% (<link>), the provisions for 2013 grew by 6.3% compared to 2012 (totalling about €13.75b) and, despite the attempt of budgetary consolidation, the Government draft for the 2014 federal budget provides for a further increase in the 2014 budget for the BMBF of about €224 million, up to a total of some €14 billion. <link>

The BMBF Innovation Initiative **"Entrepreneurial Regions"** (*Unternehmen Region*) stands for innovation-oriented regional alliances which develop a region's identified core competences to clusters on a high level and with strict market orientation.[25] With this aim in mind, the BMBF has systematically developed a series of programmes for East Germany (*Neue Bundesländer*) since 1999. The individual programme lines[26] seek to improve the conditions for innovations and set the course for the long-term success of regions ("clusters"). All programmes represent the basic principles of the BMBF innovation support policy and thus of 'Entrepreneurial Regions': lateral thinking, cooperation, strategic planning and entrepreneurial action. In this regard, the most recent initiative is the **Zwanzig20 – partnership for innovation** (*'Partnerschaft für Innovation'*), which was launched in 2012. In July 2013, the first 10 consortia were selected and received funding.[27] The BMBF has earmarked for this programme a total budget of €500m until 2019. <link>

Further, there is a new National Research Strategy **BioEconomy 2030** <link>, which aims at reducing oil dependence by use of renewable resources. The federal cabinet adopted this strategy on 17 July 2013 to strengthen the bio-based economy in Germany and reduce dependence on fossil fuels. The bio-based economy is a fast growing market and Germany is already at the fore-

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25 The programmes' aspirations are generally based on the fact that the most innovative products and applications are almost exclusively the result of highly specialized and integrative knowledge from many sources, minds and organizations of widely varying origins and orientation. In "Entrepreneurial Regions", this philosophy is closely tied to an entrepreneurial approach.

26 Innovative Regional Growth Cores (*Innovative regionale Wachstumskerne*, since 2001), with GC Potential (*WK Potenzial*, since 2007), Centres for Innovation Competence (*Zentren für Innovationskompetenz*, ZIK, since 2002), Innovation Forums (*Innovationsforen*, since 2001), InnoProfile (since 2005), ForMaT (since 2007), Twenty20 – Partnership for Innovation (German: Zwanzig20 - *Partnerschaft für Innovation*, since 2012), InnoRegio (1999-2006).

27 The consortia will carry out research on a wide spectrum of thematic subjects such as innovative materials for construction, new medicines and therapies, and affordable and clean energy.

front of developments. By means of the new strategy this position shall be further consolidated while implementing new technologies, creating jobs and improving environmental protection. According to the BMBF, with the new bio-economy strategy and the future-oriented project '**Renewable resources as alternatives to oil**' the research foundations for the bio-based economy in Germany are due to be improved.

In June 2013, the new initiative "**r4 - Innovative technologies for resource efficiency – Research for the supply of raw materials of strategic economic importance**" was presented <link>. This funding measure tackles the availability of raw materials of strategic economic importance as being crucial for an export-oriented and industry-based Germany to secure employment and prosperity. Research and industry are invited to work jointly on new strategies and technologies and to develop innovative, economic and environmentally friendly solutions to respond to the increasing risks in terms of security of supply and the increasing costs for raw materials. The BMBF supports such research by funding the German partners of corresponding R&D projects. The initiative is a further concretion of the High-tech Strategy 2020 in the area of climate/energy (valid for the period 31.07.2013 - 30.01.2015) and is embedded into the BMBF-Programme on "*Wirtschaftsstrategische Rohstoffe für den Hightech-Standort Deutschland*", which has been released in October 2012 and, moreover, forms also part of the framework programme '*Forschung für nachhaltige Entwicklungen* (FONA)'.

National Research Infrastructure Roadmap: On April 29th 2013, the Federal Ministry of Education and Research (BMBF) presented a National Roadmap for Research Infrastructures (RI) in Germany ('*Roadmap für Forschungsinfrastrukturen*'). The launching of the new strategy is meant to support and guide political decisions in terms of research infrastructures (i.e. for instance large scale research infrastructures of national/European importance, comprehensive experiments, etc.). It is assumed to be an impetus towards joint planning of research infrastructures (at federal and *Länder* level in Germany and with regard to large scale RI development in the EU). <link>

German ERA position paper 2013: In its communication on 'A Reinforced European Research Area Partnership for Excellence and Growth', released in 07/2012, the European Commission submitted proposals for further development of the corresponding process. In February 2013, the German federal government replied by means of a corresponding Position Paper <link>. Thus, the German government argues against a series of EC suggestions related to ERA-priority III (e.g. introducing a special 'Industry PhD', an accreditation mechanism for human resources management, and also the requirement of publishing all vacancies on EURAXESS in English). Moreover, it points to the general need of flexibility and in this regard recalls the importance of subsidiarity (esp. with regard to ERA-priority II, IV, and V). No urgent need for (own) action is seen with respect to priority I. Finally, the German government also commented on the ERA monitoring mechanism (EMM).

2.5 National Reform Programme 2013 and R&I

Among the Country-Specific Recommendations for Germany for the period 2012 to 2013, as approved by the Council of the European Union in 2012,[28] the German government – inter alia – was recommended to take action within the period 2012 – 2013 in terms of **spending on education and research** (…). Hence, investing in education and research was highlighted in the NRP 2013 as a top priority for both the federal government and the *Länder*. The federal government underlined that it is due to exceed its investment target of €12bn for education and re-

[28] Council recommendation, 10 July 2012, Official Journal of the EU, published on 24 July 2012. The recommendations were based, in particular, on the European Commission's evaluation of reform efforts made to date, as part of the European Semester 2012.

search during the 17th legislative period, with a forecast total of approximately €13.3bn (see NRP 2013, p. 9). Moreover, it is pointed out that investments in education and research have also become more efficient, for example, as part of the Skills Development Initiative for Germany, the High-Tech Strategy 2020 and within the scientific sector (see in this regard NRP 2013, p. 9 and the correspondingly cited documents).

Beyond the explicit Council recommendations and the correspondingly derived main priorities of the German NRP 2013 (the latter was briefly outlined above in section 2.1), there are indeed a number of goals and measures set out in the NRP with R&I relevance. In the light of the five headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth in Europe,[29] which the German government has identified as important objectives for German policy and adopted accordingly, *Bund* and *Länder* have set out jointly several national quantitative goals, which are partly even more ambitious than the EU-wide headline targets (<link>). For instance, with regard to headline target (2) on R&D spending, the R&D expenditures in Germany should rise to 3% of GDP and, moreover, the spending on education and research in Germany should rich 10% of GDP until 2015. Currently, total R&D expenditures in Germany are at about 2.9% of GDP (2012) – with in fact roughly 2/3 stemming from the private sector and 1/3 from the public sector, just as set out for the EU-wide indicator (see Table 1 above). The spending on education, training and research added up to about 9.5% of GDP already in 2010 figures (according to the German NRP 2013, p.17).[30] Exact figures for later years are not yet available. However, given the fact that the budgets for both research and education have been rising since, one can assume that also this figure is getting closer to the national target originally set out.[31]

With regard to headline target (4) on education levels, beside reducing the proportion of early school leavers and people leaving vocational training to below 10% and increasing the percentage of 30 to 34 year olds with a tertiary or equivalent educational qualification to at least 40% (both set out as EU-wide indicators), Germany turned the first 1:1 into a national target and aims at increasing the percentage of the latter even to 42%. According to figures from 2011, the proportion of early school leavers and people leaving vocational training in Germany is at about 11.5% (i.e. target still not reached).[32] However, the share of 30 to 34 year olds with a tertiary or equivalent educational qualification was at 42.2% already in 2011. The latter, and also the fact that the R&D investment target of 3% is almost achieved, too, gives reason to argue that the national targets as set out by *Bund* and *Länder* governments – even if going beyond the EU-wide indicators – were not ambitious enough already from beginning.

Of course, individual quantitative indicators can only provide limited information in relation to evaluating the relevant political fields. In terms of evaluating progress towards national objec-

29 (1) Fostering employment, (2) improving the conditions for innovation, research and development, (3) reducing greenhouse gas emissions and increase energy efficiency and energy from renewables, (4) improving education levels, and (5) promoting social inclusion, in particular by reducing poverty.

30 Comparable figures from EUROSTAT need to be calculated from several different tables (total public and private expenditures on education and training). For 2010 this adds up to about 8.6% of GDP. More recent figures are not available (neither from national statistics nor from EUROSTAT; state: 12/2013).

31 Various measures have contributed to this development. The HTS encompasses the Federal Government's R&D activities in five high-demand areas: climate/energy, health/nutrition, communications, mobility and security (see NRP 2012, Item 91). Under the Action Plan for the High-Tech Strategy, specific scientific and technological goals have been defined for 10 'forward-looking projects'. These goals are underpinned by measures implemented by government, industry and the scientific sector. As part of the HTS, an innovation policy plan has been drafted to boost Germany's innovative capabilities. The Länder have also developed and successfully implemented new strategies to fortify their innovation centres. These Länder programmes are delivering a fresh and sustainable impetus to research and innovation and in some cases, setting best-practice examples for future programmes.

32 Note: Between 2006 and 2011, the percentage of school leavers without a lower secondary school leaving certificate (*Hauptschulabschluss*) dropped from 8.0 to 6.2%. (source: NRP 2013, Box 2, p. 22).

tives, other factors and measures – particularly those of a qualitative nature – must also be taken into account. In general, Germany made further progress in relation to implementing the Europe 2020 Strategy over the past year, in each of the five core areas. Moreover, in the federal government's view, also the progress made to date on developing the European Research Area (ERA) has been largely positive. In fact, Germany is actively involved in the implementation of all initiatives. These include the identification of 10 themes as the focus of joint programme planning initiatives, the compilation of several strategic research agendas and the rollout of initial joint funding activities, all of which are designed to address today's major social challenges. The federal government declared that it will continue to provide active support for future development of the ERA, based on the progress made so far. For further details on goals and achievements see in particular the NRP 2013 (e.g. p. 20 ff. concerning R&D and p. 22 ff., esp. Box 2, with respect to the capacity and quality of the German education system).

2.6 Recent evaluations, consultations, foresight exercises

The most comprehensive evaluation of the German R&D and innovation system is provided by EFI (Expert Commission on Research and Innovation) in its annual reports on Research, Innovating and Technological Performance in Germany (available in <DE>, <ENG>). The most recent (6th) report was released in February 2013 (it is thus mainly relying on information from 2010 and 2011) and has been widely reflected in this Country Report. An updated EFI report should be released in February 2014. In its 2013 Report, the expert commission emphasises (again) that for Germany a strong research sector is imperative for succeeding in the global competition. In the light of the federal elections in September 2013, the Expert Commission discussed major developments during recent years and identifies priority fields of action that should be addressed by the political stakeholders in the new legislative period (see briefly summarised in chapter 2.3, above). In this context, for instance, the EFI Commission recommends setting ambitious R&D and educational budget targets for the year 2020 (i.e. going e.g. well beyond the current 3% of GDP goal for R&D investments). Furthermore, it is argued for evaluating innovation policy measures based on randomised experiments and that such randomised evaluations should be included as one of the standard tools in the evaluation portfolio of public R&D funding in the future. This is assumed to be particularly useful in areas where large numbers of applicants are anticipated and where an oversubscription of funds can be expected due to limited budgets. The EFI Commission specifically recommends commencing an evaluation on the basis of a randomised allocation of funds in the context of the ZIM, a funding programme designed for supporting innovative SMEs. According to EFI, the findings of such evaluations could lead to considerable efficiency gains and thus to a much better use of scarce R&D subsidies. Moreover, EFI commissions a number of research studies analysing and evaluating particular aspects of the German research and innovation system (<link>). See for instance the study No. 06/2013 on 'Performance and Structures of the German Science System 2012', which in turn feeds into the elaboration of the above mentioned EFI Report(s).[33]

Another source of comprehensive evaluations is the German Council of Science and Humanities (*Wissenschaftsrat, WR*), which provides advice to both federal and state governments. The WR releases periodically recommendations concerning the German R&I and education system and studies dedicated to related aspects. Such recommendations commonly rely on comprehensive

[33] Other studies concern e.g. education in Germany (No. 01/2013), industrial research and innovation (No. 02, 03, 04, o7, 08, 13/2013), patents and IPRs (No. 05/2013), and R&D&I policy aspects (studies No. 10, 11, 12/2013).

considerations of system relevant aspects of the research and innovation landscape and might therefore be seen as results of throughout evaluations <link>. Some points of a recent report (R&I policy issues to be tackled during 18th legislative period) are outlined above in chapter 2.3.

The *Gemeinsame Wissenschaftskonferenz* (GWK) elaborates annually the GWK Monitoring Report ('*GWK Studie – Pakt für Forschung und Innovation: Monitoring Bericht 2013*'), which evaluates the achievements made with regard to the national 'Pact for Research and Innovation' and points to corresponding policy needs. The 2013 report presents the current state of play – thus acknowledging explicitly the achievements made so far – and outlines where the Expert Commission still sees room for further improvement as, for instance, with regard to the general transition towards more flexible institutional framework conditions for R&D and innovation in Germany <link>.

Finally, the BMBF is carrying out comprehensive foresight activities (BMBF Foresight), which is used as a strategic instrument of the ministry. It provides technology foresight and the determination of future societal needs in terms of research and development. With a time horizon of 15 years, BMBF Foresight casts a long-range look into the future in order to provide guidance for early agenda setting and prioritization in German research and innovation policy. The process is carried out cyclically and in several phases: search & analysis, transfer, and preparation of the next cycle. In May 2012, the second BMBF Foresight Cycle was started with a new two-year search and analysis phase. While the first cycle (search phase: 2007-2009) put emphasis on possible future technological developments ("technology push"), the focus will now be on a demand perspective ("demand pull"). For this purpose, societal trends, challenges, and needs will be noted and evaluated as constraints on research and technology in order to gather information for a demand-driven research and innovation policy. The integration of national and international expertise ensures the validity of the results <read more about BMBF Foresight Cycle 2>.

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

Growth is increasingly related to the capacity of regional economies to change and innovate. Regions and cities have become the primary spatial units where knowledge is transferred, innovation systems are built and competition to attract investments and talents takes place. Regions are thus an appropriate level for stimulating innovation: Many regional governments have important competences and budgets in the field of innovation. Their geographical proximity facilitates the acquisition, accumulation and use of knowledge. Regions' performance depends not only on that of enterprises and research institutes but also on interactions between different stakeholders, enterprises and organizations, whose knowledge and know-how are build up over time.

From a conceptual point of view, Research and Innovation Strategies on Smart Specialisation (RIS3) may emerge in three forms: fully at national level (examples are territorially small Member States such as Malta, Cyprus, Baltic States, etc.), only regionally (i.e. no nationwide strategy, but explicit iS3 concepts at regional level), and as combination of the two (i.e. national overarching strategy complemented with further individual regional strategies; as e.g. in Spain). Germany is an example of the second form, i.e. conceptualising explicit smart specialisation strategies is due to be done at regional level. This is mainly due to the federative nature of the country and the diversified responsibilities in terms of R&D and innovation activities between federal and regional level. In fact, there is no document explicitly outlining smart specialization strategies for Germany as a whole. Nevertheless, as apparent by the German Position concerning the Partnership Agreement for the Structural Funds, Germany implicitly has an overall strategy towards RIS3, namely its HTS 2020. In fact, the HTS 2020 can be seen as a general frame and thus ad-

umbrates any further strategic considerations concerning R&I.[34] But, given the German constitution and the corresponding distribution of responsibilities, the *Bund* is not expected to get involved into the drafting of individual *Länder* strategies nor to assume a coordinating role meant to ensure compatibility and mutual reinforcement of the individually developed strategies at regional level. The latter, if existent, could proof to be beneficial as the *Länder* apparently follow somewhat different approaches in drafting their RIS3 strategies without having agreed on an evident mechanism that ensures coordination and the ultimate compatibility of their individual strategies. Eventually, the regional concepts will be bundled finally by the federal government in the light of its responsibility for European Social Fund resources (ESF). With regard to the latter, currently, an operational programme is being developed at federal level, leaded by the *Bundesministerium für Arbeit und Soziales* and thus involving *Bundesministerium für Wirtschaft und Technologie*, *Bundesministerium für Bildung und Forschung*, *Bundesministerium für Familie, Senioren, Frauen und Jugend*), and the *Bundesministerium für Verkehr, Bau und Stadtentwicklung*. This joint programme at federal ministry level is foreseen to be released in 2014 <link>.

In turn, the *Länder* are responsible for fundraising from the European Regional Development Fund [ERDF] and – in the light of the corresponding ex-ante conditionality – also for elaborating appropriate individual RIS3 strategies. These regional strategies are currently in the making or widely under revision (with external support provided e.g. by the VDI as for instance in the cases of RIS3 in Thuringia and Saxony-Anhalt). At 12/2013, the only RIS3 strategy released and also adopted by the regional parliament was the one of Saxony. It foresees support to any KETs and no prioritization of certain branches. Moreover, Berlin and Brandenburg presented in 11/2013 a revised joint RIS3 strategy (for discussion). It builds upon the joint innovation strategy 'innoBB' <link>), which was enacted by the two state governments on 21 June 2011. The main focus is on clusters, acceleration of technology transfer, and driving sustainable innovations. The following key clusters have been identified: healthcare industry; energy technologies; transport, mobility, logistics; ICT, media and creative industries; and photonics. Cross-sectional topics are: new materials; production and automation technology; clean technologies; and security. SWOT analyses have been conducted at sector specific and sub-regional level (<more details>).

Overall, for the programming period 2007-2013 (especially with regard to ERDF), there are altogether 17 regional development programmes (<link>, see also 'Operationale Programmes' for ESF and ESIF), but many of them are due to be replaced soon by a new one; namely the first explicit 'RIS3 strategy'. For instance, according to information from the ministry in Thuringia, the tentative planning foresees that the draft of this RIS3 strategy should be ready by February 2014 in order to be discussed (and possibly adopted) in the region's parliament in March 2014. RIS3 strategies for Saxony-Anhalt and NRW apparently have been drafted already, but they are not yet public. For further regions no information is available on whether the existing Operational Programmes are due to be revised in the nearer future (i.e. turned to be RIS3 and thus will follow smart specialisation principles). Although the latter appears to be rather likely, it can be observed that not all German regions have undertaken explicit efforts in terms of elaborating an own RIS3. In fact, by December 2013, only few regions (Berlin, Brandenburg, Saxony, and Saxony-Anhalt) had registered to the Smart Specialisation Platform of the EU and thus demonstrated search for competent support in this regard. However, this does not necessarily mean that the other regions do not engage in smart specialisation. In fact, in a study released by ISI Fraunhofer in 2013 <link>, based on a comprehensive analysis of the regional innovation system and the corresponding policies, it is pointed out that some German regions apparently are working on

[34] There is evidence that the *Bund* tries to establish a corresponding National Platform, for instance, by efforts with the *Bund-Länder Ausschuss für Forschung und Technologie*. However, no further information is currently available on this.

and according to smart specialisation principles already for more than 15 years. Bavaria was explicitly named in this regard as an example.

3 PERFORMANCE OF THE NATIONAL RESEARCH AND INNOVATION SYSTEM

As outlined above in chapter I and II, the German national research and innovation system (RIS) is compared to other EU-27 countries comparably well developed. According to the Innovation Union Scoreboard 2013 (IUS-2013), Germany is ranked as second just behind Sweden, i.e. lately Germany is climbing in this regard as it overtook Finland and Denmark compared to earlier IUS editions (since 2010). All four mentioned countries are classified as 'innovation leaders' among the EU (see PRO INNO Europe, 2013), and within this group Germany exhibits about the same average growth rate in terms of innovation performance as Finland and outpaces in this regard Sweden; i.e. Germany appears to be further catching up with the top performer Sweden. With a look at all EU countries, after years of relative convergence in innovation performance, recent evidence as presented in the IUS-2013 points to rather divergent trend patterns, i.e. differences in countries' innovation performance have started to increase. See in this regard IUS-2013, Box 1, p.12, especially the estimates concerning sigma and beta-convergence.[35]

3.1 National Research and Innovation policy

In the Global Competitiveness Report 2012-13, Germany is ranked highest among EU countries in capacity for innovation, second highest (after Finland) in company spending on R&D, and 6th in the EU on university-industry collaboration on R&D. Also according to the Innovation Union Progress Report at Country level (EC, 2013a), Germany is among the top performers in almost all categories even with growth rates above the median (estimated as an average for 2000 - 2011), i.e. Germany tends to be going further ahead. This holds in particular for the indicators R&D Intensity, Excellence in S&T, and the Index of Economic Impact on Innovation. In contrast, the Knowledge Intensity of the Germany economy was evaluated just at EU average (in terms of both absolute level and growth). And, although the contributions of high- and medium-tech sectors to the trade balance in Germany in 2011 were found to be significantly above EU average, the corresponding trend patterns over the period 2000 – 2011 appear to be stagnating or even slightly negative. This gives reason for having a more detailed look at the IUS indicators. Corresponding evidence suggests that relative strengths of Germany are in 'Innovators', 'Intellectual Assets', 'Firm Investments', and 'Economic Effects'. Relative weaknesses are seen in terms of 'Open, Excellent and Attractive Research Systems' (9th position among the EU countries) and 'Human Resources' (11th). Moreover, 'Finance and Support' is just above EU average (9th position). High growth is observed for 'Innovative SMEs Collaborating With Others', 'Community Trademarks' and 'License & Patent Revenues From Abroad' (thus however still catching up just with EU-27 average). A strong decline is observed for the indicators 'Non-R&D Innovation Expenditure' and 'Sales of New-to-Market & New-to-Firm Innovations'. Growth performance in

[35] Beta-convergence applies if a less innovative country tends to grow faster than a more innovative country. Beta-convergence can be measured by the partial correlation between growth in innovation performance over time and its initial level: a significant negative correlation confirms beta-convergence. The correlation between "2008" innovation performance and 2008-2012 innovation growth is -0.220 but not significant indicating that there is no beta-convergence. Sigma-convergence occurs when the spread in innovation performance across a group of economies falls over time. This spread in convergence is measured by the ratio of the standard deviation and the average performance of all EU27 Member States. This spread, however, has been reduced up until last year confirming sigma-convergence but the rate of convergence has been slowing down and has even reversed into divergence in 2012.

terms of 'Linkages & Entrepreneurship' is well above EU average, but well below with regard to 'Firm Investments' (see: IUS-2013, p.32 ff). Table 3 below presents a series of further and more disaggregated indicators used to characterise national research and innovation systems' state of play and their performance. Apart from the absolute levels in each category, the average corresponding indicators' growth and the relative standing compared to the EU average is illustrated.

Table 3: Selected indicators characterizing the German national RIS
(Figures according to Innovation Union Scoreboard 2013, IUS-2013, p. 70ff, <link>)

	Absolute	Annual average growth [%]	IUS-2013 indicator value relative to the EU-27 (EU27=100)
HUMAN RESOURCES			
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	2.7	1.9	180
Percentage population aged 25-64 with completed tertiary education	30.7	3.7	89
OPEN, EXCELLENT AND ATTRACTIVE RESEARCH SYSTEMS			
International scientific co-publications per million population	715	5.3	238
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	11.64	2.0	107
FINANCE AND SUPPORT			
R&D expenditure in the public sector as % of GDP	0.94	5.5	125
Public funding for innovation (i.e. non-R&D innovation expenditure)*	0.88	-4.8	157
FIRM ACTIVITIES			
R&D expenditure in the business sector as % of GDP	1.90	1.8	150
Venture capital and seed capital as % of GDP	0.88	-0.9	61
LINKAGES & ENTREPRENEURSHIP			
Public-private co-publications per million population	75.5	1.9	137
Intellectual assets			
PCT patents applications per billion GDP (in PPS€)	7.42	-0.5	190
PCT patents applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	1.85	0.8	193
OUTPUTS			
ECONOMIC EFFECTS			
Medium and high-tech product exports as % total product exports	8.54	0.0	667
Knowledge-intensive services exports as % total service exports	56.70	2.6	126
License and patent revenues from abroad as % of GDP	0.40	5.8	69

* For instance, innovation vouchers, venture/seed capital, access to finance granted by the public sector to innovative companies)
Source: IUS 2013 <link>.

From considering all indicators jointly it emerges that the international dimension of the German RIS might still remain to be below the EU average, in particular in relation to foreign investment in business R&D and EU Framework Programme funding. Possible explanations relate to the country-size effect and to the high level of German domestic public and private expenditures on R&D. Despite the easy access to and relative abundance of national funding for research, Germany could certainly better use the opportunities offered within the ERA and more specifically within the Framework Programme. Germany is relatively strong in business R&D, especially in terms of innovative SMEs, many of which are world leaders in their particular small market segments. The high level of patenting is an indication of industrial leadership in several domains, most notably in medium-high-tech industries including engineering industries, automobiles and chemicals and also in environmental and energy technologies. Apparently, public-private co-operation in publications and in research is functioning well and is further supported by new programme activities for innovation as outlined in the High-Tech Strategy. However, while Germany performs well in terms of new doctoral graduates, its performance as regards new science and engineering graduates has only recently surpassed the EU average and there is the risk of slower growth in the long term as a result of the ageing of the German population. In fact, although during recent years there has been an increase in the number of students in science and engineering subjects (MINT), the risk of a scarcity in terms of appropriately qualified human resources/workforce could in the long term endanger the strong German export position in engineering and science based industries (see EC, 2013a, p.3). Hence, efforts should be maintained to further reduce dropout rates and, for instance, to increase the share of female professors, which in turn could help attracting more female students, especially in MINT disciplines.

The overall quality of the German R&I relevant infrastructure is relatively good (if benchmarked against other EU countries). The legal and regulatory framework is perceived by businesses as widely appropriate. Weak points in this regard concern e.g. the availability of broadband and the usage of e-government services. Critical is the access to venture capital in Germany. In fact, its volume (0.021% of GDP in 2012) remains below EU average and lately was even falling (0.030% in 2011), which is an alarming signal and somehow questions all the efforts made so far with the ultimate goal of facilitating access to finance (in general and also for R&D in particular).

Table 1 in the Annex provides an assessment of the German national and regional research and innovation system performance (and latest developments in this regard), structured along the 10 criteria of the IU Self-assessment tool.[36] Below, the individual assessments are briefly outlined.

(1) For Germany it can be stated that promoting R&I is considered as a key policy instrument to enhance competitiveness and job creation, to address major societal challenges and to improve the general quality of life (and it is communicated as such to the public).

(2) Design and implementation of research and innovation policies is steered at the highest political level and based on a multi-annual strategy.[37] Policies and instruments are targeted at exploiting current or emerging national/regional strengths. However, smart specialisation (RIS3) strategies are elaborated at *Länder* level (which is still widely work in progress) without a clear mechanism that ensures compatibility and mutual reinforcement of the individually developed strategies. Corresponding mismatch and eventually 'frictional losses' might be possible and may require some further coordination efforts.

(3) Innovation policy is pursued in a broader sense thus going beyond technological research and its applications. In fact, while the majority of programmes focus on technological research, some measures go beyond. Furthermore, demand-side innovation policies are an integral part of the innovation policy mix in Germany, comprising legislation and standardisation as well as lead-market initiatives.[38] Accordingly, supply and demand-side policies are developed in a consistent manner, building on and increasing the absorptive capacity of the Single Market and, as a general assessment, a broad concept of innovation – including innovation in services, improvements of processes and organisational change, business models, marketing, branding and design – is actively promoted.

(4) Public investment in R&I was not decreased during the years of crisis and expanded significantly since, thus providing adequate and predictable funding which is inter alia focused on stimulating / leveraging private investment. In fact, in terms of firm investments in R&D, Germany is doing very well (2nd in EU acc. to IUS-2013). Moreover, the investment targets set out for public and private R&D investments are both about to be achieved. In other

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36 See: SEC(2010) 1161: Europe 2020 Flagship Initiative - Innovation Union, Annex I. <link>

37 The main priorities in Germany's R&I policy have been pursued over the last couple of years. The same holds for the set of policy instruments in place. In fact, R&I policy in Germany is persistent and straightforward. The key priorities of research and innovation policy continue to be: (i) keeping pace with global technology trends (envisage to be technological frontier setter), (ii) ensuring sufficient funds for public and private R&D and thus keeping research excellence at a top international level, (iii) maintaining and further improve the industry-science link (i.e. enabling knowledge flows at the public~private nexus), and (iv) strengthening the education sector (at all levels) in order to stimulate knowledge creation, capability building, absorptive capacities and ultimately a qualified workforce.

38 The High-Tech Strategy 2020 has reinforced the role of demand-side policies by defining five demand areas which future technology development should target. Through the instrument of so-called future-oriented projects, the link between fostering technology-demand and developing technologies that are needed by future users is established and demand-side and supply-side policy approaches are aligned. For more details and examples on the role of demand-side innovation policies see chapter 3 in the TrendChart Mini Country Report/Germany, 2011.

words, it is widely recognised that public funding assumes an important role in providing a high quality knowledge infrastructure and as an incentive for maintaining excellence in education and research. Accordingly, public investments in education, R&D and innovation are prioritised and budgeted in the framework of multi-annual plans to ensure predictability and long term impact (and drawing on the Structural Funds where appropriate). However, with regard to the general level of 'Finance and Support', according to the IUS-2013, Germany is just at 9th position within EU-27. Critically seen is, for instance, that innovative financing solutions for innovation remains a widely untapped field (e.g. crowd funding), the comparably low level of VC, and that there are no tax incentives for investments in R&D.[39]

(5) Excellence is a key criterion for research and education policy in Germany. As outlined in Chapter 2.2.1.1 above, research funding is increasingly allocated on a competitive basis and the balance between institutional and project-based funding of research has a clear rationale (leveraging effectiveness). Research performers receiving public funds are evaluated regularly on the basis of internationally recognized and transparent criteria and projects are selected on the basis of the quality of proposals and expected results, subject to external peer review. Funding to researchers is portable across borders and institutes. In fact, legally there is no difference in grant accessibility for foreigners and Germans working at HEIs or PROs located in Germany.[40] Higher education and research institutes enjoy the necessary autonomy to organise their activities in the areas of education, research, and innovation, to apply open recruitment methods and to draw on alternative sources of funding such as philanthropy.[41] Comparison to international standards, the legal, financial and social frameworks for research careers offer sufficiently attractive conditions to both men and women. In fact, researcher salaries in Germany are above the EU average, but lag behind those in the US and e.g. Switzerland. However, recently, the Constitutional Court issued a ruling on minimum wages for full professors in HEIs that could lead to increased salaries for those at the lower end of the wage scale and eventually work as an incentive to attract international talent.

(6) In terms of Human Resources, Germany cannot be assessed as a leading country as it is just ranked at 11th position within EU-27 acc. to IUS-2013. In fact, Germany exhibits significant challenges in ensuring a throughout high level of education and the right mix in terms of appropriately skilled workforce. Accordingly, insufficient supply of qualified labour is a constant challenge. Various measures and initiatives are in place to strengthen the education system and to mobilise human resources.[42] Some progress has been made, but further efforts

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39 The lack of tax-based R&D incentives in Germany as a continuous impetus for businesses to invest in R&D is often perceived as a drawback. Consequently, its introduction is frequently suggested (see e.g. EFI, 2008, 2009, 2010, 2011; Deutsche Telekom Stiftung, 2011).

40 However, the eligibility and portability of grants depend on the programme. A wide range of funding programmes exists for non-residents to work in Germany. Corresponding research grants are e.g. provided by the German Academic Exchange Service (DAAD), DFG, AvH and some PROs (for an overview see e.g. https://www.daad.de/deutschland/en/. The DFG implemented the general principles of portability as defined in 'Money Follows Researcher' (corresponding agreement signed in 2004). The conditions for grant portability can be assessed as moderately complex.

41 Please note: The European University Association (2009, 2011) assessed the autonomy of universities in Germany as rather limited. In fact, increased flexibility in terms of budgets, which was implemented for PROs (*Wissenschaftsfreiheitsgesetz*), was not adopted for German universities. However, over recent years a change of paradigm occurred that involved movement from detailed input-oriented state control to an output-oriented form of global control. Currently, almost all *Länder* are working with flexible institutional budgets and with indicator-based allocations of funds. A new salary scheme for professors, based on performance criteria, has been introduced. In some *Länder*, contracts between state and universities –which describe the performances expected of the institutions –have been concluded.

42 For example, the continuation of the 'Higher Education Pact 2020' was decided in 2009 and further expanded in 2011 to create 327,000 additional places for university entrants (compared to 2005) expected between 2011 and 2015. The national 'Pact for Women in MINT Professions' was implemented to attract more wom-

will be needed. One opportunity is to mobilise existing resources to a larger extent (e.g. women, foreign-born residents). Another is to stimulate immigration (see in this light the Foreign Skills Approval and Recognition law, approved in 04/2012). Nevertheless, Germany can build upon a strong vocational training system and in terms of 'Innovators' it is even at the top in Europe (acc. IUS-2013).

(7) Partnerships between research and innovation stakeholders are quite well developed in Germany. A broad range of links between science and industry are supported, such as cooperation, clusters, networks, alliances, and most recently public-private partnerships. In addition, the German science system includes a number of organisations that are devoted to knowledge transfer with the business sector, for instance the Fraunhofer Society (FhG), technical universities, and universities of applied science. Most of the universities have their own knowledge transfer office. Moreover, the funding programme 'SIGNO' supports universities, companies and inventors in identifying inventions suitable for patenting or other secure legal protection of intellectual property rights and in exploiting them commercially. In general, co-operation and knowledge sharing is encouraged and creating a more favourable business environment for SMEs is among the top policy priorities in Germany. Researchers and innovators are able to move comparably easy between public and private institutes. There are clear rules on the ownership of intellectual property rights (IPR) and sharing and support systems are in place to facilitate knowledge transfer and the creation of university spin-offs and to attract (venture) capital and business angels. There are no major obstacles to setting up and operating transnational partnerships and collaborations. Nevertheless, recognized experts as well as government bodies still perceive an untapped potential to link research results to commercialisation and suggest expanding technology and knowledge transfer mechanisms (stimulate and/or improve effectiveness of public~private nexus).

(8) German R&I policy offers a broad range of public funding measures to strengthen research and innovation activities in the business sector. Thematic R&D programmes are the main channel to provide financial means and comprise a large set of individual programmes and sub-programmes. They usually aim at achieving fairly specific goals in given technological fields. The majority of support measures address R&D performing/innovative firms and encourage public-private collaboration. Several initiatives are in place seeking to further improve the framework conditions for private investments, which range from strengthening the start-up culture to facilitating access to venture capital. With regard to latter, however, further efforts appear to be needed. In fact, Germany has to improve access to finance for R&D and innovation significantly (thus especially for SMEs). This point is seen as one of the main threats to the German system. Opportunities for further improvements remain in particular in the provision of equity to companies and in terms of simplifying the general legal framework and the rather complex tax system. To facilitate access to public support, the BMBF established a 'Federal Research and Innovation Funding Advisory Service' as the central point of contact for any questions concerning research and innovation funding. Relevant information about public support programmes is accessible through the internet. Applications can also be submitted online. However, the transparency about the broad range of existing support schemes needs to be improved. A first approach has been undertaken by bundling programmes, for instance, within the 'Central Innovation Programme' (ZIM).

(9) Overall it can be stated that the public support to R&I in businesses in Germany is conceptually rather simple (although in practise not always as simple to operationalise), comparably easy to access and of high quality. However, improvements in all these dimensions appear to

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en to courses in the so-called MINT subjects (including mathematics, information technology, natural sciences and technology).

be still feasible and desirable.[43] Funding support is consistent with the Small Business Act for Europe and generally tailored to the needs of companies (with special emphasis on SMEs). Administrative burdens and bureaucracy are comparably low, but certainly not at a minimum. Funding schemes are regularly evaluated and benchmarked against comparable schemes in other countries; participation is aligned with EU programmes (i.e. applying for international funding and trans-national cooperation is both encouraged); and the selection criteria for national and regional support measures are transparent and straightforward.

(10) Finally, the public sector itself aims at being a driver of innovation. In fact, the public sector provides incentives to stimulate innovation within its organisations and in the delivery of public services. For instance, the use of public procurement as an instrument to stimulate innovation and R&D is gaining ground. In a joint initiative, six federal ministries with responsibility for a high volume of purchases committed themselves to make active use of public procurement of innovative solutions in order to improve public services. Furthermore, the Law against Restraints on Competition (GWB) was modified in 2009 in such a way that public authorities can also require innovative aspects apart from a social and an environmental dimension in the service specifications. Overall, procurement of innovative products has increased, in particular with respect to energy efficiency. However, a binding strategy for innovation-oriented procurement across all public bodies and thus opening up towards a wider thematic scope has not yet been put forward although public procurement as an instrument offers ample potential in this regard.

3.2 Structural challenges of the national R&I system

Notwithstanding the overall relatively good evaluation of the German RIS performance (see above and Annex 1), there are also some weaknesses and structural challenges which need to be addressed to further increase the innovation performance and to strengthen Germany's position. This is especially critical since the German economy – due to its strong export-orientation – witnesses growing competition from emerging economies, in particular from China. No doubt, the international rivalry for technologies and market leadership will further intensify. The federal government has acknowledged this general challenge in the High-Tech Strategy 2020.

Innovation policy in Germany lately had to respond to a number of challenges; some of which have been there already for some time while others have newly emerged.[44] For instance, an important barrier for the German business sector to increase investments in research and innovation activities continues to be the lack of appropriate financing sources. In particular, SMEs and high-tech start-ups face difficulties regarding financing R&D and innovation projects. The economic and financial crisis has reinforced this situation: Internal financing sources have decreased due to lower sales and, with respect to external financing, banks have become even more cautious to finance innovation activities due to the risky nature and typically little collateral (a prob-

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43 For instance, on 15/11/2013 the Commission Opinion on the German Draft Budgetary Plan was published {SWD(2013)601 final}. In paragraph 12 it is stated: "…The Draft Budgetary Plan does not address the Council recommendations issued to Germany in the context of the 2013 European Semester with respect to enhancing the cost-effectiveness of public spending on healthcare and long-term care, improving the efficiency of the tax system, **using the available scope for increased and more efficient spending on education and research**, completing the implementation of the constitutional balanced-budget rule at *Länder* level, reducing high taxes and social security contributions, especially for low-wage earners; and removing disincentives for second earners."

44 See in this regard, for instance, the corresponding recommendations continuously been made by the national research council 'Wissenschaftsrat' (WR) <link>) and the ProInno-Europe: Mini-Country Report Germany 2011 <link>.

lem faced in many countries).[45] In top of this, even in times of historically low interests (i.e. capital is relatively cheap at financial markets, which is expected to leverage resources available for ventures), VC volume in Germany was lately even decreasing (see IUS-2013 and Table 1, above).

Public support to R&D and innovation is recognised to be crucial (particularly for SMEs, see above chapter 3.1). However, in Germany it is remarkably small in volume compared to other countries although the federal government significantly increased already the budget of its main research and innovation financing programmes (ZIM, thematic R&D programmes, ERP Innovation Programme, etc.). The programmes thus provide direct support as well as facilitate access to finance. R&D spending of the German enterprise sector remained fairly stable during 2009 despite a 5% decrease in GDP (and an up to 30% fall of sales in R&D-intensive sectors), followed by a remarkable increase since then (see Table 1, above). However, this does not mean that there is no room for further improvement. According to the IUS 2013, the general level of 'finance and support' for R&D and innovation in Germany is critical (compared to other innovation leaders in Europe). As outlined above, in this regard, Germany takes only position nine among the EU-27 countries (i.e. since IUS-2011 Germany even lost one position). In other words, the normalized volume of public support to business sector R&D and innovation in Germany remains below the figures of other leading EU countries and the availability of Venture Capital (VC) for German firms is, first of all, below EU-27 average and, second, followed lately even a negative trend. Accordingly, (small) innovative companies and especially young high-tech firms, which generally tend to face a shortage of equity (EFI, 2011), have difficulties to address this issue due to lacking venture and seed capital. Hence, the challenge for the German government remains to facilitate substantially the **access to finance for corporate R&D and innovation**.

Another important factor for the long-term development of an innovation system is the **supply of human capital**. Also in this regard Germany exhibits some weaknesses. In the light of several comparative OECD studies, areas of concern relate to detected deficits in secondary school education[46] resulting in shares of students with low scores in certain competences (i.e. just about OECD-average-level as tested in PISA 2009).[47] Furthermore, although the percentage of youth aged 20-24 having attained at least upper secondary level education (70%) is above the EU27 average (65%), Germany is not taking a top position in this regard in an international comparison. Moreover, there is still a comparably low share of population with a completed tertiary education (30.7% in 2012), though the rate significantly increased during the last decade.[48] Further raise of concerns is given by the fact that there will be a generally decreasing number of young people graduating from secondary schools due to demographic change and also since only a comparably low share of tertiary students are actually graduating in MINT disciplines (esp. engineering and natural sciences).[49] Finally, although immigration for high-skilled personnel lately has become somewhat easier, immigration barriers still remain relatively high (e.g. due to language).

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45 For a discussion of corporate R&D and innovation activities in times of a crisis see, for instance, Cincera et al. (2012).

46 Note that there is no OECD study on primary school students. According to the IEA-Studies TIMSS and PIRLS (both 2011), Germans in this regard perform better than the EU average and the share of 'low performers' is comparably small.

47 In general, the shares of low performers in the OECD PISA Studies have become considerably smaller over the PISA cycle and are now lower than OECD-average in 'Mathematics and Science', and on OECD average level in 'Reading'.

48 The share of 30-34 years old having completed tertiary or equivalent education (ISCED 4), which is the corresponding EU-benchmark, Germany has just achieved the goal set out (42%).

49 In general, recent figures suggest that Germany is improving in most of these points but remains still behind its peers. See BMBF (2012): *Bildung und Forschung in Zahlen* 2012.

Overall, compared to its peers in terms of innovation performance within the EU-27, Germany is still notably behind in terms of education and human resources (at least if benchmarked compared to Finland and Sweden). Admittedly, this is to some extent compensated by the dual system of vocational training in Germany, which is well established and contributes significantly to the provision of qualified personnel for the labour market. However, the sufficient supply of a qualified workforce has been a constant challenge for many years. Although there are discussions about the extent to which a lack of qualified personnel is a bottleneck for the German economy, there is consensus that a shortage is present in individual occupations/regions and that the shortage is likely to grow in the future due to demographic changes (EFI, 2012). Accordingly, substantial efforts are needed to adjust the existing education system and the policy in a way allowing Germany to catch up with the European and world wide innovation leaders' performance in terms of **societal education level and availability of adequately skilled workforce**.[50] In response to this challenge, some reforms in primary and secondary education and major reforms in tertiary education (e.g. introduction of bachelor and master studies, introduction/abolition of fee systems for universities) are taking place. However, a main obstacle for significant changes in terms of Germany's education policy is the fact that it is subject to complex policy coordination since it is within the responsibility of the individual states. As outlined in chapter 1, the federal government has only few competences and any changes in this regard would require changing the responsibilities as stipulated in the constitution (*Grundgesetz*). Moreover, adjustments in the education policy – once achieved (at primary, secondary as well as tertiary level) – take a long time until they have an effect. Accordingly, the outlined challenges with regard to education level and shortage of qualified labour likely will remain for many years to come.

A third main challenge for Germany arises from increasing international competition, particularly in knowledge-intensive sectors. Admittedly, Germany may appear well prepared for this as the innovation system seems to be well established and its R&D intensity lately almost reached 3%, which is internationally a comparably high level. However, other countries and thus especially the main international competitors of Germany have long exceeded the three-percent in terms of GERD/GDP as set out by Germany as a national target. For instance, approximated by R&D intensity or according to the indicators of the Innovation Union Competitiveness Report – 2011 (EC, 2012), Germany remains – although well above the EU-27 average – remarkably below the figures of its peer-group in Europe (Sweden, Finland and Denmark) and is also lacking behind its main global competitors (Japan, Korea, etc.). And, unfortunately, this image has not significantly changed recently. Moreover, emerging countries such as China are catching up rapidly and may challenge Germany soon.[51] In other words: Germany should orient itself towards the R&D intensity of the global leaders and not focus on the three-percent target or on any figure surpassed already (as e.g. the EU or OECD average in this regard). Keeping three-percent target as vision for R&D policy making – at least what concerns Germany – seems to be lacking ambition.

No doubt, on a global scale, Germany can only reach or maintain a competitive edge if the German innovation system continually generates new knowledge and flexibly adopts fresh impetus

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50 As a way forward in this regard, Germany could mobilise existing resources to a larger extent. Potentials lie in a greater participation of women, in particular in MINT-disciplines (mathematics, information technology, natural sciences and technology). In fact, compared to other industrialised economies, the share of women in research activities in Germany is relatively low, in particular in the business sector (OECD, 2011). Moreover, the 'social selectivity' in terms of higher education (social bias) needs to be reduced and further efforts could be made to use the potential of immigrants already living in Germany and to further attract qualified labour from abroad (EFI, 2011; Deutsche Telekom Stiftung, 2011).

51 Emerging economies not only challenge Germany. In fact, they also provide plenty of opportunities for an export-oriented, highly internationalised and innovative economy such as Germany. This is particularly true for manufacturer of equipment and vehicles. Therefore, the German federal government is actively supporting increasing linkages between the emerging economies and Germany both in science and industry.

while transforming it into innovations on the market. Concerns in this regard arise from the fact that the German industrial innovation system is currently characterized by a (rather static) specialisation on medium-high-tech manufacturing, such as automotive, mechanical engineering, and chemicals. On the one hand, there is the danger to end up in a "competence trap" as existing fields of competence (manufacturing) are pushed and further expanded, while promising new fields of competence are only rarely tapped. On the other hand, the growth potential in medium-techs, however, is regarded as limited in the future. In contrast, potential for high growth rates is seen in the high-tech sector, which is underdeveloped in Germany (EFI, 2010). Thus, **enabling the high-tech sector** is important to realise further growth. This is also critical in order to keep pace with globally shifting technological frontiers and to adapt early to new technologies.

Some impetus in this regard may result from the new energy policy strategy in Germany (agreed on in 2011, in the light of the meltdown at the Japanese nuclear power plant of Fukushima), which, however, can be seen in a wider scope as a general attempt of **'greening the German economy'**. In fact, it is agreed that electricity production by nuclear power will be stopped by 2022. Hence, there is need for R&D and innovation in energy supply to compensate the nuclear phase-out. This in itself could be seen as a structural challenge for Germany (for the German economy in the first place, but eventually for the RIS, too). In fact, within the next 10 years, investment in renewable electricity production is expected to be expanded substantially. Yet, a key challenge is arising from the question how to manage the uneven quantities of electricity produced by renewables, such as wind and solar technologies, with the rather stable demand for electricity or how to balance regional differences between electricity production based on renewables in the North and high electricity demand in the South (which so far was supplied to a great extent by nuclear power plants). Current policy initiatives both in research and energy policy try to address these challenges by researching into new technologies for energy transmission.[52] Expanding the high-tech sector could contribute to cope with this challenge.[53]

3.3 Meeting structural challenges

As outlined above, the five main challenges that Germany is confronted with in the area of R&D and innovation are the expansion of **research in cutting-edge technologies**, the provision of **sufficient funding for R&D**, the **commercial exploitation of scientific knowledge** (from ideas to market), the provision of an appropriately **qualified workforce**, and **'greening the economy'** i.e. responding to the new energy concept and coordinating climate, energy and R&I policies. The current policy mix addresses these challenges through a broad range of measures.

The High-Tech Strategy 2020 outlines the research and innovation policy of the federal government for the coming years. The main aims of the HTS are to create lead markets, intensify cooperation between science and industry, and to continue to improve the general framework for innovation. With the proposed directions and instruments, basically all structural challenges can be addressed. However, making this strategy a success and achieving the goals set out requires a

52 See for instance the 6. 'Energy Research Programme' (*Energieforschungsprogramm*, released 2011). Accordingly, €3.5b are earmarked to support R&D on energy related aspects for the period 2011-2014 (which represents a substantial increase compared to its previous period). For more info see <link>.

53 Related to this change in energy policy, E-mobility is another priority of the federal government's strategy in terms of energy innovation. E-mobility is thus regarded as a critical trend in automotive mobility. A national E-mobility initiative was launched (implemented measures so far: increased R&D efforts in the area of batteries, e.g. Innovation Alliance on Lithium-Ion batteries, and related technologies as well as demand-side policies such as tax exceptions.

continuous monitoring and timely fine tuning of the instruments. Moreover, evaluations of the strategy as such will be needed too in order to ensure its appropriateness in a changing world; eventually an updating of vision and priorities might be needed already before 2020.

The federal government is funding cutting-edge technologies with numerous initiatives and measures, for instance within thematic R&D programmes and by means of innovation alliances such as '*Spitzencluster*' (Leading-Edge Clusters). Current initiatives are embedded in the objective to create lead markets.[54] Lead markets are expected to help addressing the grand challenges. However, changing industrial structure is challenging and takes time. While evaluations of longer existing programmes are positive, the success of newly initiated measures and recently chosen approaches remain to be seen. Overall, the launched initiatives address a number of bottlenecks assumed to prevent the further emergence of the high-tech sector in Germany and accordingly appear promising. However, it remains doubtful whether the measures taken will be sufficient to make Germany catching up with the macro regions/countries leading in high-tech industries (US, Japan, Korea, etc.) within the time frame set out (2020). Note in this regard that a simulation of a series of growth scenarios for R&D intensive firms revealed that in year 2020, even under very optimistic assumptions, the structural gap compared to the US in terms of high-tech would remain to be significant. In other words: It would not be realistic to assume that by 2020 Germany could have closed the high-tech gap to the US (and other leading macro regions).[55]

As mentioned above, a constant challenge for German companies is finding external sources for financing R&I activities. This holds in particular for SMEs and young high-tech firms and was further reinforced by the financial crisis. Policy makers in Germany responded by offering funding instruments with an increased focus on SMEs (SME innovative, ZIM). As part of the second 'recovery package', the budget of the ZIM programme was increased substantially in 2009 and 2010. As a response to the low share of early-stage VC investments, federal VC programmes were redesigned and expanded. For example, the 2nd 'High-tech Start-up fund' (*High-tech Gründerfonds* II) was introduced in October 2011 with an additional investment volume of €293,5m. Evaluations of the programmes are positive so that they contribute to mitigate the shortage of capital.[56] However, there is still room and need for further enhancements. As outlined above, according to the IUS-2013, Germany is still lacking behind and achieves only 61% of the EU-27 average in terms of VC (and the corresponding volume measured as share in GDP lately had even a negative trend). This is alarming. Actually, the IUS indicator concerning VC is the lowest indicator in relative terms for Germany across all IUS dimensions. Evidently, framework conditions for the provision of equity for firms need to be improved. Among others, constraints in the legislation for foundations and endowments can be eliminated in order to use them as an additional source for funding private research and innovation (see e.g. EFI, 2010; 2011).

Facilitating the knowledge exchange between science and industry enables and accelerates the commercial exploitation of research results generated by public institutions. Fostering science-industry links has been a policy priority in German R&D and innovation policy for many decades. A broad range of links are supported, including co-operations, clusters, networks, alliances,

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54 The notion of lead markets was implemented as a new approach in the HTS-2020.

55 See: Voigt and Moncada (2012). The paper investigates how would sector composition and the magnitude of R&D investments in the EU differ in year 2020 compared to the past, if a selection of top R&D-investing SMEs were assumed to be on a fast growth track while the top R&D-investing large scale companies continued to grow as before. The study indicates that if one expects the (R&D-intensive) small firms to be a driving force for a substantial structural change in the EU economy, from being driven by rather medium-tech sectors towards a high-tech based economy, it requires either a significant longer time horizon of the assumed fast growth track than the simulated 10 years, or small firms' growth figures which even exceed the assumed 30% annually (as in the most optimistic scenario). In fact, neither case appears to be particularly realistic.

56 See Technopolis, 2010 (evaluation of the *Gründerfonds* II), commissioned by BMBF <link>

and most recently public-private partnerships. For example, the Expert Commission for Research and Innovation highlighted the '*Spitzencluster-Wettbewerb*' (Leading-Edge Cluster Competition) as a good way to promote promising innovation clusters (EFI, 2010). The programme provides funding for clusters comprising of firms, research organisations and government authorities that aim at jointly developing and introducing innovations in a certain field of technology or sector within a specific region. Cluster activities may involve skill development, long-term oriented research strategies, close-to-market technology development, facilitating new business ventures and international cooperation. Moreover, entrepreneurship at universities and technology transfer activities are supported. In order to further extend and improve science-industry links two new measures ('Validation of Innovation Potentials of Scientific Research' and '*Forschungscampus*') were recently introduced and complement existing instruments.

The education system in Germany has to respond to the challenges of the knowledge society but exhibits obviously some weaknesses. In fact, meeting the economy's demand for high-skilled labour – in terms of both quantity and quality – is a constant challenge for the German education system. The German government has recognized this challenge[57] and is trying to address it by means of a number of initiatives. First of all, the *Bund* has increased the overall investment in education. A number of new initiatives were set up, others were updated and expanded to strengthen the education system and to mobilise human resources, such as the 'Higher Education Pact', the 'Initiative for Excellence', the 'Pact for Research and Innovation', and the 'Quality Pact for Teaching'. In 2008, the federal and state governments agreed on the 'Qualification Initiative' for Germany, which addresses all areas of education from early-childhood education to lifelong learning. Examples are the upgrading scholarships programme, which allocates grants to people with good vocational qualifications to study at a HEI, support measures for lifelong learning, and the 'National Pact for Women in MINT Professions' set up to attract more women to courses in the so-called MINT subjects. Since summer 2011, a scholarship programme for students ('*Deutschlandstipendium*') provides additional grants. Further, actions are taken to remove barriers for immigration of highly qualified and highly skilled people (e.g. by means of the 'Foreign Skills Approval/Recognition law'; '*Anerkennungsgesetz*'). However, although progress is observed like growing enrolments of students at universities, further measures are necessary to improve the education system and to secure a sufficient supply of qualified workforce. Intensified efforts are needed in primary, secondary as well as higher education. According to OECD studies, Germany is lacking behind and not catching up (fast enough) compared to countries leading in terms of education performance (e.g. in Scandinavia). In particular, greater efforts are needed to remove social barriers to education and to encourage young women to study mathematics, engineering and science. Corresponding family policy is also required, e.g. through the provision of sufficient childcare facilities and the establishment of a more family-friendly corporate culture.

Overall, changes in the education system need a long time until they become apparent in performance indicators. Moreover, by virtue of the federal structure, legislative powers for school and higher education sector in Germany are in the hands of state governments, i.e. legislation, administration and financing in these areas are almost exclusively a matter of the *Länder*. In other words: the federal government has almost no competences in education policy, which appears to be a challenge for the German education system. For instance, by introducing more joint tasks into the framework of the federal structure, the *Bund* could contribute to a larger extent to education. There is a political discourse going on that ultimately points to changing the constitution in this regard, which would require a broad consensus and a vast majority (in both chambers); i.e.

57 During the first education summit in 2008, the federal government and the states called for an "Education Republic of Germany". The corresponding objective was stressed again by the CDU/FDP coalition, formed in 2009 and is likely to remain also for new CDU/SPD government, which just took office in 12/2013. Mobilising skilled workers is also a stated objective in the High-Tech Strategy 2020.

joining political forces and forming a broad political coalition, like the one that just took office in 12/2013. However, whether the new federal government will use the opportunity of having a constituent majority (in both chambers) and pushes that issue forward remains to be seen.

Finally, as outlined above, German policy needs to respond to the new paradigm of 'greening the economy' and in this regard especially the new energy concept and meet thus the challenge of coordinating climate, energy and R&I policies in the light of expanding R&D and innovation activities (especially in terms of renewable electricity production). The latter is particularly needed to compensate the recently decided nuclear phase-out until 2022 and to secure the energy supply afterwards (for an affordable price). The federal government is aware of this challenge and launched already in 2007 a comprehensive package of energy and climate policy measures (the 'Integrated Energy and Climate Programme', (IEKP)). Inter alia it contains a broad range of measures, especially aiming at increasing energy efficiency and advancing the use of renewable energy. Future-oriented projects are included in the HTS-2020 and the corresponding Action Plan, for example the project 'Intelligent restructuring of the energy supply system'. Supporting instruments of various ministries have environmental aspects as a cross cutting issue. Corresponding policies and activities are coordinated at the 'Coordination Platform for Energy Research Policy' at the BMWi. Nevertheless, the objective is rather complex and therefore challenging, i.e. its achievement remains to be seen.

In sum, R&I policy in Germany responds to the key challenges that the German innovation system is facing. The HTS-2020 as well as the plenitude of implemented measures seems to be appropriate to mitigate the structural challenges (EFI, 2011; Deutsche Telekom Stiftung, 2011). However, the success of the HTS-2020 will critically depend on its further implementation process (EFI, 2011). The potential of only recently implemented measures have not been unfolded yet and remain to be seen. Moreover, further efforts and instruments are required, particularly in the education system, with regard to access to finance for corporate R&D and innovation activities (especially in SMEs and start-ups), and concerning the redefined energy policy.

Table 4: Assessment of the German policy mix meeting the structural challenges

Challenges	Policy measures / actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
1. Keeping pace with global technology trends	▪ New approach: creation of lead markets to address societal challenges. ▪ Various measures are directed towards cutting-edge technologies (e.g. thematic R&D programmes, innovation alliances; embedded in the HTS-2020) as well at supporting new technological developments and its adaptation. Ultimate policy goal: Envisage to become technological frontier setter (thus ensure competitiveness and jobs in DE)	Changes in industrial structure are difficult to induce (by policy makers) and take time. The programmes in place appear to be tackling the right challenges and actions taken seem to be reasonable and widely appropriate. However, success of new approaches remains to be seen. Nevertheless, as known from technological history, cutting-edge technologies/break-through innovations often emerged from SMEs/start-ups. Since access to finance for R&D and innovation activities in Germany is generally limited and appears to be particularly difficult for small firms, the individual challenges are linked, i.e. they can neither be seen nor tackled in isolation. In other words, whether Germany will manage to keep pace with global technological trends will – apart from the corresponding support measures – also depend on access to finance for small firms, supply of appropriately skilled workforce, knowledge capacities and quality of transfer systems, etc.
2. Ensuring sufficient funds for public and private R&D and thus keeping research excellence and innovativeness at a top international level	▪ High-Tech Strategy 2020 ▪ Initiative of Excellence ▪ Increased focus on SMEs in public R&D programmes (such as 'SME innovative', 'ZIM', etc.). ▪ Expansion of the provision of VC through 'High-tech Start-up Fund II'. ▪ Note: various (not all) programmes provide funds based on an assessment of excellence/peer review	Evaluations of programmes are widely positive. However, overall volume of finance available for R&D still needs to be expanded. In this regard, framework conditions for the provision of equity could be improved further. Introduction of tax-based incentives for R&D may provide new impetus for business enterprise R&D expenditure. Implemented actions seem to be reasonable and widely appropriate but insufficient in volume and leverage. Room for further advancements!

Challenges	Policy measures / actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
3. Maintaining and further improving the industry-science link	Ultimate goal: Commercial exploitation of scientific findings through enabling/intensifying knowledge flows (stimulated e.g. by a more effective public-private nexus (HTS-2020) ▪ Strong focus on industry-science links in R&D funding programmes; supporting various forms of links including cooperation, clusters, networks, alliances, partnerships. Moreover, entrepreneurship at universities and technology transfer activities are stimulated. ▪ Examples: 'Validation of Innovation Potentials of Scientific Research' supports investigation of market potential of public research results. The '*Forschungscampus*' programme helps establishing public-private partnerships.	Knowledge transfer between industry and science is working relatively well and is supported already in various ways. However, it might be further improved in order to shorten the time needed to make a good idea becoming a commercially successful product, e.g. by cutting red tape, providing appropriate support to SMEs/start-ups, improving incentives for researchers working in HEI/PRO to collaborate with businesses, facilitate spin-offs, etc. There is a broad range of existing and new programmes to further strengthen the industry-science link and to commercially exploit research results to a larger extent. Actions seem to be generally appropriate. However, commercial success/further rise in competitiveness and evidence of improvements in terms of innovativeness in Germany still to be seen.
4. Strengthening education sector at all levels in order to stimulate knowledge creation, capability building, absorptive capacities	Ultimate goal: Ensuring supply of an adequately qualified workforce ▪ Several initiatives to strengthen education system and to mobilise human resources are in place, including e.g. 'Higher Education Pact' and 'Qualification Initiative' ▪ Opening of the labour market for third country residents (Blue Card), recognition of foreign diploma/certificates ▪ High-Tech Strategy 2020	Initiatives have been successful as far as implemented and evaluated. However, there are still large untapped potentials (e.g. by further opening the labour market to skilled immigrants, more woman in science, etc.). Complex coordination in education policy and the split of competences prevents Germany's education system from unfolding its full potential. Actions seem to be appropriate but room for further advancements, particularly regarding structural developments (reform of federalism in order to boost education sector).
5. Fostering research and innovation in energy supply	▪ High-Tech Strategy 2020 ▪ Broad range of support programmes by various ministries, e.g. the 'Integrated Energy and Climate Programme' (IEKP) aimed at increasing energy efficiency and stimulating the adaptation of renewable energy technologies	The objective of nuclear phase-out until 2022 is rather challenging. The same holds for climate policy goals. However, apart from the ambitions of the individual thematic objectives, the coordination of the corresponding climate, energy and R&I policies and ensuring a coherent joint policy framework might be the ultimate challenge from a policy perspective. In any case, further efforts to integrate the policy fields appear to be needed. Moreover, whether the initiatives that tackle certain thematic aspects will be successful (e.g. those that seek to ensure that by 2022 economically priced solutions for the key technological questions can be found) remains to be seen.

Source: Own compilation / authors' assessment.

4 NATIONAL PROGRESS IN INNOVATION UNION KEY POLICY ACTIONS

Germany's policy mix addresses all five ERA priorities. In fact, **increasing the effectiveness of the national research system** has been at the core of the policy agenda. Competitive funding plays thus an increasing role. Assessments and peer reviews are performed at (1) the level of individual research performers, (2) at programme level, as well as (3) at research institutions' level. For instance, the Institute for Research Information and Quality Assurance (iFQ) is monitoring any initiative launched and/or commissioned by the German Research Foundation (DFG). However, a number of further improvements are suggested based on throughout evaluations of the system as outlined for instance by the EFI Expert Commission, the *Wissenschaftsrat* (WR), and the GWK (see chapter 2.6 above).

In general, EU level instruments in Germany are used for national goals and there are attempts to influence the European level policy with core ideas as set out e.g. in the German 'Internationalisation Strategy' and the 'High Tech-Strategy 2020'. In general, the intention is thus to ensure **optimal transnational co-operation and competition**. In fact, the importance of international cooperation – especially with regard to solving the Grand Challenges – has been highlighted and reinforced in the High-Tech-Strategy 2020. Moreover, there have been notable steps towards a more functional 'horizontalisation' at national level, i.e. European involvement is becoming part of the strategic thinking and there is a stronger awareness of European issues across all ministries (e.g. visible in ERA-Net participations and a generally strong participation in all new multilateral joint initiatives at EU level). Another example is the G8 Research Council's 'Initiative on Multilateral Research Funding', established in 2010 under the leadership of the German Research Foundation (DFG). And there is a growing number of bi-/multilateral agreements on cooperation and joint activities in terms of R&D and innovation (and education).

With regard to a **more open labour market for researchers**, Germany has undertaken significant efforts to facilitate researchers' mobility, for instance, by adopting in 2012 a new law facilitating the recognition of foreign professional qualifications (*Anerkennungsgesetz*) and by drafting the 'Mobility Strategy 2020'. In general, vacancies and grants are increasingly announced internationally, which is a step towards further opening up the German labour market for researchers and thus stimulating mobility (researchers' migration). In the same direction work some German efforts concerning more mobility-friendly conditions of the existing social security systems, tax and pension schemes. All this seeks to enhance the attractiveness of academic careers in general and, moreover, the attractiveness of Germany for foreign researchers. A number of comprehensive bi-/multilateral collaboration agreements have been signed in order to further improve the open market for researchers (beyond the borders of Germany). The BMBF opened in 09/2013 a central office for international vocational training cooperation at the Federal Institute for Vocational Education and Training (BIBB, <more info>). See in this regard, for instance, the 'Memorandum on European Alliance for vocational training' (adopted in 12/2012, initial signing partners: Germany Spain, Greece, Portugal, Italy, Slovakia, and Latvia; <more info>).

Gender equality and gender mainstreaming in research and in this regard the improvement of equal opportunities has been included as a central goal of all large-scale initiatives of the BMBF as e.g. the 'Initiative for Excellence', the 'Higher Education Pact 2020', and the 'Pact for Research and Innovation'. In fact, excellence, quality, and equal opportunities are integral parts of German policy and are due to be considered as a universal guiding principles in all political decisions including in the drafting and implementation of programmes and measures, in the allo-

cation of funding, and in the corresponding evaluation procedures. In this regard, as key strategic areas are set out: (1) Women in academia, (2) Business start-ups by women, (3) Research on gender related issues in education and research, and (4) International issues. The BMBF has created an 'Equal Opportunities in Education and Research Division', which has the task of implementing these key strategic areas (the Unit is part of the BMBF's Strategies and Policy Issues Directorate-General). It analyses the need for action in education and research, supports strategic measures and projects, and works closely with all the BMBF's specialist directorates-general and divisions, as well as with all stakeholders in this area.

Finally, circulating research knowledge and transferring it into markets and products will be crucial for maintaining the productivity of the German economy. There is common understanding that all this creates and preserves jobs and helps to ensure Germany's prosperity. Germany has launched and/or is internationally involved in a number of activities which tackle **optimal circulation, access to and transfer of scientific knowledge** (including via digital ERA). The main (frame-giving) political initiatives are: Digital Germany 2015 (new ICT Agenda), Pact for Research and Innovation, Initiative for Excellence, and the High-Tech-Strategy 2020.

4.1 Strengthening the knowledge base and reducing fragmentation

Promoting excellence in education and skills development

According to EUROSTAT figures, the human resources in science and technology as percentage of total workforce in Germany were increasing steadily over the period 2002 – 2012 from initially 41.5 to 45.7% and remained thus well above EU average (35.0 and 42.9% in 2002 and 2012, respectively), although the distance apparently has been diminishing. The numbers of graduates in tertiary education as a percentage of the corresponding population age group (20–29 years) rose from 3.33% in 2002 to 6.21% in 2011 (most recent year available) and, accordingly, almost doubled during the last decade. However, the German figures still remained below the EU-27 level of 7.64% in average in 2011. The number of foreign students as a percentage of the total number of students in Germany was fluctuating around 9 to 11%, with 10.5% in 2009 (the last available year in Eurostat). The share of unemployed doctorate holders in Germany remained comparably low at 1.2% in 2009 (1.7% in 2006) which points to a rather demand driven situation in the labour market for highly qualified researchers. However, although EUROSTAT figures do not allow disclosing this picture, there are significant differences in the situation at the labour market (demand-supply balance) for scientists from different disciplines.

As a key feature of the German system, the federal government and the *Länder* have joint national responsibility for education and research, regardless of their respective responsibilities in the federal system. In their joint Qualification Initiative of 2008, both set themselves the target of spending altogether 10% of GDP on education and research (7% and 3%, respectively). The federal government and the *Länder* have also agreed to introduce measures addressing all levels of the education system, from early childhood education to higher education. For example, they initiated the Higher Education Pact and the Excellence Initiative; two programmes that provide billions of Euros of funding to enable institutions of higher education to create new university places and enhance their international competitiveness. Another example is the Skills Development Initiative for Germany which seeks to bring together German and especially American businesses and local education/training providers with the aim of developing training programs best suited to businesses' needs.

Moreover, Germany has undertaken significant efforts to facilitate researchers' mobility, for instance, by adopting in 2012 the 'Foreign Skills Approval and Recognition Law' (*Anerkennungsgesetz*), which is meant to facilitate recognition of foreign professional qualifications (<link,

link>) and by drafting a 'Mobility Strategy 2020' and discussing it with the European partners at the Bologna Conference (2012, in Bucharest, <link>). Beyond, vacancies and grants are increasingly announced internationally, which is a step towards further opening up the German labour market for researchers and thus stimulating mobility (researchers' migration). In the same direction work some German efforts with regard to more mobility-friendly conditions of the existing social security, tax and pension schemes. All this seeks to enhance the attractiveness of academic careers and, in particular, the attractiveness of Germany for foreign researchers,[58] i.e. facilitating qualified immigration. In fact, although Germany experiences recently rising numbers in terms of students and graduates in tertiary education, a smart immigration policy is prerequisite for ensuring the supply of adequately skilled labour force in Germany. In this light, the federal government realigned its immigration policy in 2012 with the Act to Implement the EU Directive on the Conditions of Entry and Residence of Third- Country Nationals for the Purposes of Highly Qualified Employment with a view to attracting skilled employees to the country. As of 1 August 2012, this law makes immigration easier for non-EU skilled workers with academic qualifications. In doing so, the *Bund* took full advantage of the flexibility afforded by the Directive with the EU Blue Card system. Furthermore, the federal government has also intensified its efforts abroad to approach talented professionals for possible recruitment in Germany. For instance, since 1 January 2013 the MobiPro-EU programme is activated, which aims at promoting the professional mobility of young people in the EU who want to work in Germany. Finally, a number of comprehensive bi-/multilateral collaboration agreements have been signed in order to further improve the open market for researchers (beyond the borders of Germany).

In response to the increased demand for places in higher education, *Bund* and *Länder* intensified their efforts to expand the study programmes available[59] and are together creating the framework to accept around 327,000 additional first-year students at German HEIs by 2015. As part of the Quality of Teaching Pact roughly €2b are earmarked by the federal government until 2020 as additional funding for initiatives launched by 186 HEIs which aim at improving study conditions. Another €250m are set aside for the competition 'Advancement through Education: Open Universities'. This competition is designed to support the development and integration of study programmes for advanced training at HEI. The '*Deutschlandstipendium*' grant programme, which is co-financed by the federal government and the private sector, represents another (rather new) pillar of the educational grant system. This programme is available alongside the BAföG funding (student loans and scholarships offered by organisations promoting young talent).[60]

With regard to training, *Bund* and *Länder* are both supporting initial and further training with a raft of measures. For instance, the 'National Pact to Promote Training and Young Skilled Workers' offers educational opportunities to a large number of people. Further, a comprehensive range of measures has been implemented to help ease students' transition from school into professional life. The '*Abschluß und Anschluss-Bildungsketten bis zum Ausbildungsabschluß*' educational initiative aims at supporting this transition by conducting systematic aptitude testing as of the seventh class at general schools and also by deploying career start coaches. In addition, with regard to regulations governing support for the advanced training of older workers in SMEs, the federal government has lifted time limitations, increased the scope of funding and also provided additional options for SMEs to participate in advanced training measures. In general, the *Bund* is

58 Of course, the mentioned measures are also set out to make a career in research more attractive for Germans. For instance, the Federal Government and the *Länder* are particularly focused on expanding childcare services in order to give greater educational opportunities to all children. Furthermore, expanded childcare services also help parents (and thus researchers too) to combine their work and family commitments while increasing participation in the labor market.

59 For instance, the Federal Government has increased its financial commitment to the second programme phase of the Higher Education Pact 2020 – until 2015 – to some €4.8b.

60 For recent figures on the situation of the education sector in Germany see e.g. EFI Report 2013, p. 112 ff

supporting extensive structural improvements within the educational landscape at municipal level and thus contributing to higher efficiency in educational services.

Germany cooperates with many countries in terms of international vocational training. This supports German providers of initial and continuing vocational training in developing the rapidly growing international education market. In bilateral working groups under the leadership of the BMBF, German representatives and their corresponding international partners address issues of vocational education. Thus, Germany contributes to the finding of solutions on the basis of its world renowned dual system of vocational education and training. In this light, the European education ministers have agreed to optimize their national systems of vocational education while creating the basic conditions for a 'European Vocational Education Area'. In doing so, the mobility of young people and employees in Germany for training or employment is due to be strengthened. The European Commission and the European Centre for the Development of Vocational Training CEDEFOP will support this process. The EU is placing special focus on practically oriented training in its new strategy 'Rethinking Education'. Starting in 2014, the new EU Education Programme 'Erasmus for everyone' and the new European Social Fund will contribute significantly to the financing. With a 'European Alliance for Apprenticeship', it is planned to integrate further countries into the reform process that Germany has initiated.[61] German social partners are also supporting the BMBF initiative. Leading organizations in trade and industry are already preparing contracts for cooperation in the transfer of German principles of training with international partners. The German Chamber of Commerce and German businesses with locations in partner countries will play a central role, particularly in the regional development of vocational training networks with businesses, schools and chambers in partner countries.

Overall, the German objectives and measures within the framework of the Research Partnership are well aligned with the priority actions as formulated by the Competitiveness Council on the basis of the Commission's communication to the European Parliament and the European Council 'Better Careers and More Mobility: A European Partnership for Researchers'.[62] Moreover, the European Charta for Researchers and the Code of Conduct for the Recruitment of Researchers <link> and the corresponding recommendations to improve employment and working conditions for researchers in Europe as set out by the European Commission, are giving frame for Germanys education and labour market related policies. The Charta & Code is thus assumed to contribute to establishing "best practice" within the European Research Area. The German government's efforts in this regard focus on the optimization of research and working conditions of researchers as well as the future development of a job market for researchers in the European Research Area. For individual research institutions it is nevertheless optional to ratify Charta & Code. If a host institution decides to implement the principles of Charta & Code, the institutions' official decision (e.g. in form of a rectorate's resolution) can be communicated to the EC (DG Research & Innovation). By following this procedure, the institution will be added to the 'Signatories List' of the Charta in the EURAXESS-portal. German subscribers of Charta & Code

61 In this light, the BMBF opened in 09/2013 a central office for international vocational training cooperation at the Federal Institute for Vocational Education and Training (BIBB). In the area of vocational training exports, the BMBF supports the internationalization of German initial and continuing vocational training services providers. The aim is to develop innovative export channels for basic qualifications up to the further training of skilled staff and to test them in practice. Under the motto of 'Training - Made in Germany' the BMBF initiative iMove (International Marketing of Vocational Education) promotes German initial and continuing vocational training. German education service providers are supported in establishing international cooperation and business relations by means of trainings, delegation visits and market studies. See in this regard e.g. the G8 Research Council's Memorandum on European Alliance for vocational training' (adopted in 12/2012, initial signing partners: Germany Spain, Greece, Portugal, Italy, Slovakia, and Latvia (<link>).

62 (1) systematic open recruitment of researchers, (2) meeting the needs of mobile researchers with regard to social insurance and supplementary pensions, (3) improving employment / working conditions to enhance the attractiveness of scientific careers, and (4) improving the training, skills and experience of researchers.

are, for instance, the German Rector's Conference (HRK), the Alexander von Humboldt-Foundation (AvH), the German Academic Exchange Service (DAAD) as well as the Albert-Ludwigs-University of Freiburg and the Friedrich-Alexander Universität Erlangen-Nürnberg.[63]

However, although all the measures in place seem to go into the right direction and are due to promote excellence in education and skills development, according the IUS 2013, Germany is still lacking behind other European countries in terms of 'human resources' and the 'open, excellent and attractive research system' (see: IUS 2013, p. 18ff). In fact, both 'the supply of human capital' and the 'societal education level and availability of adequately skilled workforce' have been identified already as main challenges for the long-term development of the Germany innovation system in earlier Country Reports (see e.g. CR 2012). Admittedly, some improvements have been achieved (as outlined e.g. in the NRP 2013), but the challenges generally remain and require more – and e.g. in the light of demographic changes eventually even further intensified – policy attention. For instance, areas of concern relate to deficits (mainly revealed by OECD studies) in secondary school education[64] resulting in shares of students with low scores in certain competences (i.e. just about OECD-average-level as tested in PISA 2009).[65] Furthermore, although the percentage of youth aged 20-24 having attained at least upper secondary level education (69.7%) is above the EU27 average (64.8%), Germany is not taking a top position in this regard in an international comparison. Further raise of concerns is given by the fact that there will be a generally decreasing number of young people graduating from secondary schools due to demographic change and also since only a comparably low share of tertiary students are actually graduating in engineering and natural sciences. Finally, although immigration for high-skilled personnel lately has become somewhat easier, immigration barriers remain relatively high.

In sum, evidence suggests that Germany is improving in most of the points mentioned above, but in several dimensions it still remains behind its main peers (see e.g. IUS 2013 and in this light BMBF, 2012: *'Bildung und Forschung in Zahlen 2012'*). In other words, the German initiatives that aim at improving the R&D and education system seem to be on track, but it remains still to be seen whether all this will be sufficient to close the existing gaps to the top performing countries in this regard. Perhaps it is still too early to assess the full (potential) effects. However, given that substantial changes commonly require some time to fully unfold the anticipated effects, the outlined challenges concerning education and shortage of qualified labour in Germany likely will remain for the years to come.

Research Infrastructures

Germany has just published a National Research Infrastructure Roadmap (presented in 04/2013, <link>). This Roadmap is meant to support and guide political decisions in terms of research infrastructures (RI), i.e. for instance large scale RIs of national/European importance, comprehensive experiments, etc. Its primary aim is enforcing the efficient use of RIs in Germany. It is assumed to be an additional stimulus towards joint planning of RI (at federal and *Länder* level in

63 For details on the situation of researchers in Germany and the way forward with regard to generating an enabling framework for the implementation of the HR Strategy for Researchers incorporating the Charter & Code see e.g. BMBF, 2010 (<link>) and the 'Report on the Promotion of Young Researchers' (BuWin 2013). In general, the plan is to improve social security and adapt pension schemes to the situation (of internationally mobile) researchers.

64 There is no OECD study on primary school students. The IEA-Studies TIMSS and PIRLS (both 2011) show that German primary students perform better than EU average and that the share of 'low performers' is comparably small.

65 The shares of low performers in Germany have become considerably smaller over the PISA cycle and were latest (in 2009) below OECD-average just in 'Mathematics and Science' and about at OECD average level in 'Reading'.

Germany, but as well with regard to large scale RI development in the EU). The BMBF has encouraged all relevant (German) stakeholders to participate in this debate. In a dialog with all research organisations it is envisaged to decide on how the current pilot phase could be continued or whether – in 2014 – a standardised approach for selecting and developing certain projects and RI should be installed.

The Roadmap needs to be seen in the light of Germany's Internationalisation Strategy and thus in particular the opening up of RI to foreign/collaborative research activities. Moreover, any planning of new RI's – especially large scale/costly installations – is coordinated in the light of the European Strategy Forum on Research Infrastructure (ESFRI) and the corresponding roadmaps. Thus, the main task of ESFRI is to help the roadmap projects moving towards its implementation, to get/keep Europe at the rapidly evolving forefront of science and technology, and to increase the capacity to meet the needs of the EU and global scientific community. In this regard, Germany runs already since many years (1957) comprehensive thematic R&D support programmes[66], i.e. it is providing direct support to business R&D by means of grants and loans (which are increasingly aligned to the ESFRI roadmap).

Further to be mentioned with regard to RI in Germany is the German Research Council (DFG) whose funding includes academic RI. Moreover, there are several individual projects, such as e.g. the D-Spin (later Clarin-D project) and DARIAH-DE project. The former is the German contribution to the European CLARIN-Project (Common Language Resources and Technology Infrastructure). D-SPIN and its follow-up projects provide the basis for a stable and sustainable infrastructure of language resources and language technologies, serving above all empirical research in humanities and social sciences.[67]

Other important examples especially with regard to removing legal and any other barriers to research funding (thus to some extent also funding of RI) are the G8 Research Council's 'Initiative on Multilateral Research Funding' and the 'D-A-CH' Agreement between the three German-speaking funding organisations, the German Research Foundation (DFG), the Swiss National Fund (SNF) and the Austrian Research Fund (FWF), which agreed upon simplifying and mutual opening of the respective research funding programmes (since 2009, 'Lead Agency' process) thus facilitating inter alia also the access to RI.

Overall it can be stated that Germany undertakes substantial efforts to remove legal and other barriers to R&D and innovation and is thus seeking to join forces and resources and using available infrastructures more efficiently and to the mutual benefit. Germany participates in all major international projects developing large scale RI (such as CERN, ITER, etc.) and has, moreover, signed a number of bi-/multilateral cooperation agreements, which, inter alia, focus on financing R&D activities, alignment of national support programmes and/or on access to or creation of relevant RI in either country (done individually or jointly). The main political strategies rendering

66 By mid 2011 there were more than 60 on-going main thematic programmes (excluding defence research and technology). Exemplary can be seen the following initiatives: "SME Innovative", "Top Cluster Competition", "Enterprise Region", "Innovation Alliances" (some already mentioned in relation to MS01). Further initiatives with some relevance for RI are, for instance, the "Central Innovation Programme" (ZIM; providing direct support to corporate R&D in form of grants and loans; total of ~600 million p.a.), "IGF - Promotion of Joint Industrial Research" (supporting innovation in manufacturing; ~130 million p.a.), the "ERP Innovation Programme" (comprising of horizontal measures which aim to support financing; ~50 million p.a.), the "High-tech Start-up Fund" and the "ERP Start-up Fund" (both providing support to risk capital; together ~120 million p.a.), and "EXIST -Start-ups from Science" (supporting innovative start-ups/spin-off activities from universities; ~70 million p.a.).

67 The D-SPIN project ended in 03/2011 and was followed by CLARIN-D, which is a web and centre based RI for the social sciences and humanities. The DARIAH-DE project is the German contribution to the EU research infrastructure DARIA whose general aim is to enhance and support digitally-enabled research across the humanities and arts.

these efforts from a RI point of view are the German Internationalisation Strategy and the High-Tech Strategy 2020.

4.2 Getting good ideas to market

Getting good ideas to market and in particular the process of turning promising research findings into commercially successful products is proven to be difficult and – according to BMBF – takes too much time in Germany (16/08/2013, <link>). As the main impeding factors have been identified uncertainty concerning the potentials of any promising idea, technological challenges, and above all financial risks. In this light, the BMBF launched in 2010 the initiative VIP (*Validierung des Innovationspotenzials wissenschaftlicher Forschung*), which aims at validating ex ante the innovative (and economic) potentials of scientific results. According to a recent evaluation of the corresponding programme (<link>), this new measure has proven to be working fairly well and meets the requirements of the target group (as set out in the HTS 2020). Currently, about 90 projects are receiving support, which adds up to a total of €100m. It is foreseen to continue and expand this support line in future.

In general, there is a wide array of measures that aim at stimulating innovation and getting ideas to market. First and foremost, ensuring a constructive environment for innovations is necessary if good ideas are to lead to the commercial success of products, processes and services. The HTS therefore combines research funding with innovation-oriented development processes and framework conditions. The German R&D and innovation policy seeks to provide stimulus and incentives for growth and innovations, to eliminate barriers to innovation and to create scope to inspire innovations. A number of recent achievements in this regard are worth to be mentioned:

- Strengthening funding: A corporate tax reform is creating financial leeway, the High-Tech Start-up Fund is providing innovative young companies with venture capital, and the 'Help for Helpers' Law is strengthening incentives to channel private capital into foundations.
- Improved conditions for setting up a business: The amendment to legislation governing limited liability companies makes it easier to set up a business. Start-up programmes such as EXIST encourage people to venture into self-employment.
- Public procurement: The policy for awarding procurement contracts pays increasingly attention to the use of new products, technologies, and services. This stimulates innovation.
- Protecting intellectual property: Universities/people setting up new businesses are provided with advice on issues relating to patents under the 'SIGNO - Protection of ideas for commercial use' initiative. At the same time, measures to combat product piracy are introduced.
- Standardization as a driver for innovation: The 'Innovation with Norms and Standards' project is helping in particular SMEs to cope with often very complex standardization processes.
- Reducing bureaucracy and cutting 'red tape': Acc. to the federal government, 330 regulations have been simplified recently (estimated to save businesses more than €7b per year, <link>).
- Rising Germany's attractiveness as a place for science: The federal government has taken important steps towards modernizing the German science system with the Excellence Initiative, the Higher Education Pact 2020 and the Joint Initiative for Research and Innovation.
- Expanding the international approach: The Internationalization Strategy has helped to make better use of the opportunities of worldwide cooperation.

The overall policy objective of *Bund* and *Länder* continues to be establishing attractive framework conditions and the best possible preconditions for innovations. This includes providing adequate and reliable funding for innovations. Evidence suggests that the market for venture capital must

be further strengthened in Germany. At the same time, further incentives are needed to fund innovations and company start-ups. See further details in the chapters below.

Improving access to finance

As outlined above, access to finance for research and innovation has been identified as one of the major obstacles for getting good ideas to the market. However, improving access to finance is a cross-cutting issue tackling many policy fields. Accordingly, the measures in place that have directly or indirectly an (desired) effect on the availability of finance for innovation are cross sectional too, ranging from public procurement, to direct grants, subsidized loans and loan guaranties, tax incentives, up to ensuring a simplified and effective IPR system. For instance, the HTS provides targeted incentives for research and innovation activities, thus bridging science and business sector and help them to bundle crucial competences in co-operations, partnerships and innovation alliances. Cluster and network building – especially with involvement of SMEs – is vital in this regard and stimulates transfer of knowledge and technology among science and businesses, which is generally assumed to leverage the amount of commercially successful innovations. The latter in turn is due to facilitate access to finance for R&D and innovation for all partners involved.

In this light, a number of initiatives can be mentioned that (inter alia) aim at facilitating / affect the access to finance for innovation in Germany. For instance: '*Zentrales Innovationsprogramm Mittelstand*' (ZIM, focus on SMEs), a series of thematic R&D programmes, the ERP Innovation Programme (KfW loans for corporate R&D and innovation), SME-innovative (support to innovative SMEs with special emphasis on cutting red tape and support to fund raising), '*Industrielle Gemeinschaftsforschung*' (IGF, financing joint research activities of businesses and public research centres),[68] *Forschungscampus* (public-private partnerships for innovation), VIP-initiative (see discussed above), EXIST and '*High-Tech Gründerfonds*' (both supporting founders and start-ups), the SIGNO-programme that aims at facilitating IPRs for commercial use of innovative ideas (especially for SMEs), etc.[69]

Overall, there is indeed a wide array of measures and initiatives seeking to improve access to finance for innovation and tackling in this regard numerous individual obstacles especially for small / young firms. However, given Germany's positioning among the EU countries as 'innovation leader' (see IUS), the indicator values for finance and support in Germany remain comparably low and can be seen as one of country's weaknesses, i.e. holding back an even better innovation performance. According to the IUS 2011, the general level of 'finance and support' for R&D and innovation in Germany, compared to other innovation leaders in Europe, was highlighted as critical as Germany took only position eight among the EU-27 countries. In the IUS 2013, Germany has even lost a position in this regard and is ranked now only at number nine. In fact, public spending on R&D in Germany is above the EU-27 average (ca. 125%), but still comparably low if compared to the figures of the other innovation leaders such as Finland and Sweden. Furthermore, Germany performs remarkably low in terms of Venture Capital (VC) investments (on-

68 The German Federation of Industrial Research Associations "Otto von Guericke" (AiF) finances applied R&D, especially for the benefit of SMEs. Entitled to apply are exclusively the members of the '*Arbeitsgemeinschaft industrieller Forschungsvereinigungen „Otto von Guericke" e.V.*' (AiF). Since its foundation in 1954, about 180,000 research projects have received support (overall represent a R&D spending of €8.5b). AiF estimates that about 50,000 mainly mid-size enterprises benefit from its support.

69 Budget for ZIM in 2013 ca. €500m (e.g. for R&D projects carried out by individual companies or collaborative projects; not restricted to particular technologies or branches). Moreover, the "SME-innovative" funding initiative was expanded again in 2012 and given a new substantive focus; in 2012, funding of over €100m was made available to SMEs for cutting-edge projects. The EXIST programme allocated approximately €40 in 2013 to help funding e.g. university-based start-ups. (source: NRP 2013, p.20).

ly 61% of EU-27 average). According to IUS 2013 figures, progress has been made recently especially in terms of public R&D spending (average annual growth 5.5% according to IUS 2013, p. 32) as well as with regard to firm investments (150% of EU-27 average and +1.8% annual growth). However, Germany seems to be falling further behind in terms of VC (average annual growth was found to be negative at -0.9% according to IUS 2013), and this even in the light of a number of initiatives that have been launched or intensified recently in order to improve the VC situation.[70] Moreover, although initiating at a fairly high level (156% of EU-27 average according to IUS 2013 figures), Germany is also facing a negative trend in terms of non-R&D innovation expenditures (-4.8% annually). In contrast, the indicators capturing the activities of SMEs point to a shift from doing R&D and innovation in-house (level at 142% of EU-27, but negative annual growth of -0.9%) towards collaborative approaches with regard to R&D and innovation (level at 120% of EU-27 and rather fast annual increase of 11.8%); the latter being most likely a result of substantial policy support going into this direction and tends to indicate some success in terms of recent German R&D and innovation policy making.

Accordingly, although the measures in place that seek to facilitate access to finance in general and to seed and venture capital in particular appear to be widely well-targeted, rather clearly differentiated, comparably easy to access (further simplifications would certainly be desirable, especially for SMEs), and also (many of them) are especially tailored to the needs of SMEs, evidence suggests that the efforts made so far still remain insufficient. Especially the VC market appears still too small, i.e. there is need for action to further substantially increase the VC volume available for innovative firms. The supporting schemes – although regularly evaluated – could thus be benefiting from being questioned more critically and from benchmarking against comparable schemes in other countries which apparently seem to work more successfully. With regard to bureaucracy, the German government has made lately substantial efforts in cutting red tape.[71] However, there is certainly room for further improvements.

Protect and enhance the value of intellectual property and boosting creativity

Germany is among the leading countries with regard to the overall importance of IPR. In fact, When considering the number of (transnational) patent applications[72] in relation to the size of the country (patent intensity), smaller countries such as Switzerland, Sweden and Finland are at the top, and Germany comes fourth in this comparison and third in the area of high technology (see EFI Report 2013, p.131). Moreover, with regard to the IUS indicators 'innovators' and 'intellectual assets', acc. to IUS 2013, Germany is ranked first and second in the EU-27, respectively. All this points to a rather efficient framework for intellectual property in Germany and underlines that creativity and innovativeness is well developed and highly encouraged.

For more details, patent activities in the field of high technology can provide further insights into a country's scientific and technological performance. As regards Germany, the patent statistics indicate a strong specialization in high-value technology. Due to its traditional strengths in the automotive industry, mechanical engineering and the chemical industry, Germany is in second

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70 For instance, on 27/10/2011 the *Gründerfonds II* was launched with further investors from industry on board (fond volume now at about €300m). The objective is providing VC for NFBF with promising concepts for commercializing R&D results and innovative ideas. Start-ups can make use of the so-called '*Seed Finanzierung*' of up to €0.5m for R&D projects up to prototypes or market ready products. The fond comprises of the BMWi and KfW-Bank Group and numerous companies such as BASF, Deutsche Post DHL, Deutsche Telekom, RWE, Robert Bosch, Daimler and Carl Zeiss.

71 Recently, 330 regulations have been simplified, thus saving industry more than €7b per year (<link>)

72 These are patents or 'patent families' that comprise at least one application filed with the World Intellectual Property Organization (WIPO) via the Patent Cooperation Treaty Procedure (PCT) or an application filed with the European Patent Office (EPO).

place after Japan when compared internationally. In the field of cutting-edge technology (R&D intensity >7%), however, Germany is still poorly positioned, remaining well behind leading countries such as China, Korea and the US (see figure C5-3, EFI Report 2013, p. 133).73

However, the figures above only partly reflect innovativeness of a country as the mere numbers of patent applications can only provide a somewhat biased image. With regard to 'Getting good ideas to market', the quality of a patent, its commercial potential, and how quickly it can be commercially exploited are vital points. This was the toehold for the BMBF to launch in 2010 the initiative VIP ('*Validierung des Innovationspotenzials wissenschaftlicher Forschung*'), which aims at validating ex ante the innovative and commercial potentials of scientific results (see briefly discussed above under point 5.2).[74] In a complementary effort and in order to further exploit the innovative potential of SMEs and universities for economic value chains, in spring 2008, the Federal Ministry of Economics and Technology (BMWi) combined its former programmes "Commercialization campaign" and "INSTI" under the new umbrella brand "SIGNO – Protection of Ideas for Commercial Use" and divided it into three pillars: SIGNO Universities, SIGNO Companies and SIGNO Inventors (<link>). By this means the BMWi supports universities, companies, and independent inventors with legal protection and commercial exploitation of their innovative ideas. In the context of SIGNO Universities, HEI can commission specialized patent agencies or other organizations to identify professionally marketable know-how and register it as patents. With SIGNO Companies, BMWI intends to address SMEs in particular and in so doing, specifically integrate them into the innovation processes. The overall objective is supporting inventors, companies (especially SMEs) and HEIs in the commercially exploitation of their innovative ideas and thus particularly in ensuring their IPRs. The success rate of SIGNO supported patent applications at the German Patent and Trade Mark Office (DPMA) is at 80% and thus well above the average, which indicates the high quality of such applications. Also the commercial success appears above average. According to a survey among 1,100 former beneficiaries of SIGNO Companies, the SME-patent support contributed to the creation of more than 1,450 new jobs. Moreover, the initiative seems to have a sustainable learning effect as almost half of the former participants in the programme meanwhile have filed at least one further patent. Finally, also the participants itself rate the measure as very positive and highlight in particular the timely decision about any project proposals, the un-bureaucratic handling and the competent guidance by SIGNO partners (<link>).

The SIGNO-Programme supports moreover the '*TechnologieAllianz*' which is set up to form a German-wide network of more than 200 scientific institutions, agencies and stakeholders dealing with patents, commercial use of IPRs, and technological transfer. A further tool in this regard is the '*Patentserver*' of the BMWi, which aims at leveraging the number of good ideas being commercially exploited by making this database available to everybody who deals with patenting and the commercial use of inventions. Thematic subjects covered in this regard are IPR, exploitation of patents, support and guidance and overall patent policy (<link>).

With regard to the latter, the European Parliament's decision to introduce a unitary European patent and corresponding patent jurisdiction in fact has raised some questions. No doubt, it certainly improves on the previously existing European 'bundle of patents'. SMEs in particular are likely to benefit from these new regulations. Yet, the EFI Expert Commission and further rele-

73 Some of these countries are able to compensate for their lower-than-average patent activity in the area of high technology through their successful specialization in cutting-edge technology, while Japan even takes a leading position in both high-value technology and cutting-edge technology.

74 According to a recent evaluation of the corresponding programme (link), this newly introduced measure has proven to be working fairly well and meets the requirements of the target group (as set out in the HTS 2020). Currently, about 90 projects are receiving support which adds up to a total of €100m. It is foreseen to continue and expand this support line in future.

vant voices have raised concerns and underlined that it will be essential to further harmonize the EU patent system. In the medium term, ideally all EU member states should fully replace the EPO bundle patent with the unitary European patent. Moreover, it is argued that fees should be designed attractively in order for the new system to be favoured over the old bundle patent system, while at the same time effectively limiting incentives for increased filing of low-quality patent applications. To maintain current high standards and to deal with an expected increase in the number of patent applications, the European Patent Office will require corresponding equipment and administrative support structures, which first and foremost has a European dimension but – as EPO is located in Munich – may also mean need for action especially for Germany. The EFI commission further recommends that the highest standards should be applied to the selection and specialized training of judges and to the ongoing support of patent courts, which are due to be established as part of the Central Division. Finally, expertise and current benefits of the German system need to be integrated into the new system (EFI 2013, p. 5, <link>).

Public procurement

Beyond stimulating R&D and innovation by providing direct support in forms of grants or initiating certain thematic programmes, leveraging the demand for innovative products and services may also be a strong driving force for an innovation system and certainly could help 'getting good ideas to market'. Innovative solutions can make public services more customer/citizen-friendly and, moreover, help to minimize the corresponding costs of public services. In this light, within the EU and also in Germany (as part of its HTS 2020, <link>), proposals for designing innovation-oriented procurement as an innovation-promoting policy instrument are being discussed. The interest in the effects of innovation-oriented procurement is thus largely driven by the considerable volume of public demand.[75] In order to enforce innovation-oriented procurement of the federal government, the following Ministries and subsidiary institutions have committed themselves to increasingly apply procedures that foresee using innovation-oriented procurement: BMWi, BMBF, BMVBS, BMVg, BMI and BMU <link>. Moreover, the federal government formed an Alliance for Sustainable Procurement ('*Allianz für nachhaltige Beschaffung*') as a platform of experts providing corresponding intelligence and advice (see Report 10/2011 <link>). Further, on behalf of the BMWi, a competence centre for innovative procurement ('*Kompetenzzentrum innovative Beschaffung*', KO-INNO) is due to be created and leaded by the *'Bundesverband Materialwirtschaft, Einkauf und Logistik e.V.*' (BME).

However, in an effort to evaluate the current approach to procurement as an instrument for stimulating innovation in Germany, the EFI Expert Commission (in its 2013 Report) concludes that Germany is not sufficiently exploiting the potential of innovation-oriented procurement. Accordingly, it is still too often the case that public procurement makes use of established solutions or solutions with minor innovative potential, thereby disadvantaging or inhibiting the development and distribution of innovative products and services by German firms. The EFI Commission therefore recommends (see: EFI Report 2013, B3, p. 84ff):

- The federal Government should support measures initiated by the EC to promote innovation-oriented procurement, particularly the initiatives for the implementation of Pre-Commercial Procurement (PCP) and the renewal of the directive on public procurement in Europe. Yet, in the implementation of this reform, the federal government must take (better) care that these measures do not lead to a permanent restriction of competition.

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75 The annual volume of public procurement in Germany (accumulated at federal, *Länder*, and municipality level) is rather constant since several years at about €300b. The lion's share of procurement is made by the municipalities (<link>).

- Public procurement in Germany is highly fragmented and should be coordinated more closely. Further, it is important to raise awareness among procurers about the opportunities of innovation-oriented procurement. EFI therefore welcomes the creation of a competence centre (KO-INNO) that offers advice and assistance to public procurers in the field of procurement.
- It is moreover essential to collect and publish relevant data in order to monitor the effectiveness of measures promoting innovation-oriented public procurement and to take corrective action if necessary. The Alliance for Sustainable Procurement (<link>), initiated by the federal government, should therefore develop explicit recommendations for an improved statistical collection of data relating to innovation-oriented procurement.
- The federal government's planned projects for the promotion of innovation-oriented procurement should be monitored and evaluated from its very beginning.

The role of public procurement as a driver for innovation is also one of the dimensions assessed by the European Public Sector Innovation Scoreboard (EPSIS 2013). The concerns raised by EFI 2013 appear to be widely confirmed with a look at the EPSIS Indicator 3.3.2 on 'Government procurement of advanced technology products': Germany is above the EU-27 average in this regard but not at the same level as achieved by other 'innovation leaders' such as Finland and Sweden. Moreover, as illustrated by Figure 32, p. 50: 'Importance of innovation for winning procurement tenders – perception from public administration organizations' (which contrasts the relative importance of 'innovativeness' with 'low cost' as percentage of the overall procurement decision), the innovativeness of a product or service to be procured is rated in Germany as far less important than its overall price. Admittedly, the percentage of procurement contracts for which innovation aspects are ranked as equally important as the price is remarkably high, which might be indicating that procurers are to some extent aware of the importance innovation-oriented procurement in Germany could have.

4.3 Working in partnership to address societal challenges

Over the recent years, in Germany, a more and more strategic thinking and action towards the ERA has been developed. In fact, there is (now) a strong involvement of national policy makers into European issues. EU level instruments are being used for national goals, and there are attempts to influence the European level policy with core ideas as set out in the German 'Internationalisation Strategy' and the HTS 2020[76], thus inter alia seeking to ensure optimal transnational co-operation and competition. Triggered by a broadening of R&D policy and innovation policy at EU level, there have been steps towards a more functional 'horizontalisation' at national level, i.e. European involvement is becoming part of the strategic thinking and there is a stronger awareness of European issues across all ministries (e.g. visible in ERA-Net participations and a generally strong involvement in all new multilateral joint initiatives at the European level including the European Innovation Partnerships, EIP).

Examples for this commitment can be seen, again, in Germany's Internationalisation Strategy and in the G8 Research Council's Initiative on Multilateral Research Funding[77], which was initi-

[76] The High-Tech Strategy is set up to help Germany assuming a leading role in the solution of global challenges. The HTS encompasses the federal government's R&D activities in five priority areas: climate/energy, health/nutrition, communications, mobility and security. Focus is on selected forward-looking projects which pursue specific objectives related to scientific and technological developments over a period of 10 to 15 years. According to the NRP 2013 (paragraph 26, 85, 86), this initiative has contributed to higher and more efficient investments in education and research.

[77] Accordingly, researchers of an international consortium can apply jointly for funding in one country. Proposals are also evaluated by one country, but funding of the participating researchers is provided by their respective national funding organisation according to their normal terms and conditions for project funding.

ated under the leadership of the DFG in 2010. Moreover, the general importance of international cooperation – especially with regard to solving the Grand Challenges – has been highlighted and reinforced in the High-Tech-Strategy 2020 (revised strategy released in 2010). There is in fact a growing number of bi-/multilateral agreements on cooperation/joint activities in terms of research and innovation (and education).

As a general provision (set out in the Internationalisation strategy), funding earmarked for international cooperation in Germany should be increased. The modalities regarding the opening up of research programmes range from mere acceptance of foreign partners in research projects, without neither of any explicit selection criterion nor of funding associated, to the establishment of compulsory participation of foreign research performers and allocation of a substantial share of the funds to the latter. The degree of openness is programme-specific. For example, for any research project funded by the BMBF, the participation rate of foreign partners is envisaged to be at 20% (BMBF, 2008). Germany's Internationalisation strategy has four high-priority goals:

(1) Strengthening cooperation between the best researchers

(2) Gaining access to international innovation potentials

(3) Sustainably strengthening cooperation with developing countries in the fields of education, research and development

(4) Assuming international responsibility to overcome global challenges

The 'D-A-CH' agreement between the three German-speaking funding organisations can be seen as an effort to collaborate in partnerships to ultimately address Grand Challenges. Thus, the German Research Foundation (DFG), the Swiss National Fund (SNF) and the Austrian Research Fund (FWF) agreed already in 2003 upon simplifying cross-border funding, especially in terms of evaluation. Moreover, in 2009, an agreement concerning the mutual opening of the respective funding programmes ('Lead Agency' process) and cross-border funding ('Money Follows Cooperation Line') was signed to simplify the mobility of researchers and the execution of cross-border research projects.

Evidence from the 'IU Competitiveness Report 2011 – Germany' concerning industrial collaborations reveals that Germany is indeed cooperating mainly with its language clustered neighbouring countries such as Switzerland and Austria, but also with the Netherlands, Sweden, Finland and France. In terms of scientific cooperation, the main partners are the larger counties like the UK, France, Italy and Spain and as well Switzerland and the Netherlands. However, the relatively low degree of co-patenting with countries such as the UK, Italy or Spain, as compared to the degree of scientific co-publications, may signal an untapped potential for fruitful economic cooperation to be further developed.[78]

Among several further activities that seek to stimulate working in partnerships and addressing Grand Challenges are e.g. the BMBF initiative '*Förderung von Innovation and Forschung in Deutschland*',

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First projects have started in March 2011. The programme's medium-term goal is to establish a large pool of multilateral projects which can be supported by the national programmes of the DFG and its partner organisations at any time. The first call for proposals encouraged scientists from Germany, France, Japan, Canada, Russia, UK and the US to not only collaborate with existing scientific research groups on a bilateral or trilateral basis, but also created entirely new and productive multilateral research constellations. The first call for proposals focused on the high-performance computing power expected from the world's fastest supercomputers in the coming decade. In the pilot phase, the participating organisations will jointly announce a call for proposals with a different thematic focus each year to encourage widespread multilateral collaboration. After submitting a brief preliminary proposal, the review committee may request a full application, which is then peer- reviewed by the organisation in whose country the scientific project coordinator is based.

78 This relatively low rate of co-patenting should be seen in the light of findings that the establishment of multinational companies has an impact on the co-patenting activity in a country.

which seeks to promote innovation and research in Germany by presenting Germany's research achievements and opportunities to the international community (since 11/2006 under the brand name 'Research in Germany - Land of Ideas'). Beside mere promotional measures and events aimed at positioning German research and innovation in key international markets, the initiative additionally sets thematic and regional priorities in order to strengthen and expand R&D collaboration between Germany and selected target countries. The thematic priorities are in line with the thematic fields of the High-Tech Strategy.[79]

In a nutshell, Germany participates intensively in multilateral joint initiatives and also in most ERA-Nets, in all joint research programmes undertaken under Article 185 of the Treaty of Lisbon (European and Developing Countries Clinical Trials Partnership, Ambient Assisted Living, EUROSTARS, EMRP and Bonus), in the EIPs and in most Joint Programming Initiatives. German partners are also involved in European Technology Platforms (ETP) such as the ETP on Smart Systems Integration or the ETP on Photonics21 whose activities are coordinated by German partners. Through its engagement, Germany wants "…to become a motor of European strategy development in research and innovation policy" (BMBF, 2008).

For a comprehensive overview of joint programming activities in Europe see, for instance, the JOREP Report (released 12/2012). In fact, the country specific JOREP Report for Germany confirms that Germany has been part of all relevant European initiatives to support European and international collaboration from their early years and, moreover, that Germany is also in the process of further opening up its own funding programs to international partners. However, although there is a declared intention to increase international participation in national programs and the need for increased national, regional and international coordination is even proclaimed in the Germany Internationalization Strategy – so far – a clear strategy concerning opening up of national programmes is widely lacking. In fact, currently, project funding within the national funding programs is however primarily provided to German participants. International partners (mostly) have to ensure their own funding.[80] As a common praxis, the final decision on opening up and internationally granting project funds lies with the parties responsible for the individual programme. And the regulations have to be in line with national budgeting conditions, which commonly not foresee (yet) funding of international partners. There is nevertheless a general objective that – while taking into account the specificities of any programme – international collaboration in Germany's thematic programmes should be extended to about 20% on average.[81]

4.4 Maximising social and territorial cohesion

As briefly outlined in chapter 2.7, the *Länder* take responsibility for elaborating their own RIS3 strategies and conceptualise explicit smart specialisation strategies widely independently, given the frame as set by the HTS 2020. However, there is no coordinating mechanism at federal level aligning individual concepts and – as evidence suggest – the *Länder* do not seem to be closely collaborating when drafting their individual strategies. In fact, with the exception of Branden-

79 So far, the initiative focused on two key thematic fields: Nanotechnologies and Environmental Technologies. Currently emphasis is 'Production Technologies'. Regional priorities have been South Korea and India.

80 There are indeed a number of programs providing additional resources dedicated to kicking off research collaborations (these are specific collaboration programs aiming at specific countries or regions). Such programs are implemented and run by the International Bureau (IB) of the BMBF. The funding is in particular thought to support the preparation of further research collaboration in the framework of the specific thematic funding programs of the BMBF or relevant European Initiatives (e.g. FP). The major players enabling international research collaboration, which are providing the by far largest share of respective resources, are the BMBF, its International Bureau and the DFG.

81 JOREP Report, p. 45 (for details on the German participation in Joint and open Research Programmes see p. 49ff).

burg and Berlin, which have developed a joint innovation strategy for the German Capital Region (innoBB[82]; adopted in 06/2011,<link>), currently there is no further explicit example of two or more German regions that seek to develop regional innovation concepts jointly and thus particularly ensure adapting and ideally complementing their individual RIS3 strategies in a way that allows dovetailing for the mutual benefit.

Admittedly, in several regions in Germany RIS3 strategies are currently in the making (i.e. either at the stage of drafting, undergo evaluations/impact assessments, or in the process of parliamentary adoption). It might be therefore too early to assess quality and appropriateness of the concepts, especially with a view at their impact across regions and for regional cohesion. However, it can be observed that not all German regions have undertaken so far explicit efforts in terms of elaborating an own RIS3. By December 2013, apparently only four regions (Brandenburg, Berlin, Saxony, and Saxony-Anhalt) had registered to the Smart Specialisation Platform of the EU and by that means demonstrated their interest in competent support in this regard. The strategy of Saxony (released in 2012) is currently under peer review.

It needs to be mentioned that the ex-ante conditionality for access to the ERDF funds has different importance for some German *Länder* and that is therefore not surprising to see the East German *Länder* being particularly active in developing RIS3 strategies. In turn, there are some regions as e.g. Baden Wuerttemberg (being one of the innovation leaders across European regions), which have not yet developed/communicated explicit RIS3 strategies. However, this does not mean that the innovation strategy applied in these regions is not 'smart' (i.e. it complies with the criteria set out in the 'guide to Smart Specialisation' <link>). In fact, it is rather true that the leading regions in Germany (see ranking in Regional Innovation Scoreboard)[83] have been applying RIS3 principles (although not labelled as such) already for many years and are often taken as case study examples when outlining successful strategies to regions seeking to catch up.

In general, the fact that the German *Länder* apparently rather independently develop their individual RIS3 strategies gives reason to question whether these strategies are set up to ultimately complement each other. This is a critical point as each strategy and each region's RIS always needs to be seen in the context of its neighbours and, as a matter of fact, reaping the full potential in terms of innovation performance in any region certainly requires that the individual systems are well aligned and ideally mutually reinforcing their specific strengths. In fact, this is rather the essence of the smart specialisation approach. Hence, significant concerns remain with regard to the conceptualisation of individual RIS3 at *Länder* level only, especially if being done rather in isolation. To this end, a coordinating mechanism at federal level – for instance ensured by the '*Bund-Länder Ausschuss für Forschung und Technologie*' – could be helpful and may likely be found to be necessary once all or at least a significant number of regions will have released their strategies in order to achieve a bundle of RIS3, which are coherent each in itself as well as across regions (thus especially exploiting the full potential of complementarities and also addressing mismatching points). But, to install such a mechanism will be difficult in the light of the constitutional distribution of responsibilities for R&D and innovation in Germany, especially with a corresponding regional focus such as in the case of RIS3. However, without such a coor-

82 This joint innovation strategy outlines how Germany's capital region plans to further develop as an internationally competitive innovation zone. It is the result of a successful cooperation of all innovation policy players of both states, initiated in 2007. The strategy plans for even closer cross-border coordination in order to concentrate forces and to enable the locations to position them optimally with regard to the global competition.

83 For a comparative overview of regional research systems across Europe see e.g. Regional Innovation Scoreboard – 2012 and European Commission: Europe's regional research systems - current trends and structures, 2009 <link>. For regional innovation policy strategies check e.g. OECD (2009) <link, link> and for exploring regional structural and S&T specialisation across EU regions see EC (2009): <link>.

dinating effort it might be rather assumed that the development of individual RIS3 at *Länder* level could tend to hamper or even antagonize territorial cohesion.

4.5 International Scientific Cooperation

According to the IUS 2013 (and before), Germany is generally a good location for doing research. 'Intellectual assets' and 'Innovators' are particular strengths of the German system while, in contrast, relative weaknesses were found e.g. in terms of 'human resources' and concerning 'open, excellent and attractive research systems' (although the indicators in this regard seem to be improving with growth rates well above EU-27 average, i.e. Germany is catching up). The latter might in fact be a result of the German efforts to raise the country's attractiveness as a place for science. In fact, the federal government has taken important steps towards modernizing the German science system with the Excellence Initiative, the Higher Education Pact 2020 and the Joint Initiative for Research and Innovation and has, moreover, expanded the international approach by means of the Internationalization Strategy, which has been mainly set out to make better use of the opportunities of worldwide cooperation. Moreover, with regard to more open labour market for researchers, efforts have been made to facilitate researchers' mobility as e.g. by adopting in 2012 the '*Anerkennungsgesetz*' (recognition of foreign professional qualifications) and by drafting the Mobility Strategy 2020. Vacancies and grants are increasingly announced internationally, which is a step towards further opening up the German labour market for researchers and thus stimulating mobility (researchers' migration). In the same direction work some German efforts with regard to more mobility-friendly conditions of the existing social security systems, tax and pension schemes.

All this seeks to enhance the attractiveness of academic careers in general and, moreover, the attractiveness of Germany for foreign researchers. A number of comprehensive bi-/multilateral collaboration agreements have been signed in order to further improve the open market for researchers (beyond the borders of Germany). The BMBF inaugurated in 09/2013 a new central office for international vocational training cooperation at the federal Institute for Vocational Education and Training (BIBB).[84]

However, there are still some points that weaken the attractiveness of the German research and innovation framework. For instance, the education level (even if improving according to IUS 2013 indicators) was evaluated as partly below EU-27 and OECD averages and, moreover, the attractiveness for scientific workforce was also found to be comparably low. In fact, the German R&D and innovation system is well developed and due to its scientific excellence in various thematic fields certainly attractive for researchers from any parts of the world to come over for carrying out some research in Germany. However, the rather inflexible salary schemes applied to the German public sector (and in this regard to most of the visiting scientist that may want to come to Germany) to some extent counteract the 'gravity' which is due to high scientific quality of the system and thus limits its general attractiveness. Moreover, with a particular view at the capability of the German system to attract especially top talent from the US (or other excellent R&D locations with comparably high remuneration levels), it has to be stated that Germany and especially salaries paid in the German public research and higher education sector may appear appealing only to a limited extent. In fact, top universities and research centres in the US are much for flexible in offering top salaries (freely negotiable) to top talents, while German HEIs are bound by a number of rather restrictive rules in this regard.

[84] See in this regard, for instance, the 'Memorandum on European Alliance for vocational training' (adopted in 12/2012, partners: Germany Spain, Greece, Portugal, Italy, Slovakia, and Latvia).

5 NATIONAL PROGRESS TOWARDS REALISATION OF ERA[85]

5.1 More effective national research systems

Improving the effectiveness of the national R&I system is among the top priorities of the German policy agenda. Besides of just expanding the resources made available for R&D and innovation, in Germany, across the board performance based allocation of funds plays an increasing role. In this regard, a comprehensive multi-layer system has been established to evaluate individual proposals as well as institutions relevant for R&I funding, thus bringing in increasingly the spirit of competition while relying on appropriate forms of peer reviewing, benchmarking (i.e. performance check compared to corresponding best practice), and impact assessment analyses (ex-ante/ex-post, thus questioning e.g. additionality). Assessments are performed at (1) the level of individual research performers, (2) at programme level, as well as (3) at research institutions' level. Hence, addressing the ERA Actions 01 ***'Introduce or enhance competitive funding through calls for proposals and institutional assessments'*** and 02 ***'Ensure that all public bodies responsible for allocating research funds apply the core principles of international peer review'*** is a concerted action and related measures need to be seen jointly.

In general, with regard to ERA Action 01, competitive funding in Germany is stimulated significantly by implementing measures such as the Qualification Initiative and through calls for proposals and institutional assessments. For instance, in the light of the Qualification Initiative, *Bund* and *Länder* set themselves the target to spend altogether 10% of GDP on education and research (7% and 3%, respectively) and this with a rising share of budget allocated via competitive funding as outlined above in chapter 2.2 in the light of current Funding Trends (see especially chapter 2.2.1.1 on 'competitive vs. institutional funding'). Moreover, there are numerous thematic R&D support programmes,[86] which mostly involve competitive funds (and/or aim more or less explicitly at involving competitive funds at least to some extent). In fact, overall about 60 individual programmes are currently in place, for instance, 'SME Innovative', 'Top Cluster Competition', and 'Innovation Alliances'. The latter, for instance, has as an outset funding premise that every Euro public money spending should be matched by minimum five Euros from industry. Furthermore, agreement has been reached on the continuation of the 'Initiative for Excellence' for

85 This chapter relies on comprehensive material elaborated in the framework of ERAWATCH in course of 2013, especially on the ERAWATCH Communication Fiche 2012 (authored by Peter Voigt) and the 'Analysis of the ERA state-of-play in MS and Associated Countries: focus on priority areas – Country Report Germany', authored by Birgitt Aschhoff.

86 Thematic R&D programmes comprise a large set of individual programmes and sub-programmes for certain fields of technology/research, including Biotechnology, Nanotechnology and New Materials, Optical Technology, Health Research, Medical Technology, Environmental Technologies, Production Technology, Information and Communication Technologies, Space and Aircraft Technologies, Civil Security Research, Energy Technologies, Transport Technologies, Research on Working Conditions and Service Innovations, Nutrition and Agricultural Technologies, Research in Climate and Sustainability, Construction Technologies, Geotechnologies. By mid-2011, there were more than 60 ongoing main thematic programmes. Thematic programmes are run primarily by the BMBF while some are run by the BMWi and other Federal Ministries. Corresponding budget figures commonly do not include defence research and technology and sometimes exclude initiatives and sub-programmes funded through the thematic R&D programmes but listed as separate support measures below. Defence-related research funding by the Federal Ministry of Defence was about €1.0b in 2010.

the period 2012 to 2017 with a total funding volume of €2.7b and also with regard to the continuation of the 'Pact for Research and Innovation'[87], both being key initiatives with respect to allocating funds for research and innovation in Germany.

And also with regard to institutional funding the allocation of resources is increasingly geared towards effectiveness criteria. Admittedly, institutional funding to individual HEI is commonly not allocated on a competitive basis. However, within a HEI, a certain share of salaries might be. In fact, since 2002, a variable component for 'special achievements' was introduced in the traditional remuneration scheme of professors ('*C-Besoldung*'). The new remuneration scheme of professors ('*W-Besoldung*'), introduced in 2005, also includes a variable (i.e. performance related) component (<link>). Also within PROs a certain share of institutional funding is allocated on a competitive basis. In 2011, the share varied between 3 and 10 percent for the four large research organizations FhG, MPG, HGF and WGL.[88] Thus, each research organization has defined internal processes to allocate this part of institutional funding on a competitive basis (which includes peer review processes). According to the Pact for Research and Innovation, instruments such as performance based resource allocation should be developed further on a continuous basis. Evaluations of public research institutions are carried out on a more or less regular basis, e.g. by the WR (German Science Council). Depending on the outcome and recommendations made in the light of such evaluations, public funding might be adjusted structurally (share of institutional to total funding), in terms of total budget provisions (volume change; contribution of federal/state government), up to the closure or reorganisation of the corresponding institutes. Accordingly, the evaluations of the PROs and HEIs have a significant control and re-allocation function.

With the same general objective of increasing the effectiveness of the national RIS, a series of attempts have been made to provide further financial and managerial autonomy for universities and PROs in Germany. With the adoption of the '*Wissenschaftsfreiheitsgesetz*' (came into force on 12/12/2012) there is now increased budget flexibility for PROs. However, the new law has not been adopted for HEIs due to the responsibility of the host *Länder* for the corresponding funding. With regard to the latter, a controversial debate concerning funding of HEIs is ongoing (which tackles the question of responsibilities at regional/federal level and points towards a possible change of the German constitution (*Grundgesetz, Artikel* 91b).

As outlined above, decisions concerning allocation of public funds for R&D and innovation, in Germany, ground on a comprehensive multi-layer system that has been established to evaluate both proposals and granting/receiving institutions relevant for research and innovation funding. It is a core principle in this regard to rely on appropriate forms of peer reviewing, benchmarking, and ex-ante/ex-post impact assessments. Assessments are performed at three levels:

(1) Level of individual research performers: The process of peer review started off as the core measure. Later, additional procedures were introduced to measure the research performance of individual researchers and groups (bibliometrics, etc.) and these tended to involve internal, scientific instruments for deciding on the allocation of promotional research funds. Peer review procedures are in widespread use in the German research system, especially in the *ex-ante* evaluation of projects in basic and long-term application-oriented research. And peer review is also the pre-

87 It is an agreed objective of the Pact for Research and Innovation to launch appropriate measures to ensure and optimize the quality, efficiency and performance of science and research institutions which receive institutional funding. The initiative enables scientific and research organisations to pursue strategic goals and investigate new fields. To this end, *Bund* and *Länder* have increased the annual aid provided to the following large scientific and research organisations by five percent from 2011 to 2015: Hermann von Helmholtz Association of National Research Centres (HFG); Max Planck Society (MPG), Fraunhofer Society (FhG), Leibniz Science Association (WGL), and the German Research Association (DFG).

88 See Pact for Research and Innovation, Monitoring Bericht 2012, GWK-Heft 28, p.64 <link>

dominant evaluation instrument of the German Research Foundation (DFG).[89] Project funding provided by the DFG basically applies the international peer review standards although there is no corresponding regulation. The DFG has a standard selection process which is applied to most programmes. Applications for grants are assessed by peers, who are elected every four years by the entire scientific community. Each expert is advised to judge the application on the basis of its scientific quality alone. The recommendation to integrate peer reviewers in the review process is part of DFG's statutes (Article 8, <link>). International experts are not always required but play an important role. More than a quarter of all reviews are conducted by experts from abroad. The allocation procedure of project funding by project agencies (on behalf of ministries) also usually includes the setup of evaluation committees.

(2) Programmes: Around a core of peer review procedures a "shell" was formed which consisted of impact analyses of R&D policy programmes. Programme evaluation and impact analysis have gained acceptance in Germany since the 1970s in many political fields with the spread of programme policy and have experienced a considerable upswing since then. As a rule, independent research institutes act as evaluators on behalf of R&D policy administrators. Since the mid-1990s, many R&D policy programmes have been launched as competitions, which aim to bring about structural changes in science and the economy. Consortia of candidates (usually institutions) are required to elaborate joint project plans and detailed goals. As a consequence, new evaluation designs were required. Over two decades of programme evaluation in this context led to the establishment of a particular "evaluation scene" in the German-speaking area, consisting of a group of experts and institutes from the field of economics and social sciences, using a broad spectrum of concepts, methods and instruments, who have been organised professionally within the German Society for Evaluation (DeGEval) since 1998.

(3) Institutions: Here the performance of entire research institutions is dealt with. In Germany, the evaluations of the German Science Council (WR) have played an important role for a long time; and they even assumed a shaping function in the re-structuring of the 'research landscape' of Eastern Germany after reunification. Since the 1990s, evaluations of institutions have been carried out with greater frequency and had the main objective to assess all federal institutions with R&D responsibilities and to review the research institutes of the WGL. In November 2010, the WR has adopted a second comprehensive recommendation for the future development of research institutions supporting the federal government departments. Support measures of the DFG are continuously monitored and evaluated by the Institute for Research Information and Quality Assurance (*iFQ – Institut für Forschungsinformation und Qualitätssicherung*). The institute was established in 2005.[90] By the same token, when formulating research programmes, the ministries regularly offer opportunities for stakeholder discourses and thus allow the public to bring in further expertise and stimulating peer review. In addition, there is a well-established dialogue between the federal Ministry of Education and Research (BMBF) and the umbrella organisations of the public research institutes (large PROs). Finally, the BMBF has moreover conducted a range of foresight activities since the early 1990ths whose general aim is to foresee possible futures scenarios and corresponding implications in terms of research and technology development with a perspective of 10 to 15 years. Thematic subjects thus identified as of particular importance are taken up and will be further considered more in detail in dedicated projects.

Overall, by establishing comprehensive peer-reviewing/evaluation mechanisms as part of the German RIS, a high level of compliance with the international peer-reviewing principles and standards can be ensured. Although the importance of competitive funding of R&D and innova-

89 The DFG plays a central role in the promotion of basic research in universities, principally by granting individual researchers funds on application (so-called standard procedure, <link>).

90 iFQ is funded by DFG as "central research facility" and is designed as a scientific institution that will initially concentrate on the evaluation of DFG's funding programs.

tion in Germany is rising, during the recent years, no significant changes occurred with regard to the mechanism of peer-reviewing and evaluations of R&D and innovation funding bodies (and programmes); mainly as the system has proven to be working fairly well. However, with a view to the application of international principles of (fair) peer-reviewing for supra-national funding decisions (e.g. with regard to EU wide joint programming, Horizon 2020), the installed mechanisms in Germany still need to prove how well they will be functioning in practice for a large number of internationally competing proposals for funding.[91]

5.2 Optimal transnational co-operation and competition

Germany has been part of all relevant European initiatives to support European and international collaboration from their early years. Yet, Germany has so far no explicit strategy towards ERA (see Daimer at al., 2011). However, over the last years, a strategic thinking and action towards the ERA has been developed. In fact, there is (now) a strong involvement of national policy makers into European issues. EU level instruments are being used for national goals, and there are attempts to influence the European level policy with core ideas as set out in the German Internationalisation Strategy and the High Tech-Strategy[92]. Triggered by a broadening of R&D policy and innovation policy at EU level, there have been steps towards a more functional 'horizontalisation' at national level, i.e. European involvement is becoming part of the strategic thinking and there is a stronger awareness of European issues across all ministries (e.g. visible in ERA-Net participations and a generally strong participation in all new multilateral joint initiatives at the European level). The 'Initiative on Multilateral Research Funding' (initiated under the leadership of the DFG in 2010) can be seen as an example for this commitment.

The need for increased national, regional and international coordination is proclaimed by the German Internationalisation Strategy (adopted in 2008). However, although there is a declared intention to increase international participation in national programs (to about 20% in average), a clear strategy and/or general rules concerning the opening up of the national programs are still lacking. In the end, the decision lies with the parties responsible for the individual programs and the regulations have to be in line with national budgeting conditions, i.e. financing is primarily provided to national partners while international partners have to provide their own resources.

Nevertheless, there are a number of programs providing additional resources dedicated to start research collaborations. These are specific collaboration programs aiming at specific countries or regions. Such programs are commonly implemented and run by the International Bureau (IB) of the BMBF. The funding is in particular thought to support the preparation of further research collaboration in the framework of the specific thematic funding programs of the BMBF or relevant European Initiatives (e.g. FP). The major players enabling international research collaboration, which are providing the by far largest share of respective resources, are the BMBF, its In-

91 In this regard, in 02/2010, the G8 Heads of Research Organizations (G8-HORCs) announced their first joint call for proposals for multilateral research projects in their participating countries. The programme's medium-term goal is thus to establish a large pool of multilateral projects which can be supported by the national programmes of the DFG and its partner organisations at any time. In the currently ongoing pilot phase, the participating organisations jointly announce a call for proposals with a different thematic focus each year to encourage widespread multilateral collaboration. After submitting a brief preliminary proposal, the review committee may request a full application, which is then peer- reviewed by the organisation in whose country the scientific project coordinator is based.

92 The High-Tech Strategy is set up to help Germany assuming a leading role in the solution of global challenges. The HTS encompasses the federal government's R&D activities in five priority areas: climate/energy, health/nutrition, communications, mobility and security. Focus is on selected forward-looking projects which pursue specific objectives related to scientific and technological developments over a period of 10 to 15 years. According to the NRP 2013 (paragraph 26, 85, 86), this initiative has contributed to higher and more efficient investments in education and research.

ternational Bureau and the DFG. The framework for international research collaboration is set by the BMBF's (see JOREP Report, 2011, p. 45).

Furthermore, European initiatives such as the Framework Programs are increasingly important in the context of financing transnational research and innovation. While for the 3rd to 6th FP approximately 4% of the EU budgets were spent on them, this share increased to approx. 5.5 % with the 7th FP (see Rammer et al. 2011, p. 17). In addition, while for FP 4 to 6 on each Euro spent on R&D at the European level 15 Euro were spent nationally (in FP 1 and 2 it was between 1:25 to 1:20), this rate now is 1:10 (Rammer et al. 2011, p. 17). Further with regard to EU funding, according to the IU Progress Report at Country Level – 2013 (p. 109), Germany has allocated € 25.5b of ERDF Structural Funds to research, innovation and entrepreneurship with a 47.1% absorption rate. Germany counts 11,000 participants in the FP7 programme and receives the highest amount of FP7 funding in absolute terms (€4.3b). Its success rate of applications is above average (24% compared to an EU average of 20.4%), but FP7 funding as a % of GDP is below the EU average.

With a view to the individual ERA Actions set out under the heading of ERA priority II, the following initiatives are to be underlined:

(1) With a view to '…implementing joint research agendas, addressing grand challenges, sharing information about activities in agreed priority areas, and ensuring that adequate national funding is committed and strategically aligned at European level in these areas…' (ERA Priority II, **Action MS 06**), besides the above mentioned Internationalisation Strategy, the HTS 2020, and the Initiative on Mutual Research Funding, the 'D-A-CH' Agreement between the three German-speaking funding organisations, the German Research Foundation (DFG), the Swiss National Fund (SNF) and the Austrian Research Fund (FWF) is of high relevance. Already in 2003 the three countries agreed upon simplifying cross-border funding, especially in terms of evaluation. Moreover, in 2009, an agreement regarding the mutual opening of the respective funding programmes ("Lead Agency" process) and cross-border funding ("Money Follows Cooperation Line") was signed in order to simplify the mobility of researchers and the execution of cross-border research projects. Another activity to be mentioned here is Initiative '*Förderung von Innovation and Forschung in Deutschland: Research in Germany - Land of Ideas*'. The initiative was launched by BMBF and seeks to promote innovation and research in Germany by presenting Germany's research achievements and opportunities to the international community (since 11/2006 under the brand name "Research in Germany - Land of Ideas"). In this regard, promotional measures and events aimed at positioning German innovation and research in key international markets have been organised on behalf of BMBF. The initiative additionally sets thematic and regional priorities which each run for a period of 1.5 years, also to strengthen and expand R&D collaboration between Germany and selected target countries.[93]

(2) Germany '…Ensures mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions' (ERA Priority II, **Action MS 07**). Exemplary can be seen the Initiative on Multilateral Research Funding where researchers of an international consortium can apply jointly for funding in one country. Evaluation of proposals is thus done in one country but funding of the participating researchers is provided by their respective national funding organisation according to their normal terms and conditions for project funding (i.e. mutual recognition of evaluations). First projects have started in March 2011. Comparable to this is the D-A-CH Agreement (see above).

[93] The thematic priorities are in line with the thematic fields of the HTS 2020. So far, the initiative focused on two key thematic fields: Nanotechnologies and Environmental Technologies. The current focus is on Production Technologies. Regional priorities have been South Korea and India.

(3) Germany seeks to '…remove legal and other barriers to the cross-border interoperability of national programmes in order to permit joint financing of actions including cooperation with non-EU countries where relevant…' (ERA Priority II, **Action MS 08**). In this regard, again, the Initiative on Multilateral Research Funding and the D-A-CH Agreement have to be mentioned, which both seek to remove legal and any other barriers to the envisaged cross-border interoperability of national programmes (among EU partners in general and/or between Germany, Austria and Switzerland, respectively). The D-A-CH agreement contributes to the MS08 Action particularly by simplifying cross-border-funding, especially in terms of evaluation (2003) and joint proposal submission with Austria and Switzerland (since 2009, 'Lead Agency' process). Moreover, Germany has signed a number of bilateral agreements with EU and non-EU countries in order to launch and/or further intensify co-operations in research and education, thus removing barriers for and/or explicitly permitting joint financing of projects and programmes.

(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 Structural Fund programmes (ERA Priority II, **Action MS 15**): The efficient use of existing RIs in Germany is subject of the National Research Infrastructure Roadmap (published 04/2013, <link>). Beyond, the planning of new RI's – especially large scale/costly installations – are due to be coordinated in the light of the European Strategy Forum on Research Infrastructure (ESFRI) and the corresponding roadmaps. The main task of ESFRI is now to help the projects on the roadmap move towards implementation, to get/keep Europe at the rapidly evolving forefront of science and technology, and to increase the capacity to meet the needs of the EU and global scientific community. In this regard, Germany runs already since many years (1957) comprehensive thematic R&D support programmes[94], which are increasingly aligned to the ESFRI roadmap. Further to be mentioned with regard to Action MS15 are, for instance, the activities of the DFG, whose funding includes academic research infrastructure. Moreover, there are several individual projects, such as e.g. the D-Spin (later Clarin-D project) and DARIAH-DE project. The former is the German contribution to the European CLARIN-Project (Common Language Resources and Technology Infrastructure). The project D-SPIN provides the basis for a stable and sustainable infrastructure of language resources and language technologies, serving above all empirical research in humanities and social sciences.[95].

(5) '…Removing legal and other barriers to cross-border access to RIs…' (ERA Priority II, **Action MS 16**) is another core objective of the German research and innovation policy. In fact, as outlined above with regard to MS08, adopting bi-/multilateral cooperation agreements – be this focused on financing of R&D activities/alignment of national support programmes and/or on access to/creation of relevant RI in either country (done individually or jointly) – in general aims at "removing legal and other barriers" to R&D and innovation. The overall idea is joining the forces and resources, using infrastructures more efficiently and to the mutual benefit. Hence, in

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94 Currently there are more than 60 ongoing main thematic programmes (excluding defence research and technology). Exemplary can be seen the following initiatives: 'SME Innovative', 'Top Cluster Competition', 'Enterprise Region', 'Innovation Alliances'. Further initiatives with some relevance for RI are, for instance, the 'Central Innovation Programme' (ZIM; providing direct support to corporate R&D in form of grants and loans; total of ~600 million p.a.), 'IGF -Promotion of Joint Industrial Research' (supporting innovation in manufacturing; ~130 million p.a.), the 'ERP Innovation Programme' (comprising of horizontal measures which aim to support financing; ~50 million p.a.), the 'High-tech Start-up Fund' and the 'ERP Start-up Fund' (both providing support to risk capital; together ~120 million p.a.), and 'EXIST -Start-ups from Science' (supporting innovative start-ups/spin-off activities from universities; ~70 million p.a.).

95 The D-SPIN project ended 03/ 2011. Since 05/2011 there is a follow-up project CLARIN-D, which is a web and centre based RI for the social sciences and humanities. The DARIAH-DE project is the German contribution to the EU-wide RI 'DARIA', whose general aim is to enhance and support digitally-enabled research across the humanities and arts

essence, the same initiatives mentioned above under the points MS08 and MS15 can be named here again as being relevant with regard to MS16.[96]

In a nutshell, the general importance of transnational cooperation – especially with regard to solving the 'Grand Challenges – has been highlighted and reinforced by means of the revised strategies that give frame to the German research and innovation policies (Internationalisation Strategy, HTS 2020, etc.). Moreover, there is in fact a growing number of bi-/multilateral agreements on cooperation/joint activities in terms of R&D, innovation, and education. Germany participates intensively in multilateral joint initiatives and also in most ERA-Nets, in all joint research programmes undertaken under Article 185 of the Treaty of Lisbon[97], and in most Joint Programming Initiatives. German partners are also involved in European Technology Platforms (ETP) such as the ETP on Smart Systems Integration or the ETP on Photonics21 whose activities are coordinated by German partners. Through its engagement, Germany wants 'to become a motor of European strategy development in research and innovation policy' (BMBF, 2008).[98]

5.3 An open labour market for researchers

The German objectives and measures within the framework of the Research Partnership are based on the priority lines of actions formulated by the Competitiveness Council on the basis of the Commission's communication to the European Parliament and the European Council 'Better Careers and More Mobility: A European Partnership for Researchers' (Brussels, 23 May 2008; SEC (2008) 1911/1912), i.e. in particular (1) Systematic open recruitment of researchers, (2) meeting the needs of mobile researchers with regard to social insurance and supplementary pensions, (3) improving employment/working conditions to enhance the attractiveness of scientific careers, and (4) improving the training, skills and experience of researchers.

Germany has undertaken significant efforts to facilitate mobility, for instance, by adopting in 2012 the 'Foreign Skills Approval and Recognition Law' ('*Anerkennungsgesetz*', which simplifies the recognition of foreign professional qualifications, <link, link>) and by drafting a Mobility Strategy 2020 and discussing it with the European partners at the 'Bologna Conference' (04/2012, in Bucharest, <link>). Beyond, vacancies and grants are increasingly announced internationally which is a step towards further opening up the German labour market for researchers and thus stimulating researchers' migration. In the same direction work some German efforts with regard to more mobility-friendly conditions of the existing social security systems, tax and pension schemes. All this seeks to enhance the attractiveness of academic careers and, in particular, the attractiveness of Germany for foreign researchers. As outlined above with regard to other ERA priorities, numerous comprehensive bi-/multilateral collaboration agreements have been signed in order to further improve the open market for researchers (beyond the borders of Germany).

Germany cooperates with many countries in terms of international vocational training. This supports German providers of initial and continuing vocational training in developing the rapidly growing international education market. In bilateral working groups under the leadership of the BMBF, German representatives and their corresponding international partners discuss current

96 For instance, in 02/2012 a new Super Computer was inaugurated in Germany (one of the fasted world-wide). The facility is available not only for German users but for EU/non-EU-users too. Machine time for national research projects is allocated by/among the three German high-speed electronic data processing centres HLRS, LRZ and JSC within the Gauss Centre for Supercomputing (GCS). The use of the facility for European (international) research projects is coordinated by the 'Partnership for Advanced Computing in Europe' (PRACE). <link>

97 European & Developing Countries Clinical Trials Partnership, Ambient Assisted Living, EUROSTARS, EMRP, Bonus.

98 For a comprehensive overview of joint programming activities in Europe (and a corresponding analysis) see e.g. the JOREP Report (released 12/2012, <link>).

developments in vocational education. In this area, Germany contributes to the finding of solutions on the basis of its world renowned dual system of vocational education and training. In this light, the European education ministers have agreed to optimize their national systems of vocational education while creating the basic conditions for a European Vocational Education Area. The BMBF opened in 09/2013 a central office for international vocational training cooperation at the federal Institute for Vocational Education and Training (BIBB, <more info>).[99] See in this regard, for instance, the 'Memorandum on European Alliance for vocational training' (adopted in 12/2012, initial signing partners: Germany Spain, Greece, Portugal, Italy, Slovakia, and Latvia; <more info>). The European Commission and the European Centre for the Development of Vocational Training CEDEFOP will support this process. The EU is placing special focus on practically oriented training in its new strategy "Rethinking Education". Starting in 2014, the new EU Education Programme "Erasmus for everyone" and the new European Social Fund will contribute significantly to the financing. With a "European Alliance for Apprenticeship" it is planned to integrate further countries into the reform process initiated by Germany.

As a general rule, the large majority of researchers in Germany are employed as civil servants (*Beamte*) or public sector employees (*Angestellte*). The constitutional principle of the 'selection of the best' ensures openness of the recruitment procedures in this sector, aided by the provisions of equality legislation (gender mainstreaming) and the General Anti-Discrimination Act of 2006 and thus addresses the provisions set out in **Action MS24**, ERA Priority III, to '…Remove legal and other barriers to the application of open, transparent and merit based recruitment of researchers.' In fact, recruitment procedures for university teachers in Germany are traditionally strongly competition-based. Under current *Länder* law, the *Länder* Ministries are increasingly transferring the right to appoint staff to the respective universities and research institutions. The openness of advertisement and recruitment procedures in HEIs is guaranteed under the *Länder* Higher Education Laws, which not only stipulate the traditional supra-regional and public advertising of vacancies, but also explicitly demand that vacancies are advertised internationally (depending on the importance of the position or in some cases as a general rule) and only allow exceptions in special cases.

The involvement of external experts along with a comparative evaluation of applications guarantees the transparency and competitiveness of the recruitment of university teachers (professors) in Germany. In Germany, traditionally it is not possible to become a professor at that institution of higher education where one received one's academic training. The strictly regulated exceptions under *Länder* legislation were introduced on the basis of the Tenure-Track Model in the interest of ensuring more transparent and faster career paths for upcoming scientists. It is set out (by the BMBF) that this model should be applied more widely, i.e. also in the field of non-university research. In the meantime, 'Junior Professors' who have previously held fix-term contracts and whose work is considered excellent in their specific subject area may be granted a permanent contract. As a rule, however, the researcher must have gained the doctorate required to set out on such a career path outside the institution of higher education which is recruiting her/him. This is in the interest of ensuring academic openness.

The international advertising of every fixed-term or permanent vacancy for researchers is widely common practise (although not a compulsory rule). However, exceptions exist - and should ar-

[99] In the area of vocational training exports, the BMBF supports the internationalization of German initial and continuing vocational training services providers. The aim is to develop innovative export channels for basic qualifications up to the further training of skilled staff and to test them in practice. Under the motto of "Training - Made in Germany," the BMBF initiative iMove (International Marketing of Vocational Education) promotes German initial and continuing vocational training. German education service providers are supported in establishing international cooperation and business relations by means of trainings, delegation visits and market studies.

guably be allowed - in justified cases. In this regard it is worth mentioning that HEIs and PROs in Germany have a wide autonomy in recruiting their staff and education and research, to a major extent, falls in the responsibility of the regions rather than the federal government. Hence, across Germany, it is difficult to refer to fully homogeneous standards and procedures in terms of recruitment (especially at HEIs). However, the Academic Freedom Act, adopted in 2012 at federal level, makes provisions for generally more autonomy in staffing decisions. In this regard, institutions will be allowed (to some extent encouraged) to make greater use of third-party private funds in order to attract or keep highly qualified researchers.

In sum, there are no obvious barriers to the application of open, transparent and merit based recruitment of researchers in Germany. Nevertheless, with regard to hiring foreign researchers in Germany, some obstacles may occur due to language issues and, for instance, due to problems in terms of recognition of diploma. In this regard, there are indeed some initiatives which aim at supporting access to the German HR market for foreign researchers; see further outlined below (e.g. Recognition law, adopted 2012, and the foundation of the central institution IHK FOSA (Foreign Skills Approval) in 2012, which is carrying out the corresponding assessments and decides about recognition <more info>). In this regard it needs to be mentioned that – according to a research project conducted by the HU Berlin, the TU Hamburg-Harburg, and the RWTH from Aachen (commissioned by BMBF together with the European Social Fund (ESF)) – there is evidence of a corresponding gender-bias. In fact, the study shows that highly qualified migrant women with foreign degrees have had difficulty entering the German labour market: The move to Germany often means interrupting their careers or even accepting employment far below their level of qualification <link>. Initiatives tackling gender bias inequality and gender mainstreaming in research in Germany are discussed below under ERA Priority IV (chapter 5.4).

With a view to remove legal and other barriers which hamper cross-border access to and portability of national grants (**Action MS 25**, ERA Priority III), in Germany, scholarships are increasingly advertised internationally. The eligibility and portability of grants commonly depend on the programme. A wide range of funding programmes exists for non-residents to work in Germany. Corresponding research grants are provided by the German Academic Exchange Service (DAAD), the German Research Foundation (DFG), the Alexander von Humboldt Foundation (AvH) and public research organisations (<more info>). Theoretically there is no difference regarding grant accessibility between foreigners and Germans working at universities or PROs located in Germany. For instance, the DFG implemented the general principles of portability as defined in "Money Follows Researcher" (agreement signed 2004). The conditions for grant portability are characterized by moderate complexity (for an example see corresponding DFG rules, p. 39ff <link>). In general, the DFG expects that scholarships are advertised internationally within the framework of its DFG Scholarship funding for research training groups and graduate schools. This has resulted in an increasing number of applications from abroad.

As a general rule, scholarship-holders in Germany are commonly selected via a procedure involving experts (peer-review process). The applicant's nationality is thus generally considered as irrelevant. Nevertheless, in the grant announcement certain language skills might be made compulsory, such as minimum level in German or English in order to ensure ability to communicate with other staff, which may lead to a factual restriction in terms of access to the national grant. Beside language skills, the recognition of professional skills and/or a certain diploma as being equivalent to a national degree might be difficult for foreign researchers and may therefore lead to a restricted (or at least more complicated) access to cross-border grants and foreign employment markets. In this regard, the German government has undertaken in the recent past some efforts to facilitate recognition of skills and diploma and thus to open the access to the German grants / employment market for researchers (see *'Anerkennungsgesetz'* from 04/2012, discussed above).

As far as the portability of research grants is concerned, it is essential to differentiate between transnational European, national and regional mobility (*Länder*). Many research funding organizations such as the DFG offer schemes which enable the portability of project grants to a certain extent (see above). These presuppose relevant agreements between the organizations of the European states concerned. However, since the funding involved is public funding, a balance must be sought between outgoing and incoming researchers with regard to the portability of funding. But, there are doubts about the benefits of free portability in cases where the original host institution has established special infrastructures or particular resources for the research project. One must also consider the fact that the aim of strengthening a national or regional research priority can be thwarted by the full portability of research grants and that this is not in the interest of public funding organizations. It however makes sense to continue to provide scholarships for shorter or longer stays abroad which are necessary for research purposes. This is already being practised by funding organizations such as the Alexander von Humboldt Foundation (AvH), scientific organizations such as the Max Planck Society (MPG), and also the BMBF.[100]

Further with regard to cross-border access and portability of grants, here again, the D-A-CH agreement between Germany, Austria and Switzerland needs to be mentioned as an exemplary initiative. The core of the agreement is the mutual opening of the respective funding programmes and leveraging cross-border funding. Both together is due to simplify the mobility of researchers and the execution of cross-border research projects.

Finally, in order to generally stimulate cross-border access to and portability of national grants the relevant German bodies (i) intend to optimize the links between German platforms which publish vacancies; (ii) they aim at increasing the awareness of the possibility of advertising vacancies via EURAXESS-Jobs; (iii) at expanding the 'Information and Communication Platform for Young Researchers' (KISSWIN)[101]; and (iv) at studying possible measures to support and improve internal counselling and information services for mobile researchers at HEIs. By these means, **Action MS 26** of ERA Priority III is due to be addressed. The public and/or international advertising of positions for university teachers (professors) usually takes place via national and international newspapers and journals, which are known among the international community of scientists and which (as a rule) also have an Internet portal. The EURAXESS Germany Portal[102] makes it possible to advertise every research vacancy internationally. However, evidence

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100 For instance, the BMBF is co-financing the Sofia Kovalevskaya Award for up-and-coming young researchers. The scheme provides research scholarships to enable outstanding researchers from abroad to complete long-term research stays in Germany. It allows researchers to establish their own working groups and to spend up to 5 years working on a high profile, innovative research project of their choice at research institutions in Germany. Another example is the Alexander von Humboldt Professorship (also financed by the BMBF through the International Research Fund for Germany). It enables award winners to carry out long-term research at HEIs in Germany. Eligible are academics of all disciplines from abroad who are internationally recognised as leaders in their field and who are expected to contribute to enhancing Germany's sustained international competitiveness as a research location in consequence of the award. The award funds are made available for a period of five years. Nominations may be made by German universities; non-university research institutions may also submit nominations jointly with a German university.

101 The homepage of the German Rectors' Conference provides links to the job exchanges of the individual Member States. In addition, the BMBF-funded 'Information and Communication Platform for Young Researchers' (KISSWIN) has been operating since 2008. KISSWIN, which is also accessible in English, provides easy-to-access and straightforward information on the general situation and career paths in Germany. Furthermore, it enables interested young researchers from all over the world to look for job vacancies and scholarships in the field of science and research free of charge.

102 The online portal EURAXESS Germany, including a helpdesk, provides support for mobile researchers. The portal is funded by the Federal Ministry of Research and Education. Besides EURAXESS Germany/National Coordination Point at the Alexander von Humboldt Foundation, around 70 EURAXESS service centres provide information and assistance. In addition, all large universities have established welcome centres and dual career services.

suggests that – relative to its size as a science location – Germany tends to make little use of this portal compared with its European partners (number of vacancies entered into the data bank). In fact, of the 9,302 vacancies published in the period from 01/01/2009 to 31/07/2010, 526 were from German organizations. Accordingly, Germany is ranked at 7th place only.[103]

In general, the growing international competition for excellent researchers is prompting the increasing internationalization of recruitment efforts in Germany. This is also demonstrated by the internationalization strategies introduced by many institutions of higher education and PROs. In addition, there are service centres at numerous HEIs which support mobile researchers by providing counselling and information services. It can therefore be assumed that the comparatively small number of foreign university teachers, researchers, junior research staff, and doctoral students currently working at German HEIs and PROs will increase in the years to come.

What regards **Action MS 27**, ERA Priority III, and '…support to the setting up and running of structured innovative doctoral training programmes applying the Principles for Innovative Doctoral Training…', Germany is certainly a special case within the ERA. In fact, according to the final report of a Mapping Exercise on 'Doctoral Training in Europe - Towards a common approach', released by the EC on 27/06/2011 <link>, the EC is due to propose a common approach to help ensuring that the next generation of doctorate holders can actively contribute to the Innovation Union. This common approach may include the recommendations that doctoral training should (i) have a certain critical mass, (ii) include transferable skills training, (iii) respect the principles of Charter & Code, (iv) lead doctoral candidates to acquire the ability to challenge disciplinary borders, (v) encourage doctoral candidates to spend some time abroad, and (vi) also some research time in industry or other relevant private/public employment sectors. However, although all these points appear reasonable and desirable for a harmonisation of doctoral training standards across Europe, in Germany setting up correspondingly rather uniform rules across regions will not be so easy as this lies in the responsibility of the *Länder* (as responsible for education and especially for universities (see chapter 1). Moreover, launching doctoral training programmes, defining corresponding rules and structures is to a major extent up to each individual university; i.e. this may even differ from faculty to faculty within a certain university (each faculty may give itself its own rules – *'Prüfungsordnung'/'Promotionsordnung'*). This is due to the University Constitutions which provide comprehensive independence for HEI in such aspects. Hence, the introduction of structured and innovative doctoral training programmes in Germany has to be seen case by case (although the principles for innovative training programmes certainly may apply to all in the same way). However, there is no systematic initiative at federal or regional level. Nevertheless, in a comprehensive report outlining the German contribution to the European Partnership for Researchers: Better Career opportunities and more mobility (*'Forscherpartnerschaft'*), released in 11/2010, the federal government points out that it seeks to stimulate (literally "continue ...") a reform of the doctoral training in Germany in order to ensure a higher share of structured promotion trainings and a further improved supervising of doctoral students <link>. On the state of play of this intention is currently, however, no information available.

In turn, there are funding schemes for structured doctoral training programmes provided by the DFG (since 1990) and within the Excellence Initiative (since 2006). By May 2013, the DFG funded 219 Research Training Groups (*Graduiertenkolleg*), of which 48 were international Research Training Groups (*Internationales Graduiertenkolleg*). Within the 2nd round of the Excellence

103 The number of links with external sites, particularly third-party job sites, is larger. However, these cannot be searched via the data bank. In addition, the EURAXESS Germany portal offers commented links on the most important job exchanges for researchers and job portals in Germany. EURAXESS Germany also provides information and orientation regarding visas, working conditions, social insurance and taxation.

Initiative 45 graduate schools (*Graduiertenschule*) were funded (funding period 2012-2017).[104] However, each graduate school developed its own concept (see <link>, Aschhoff, 2013), i.e. there are no common rules. The graduate schools have been selected in a thorough selection process. Evaluation of graduates schools (within Initiative of Excellence) are conducted by DFG and Science Council (*Wissenschaftsrat*). However, in Germany the doctorate does not require a structural training. A doctorate can also be made and obtained at a chair (*Lehrstuhl*).

Another – somewhat indirect – driving force towards the emergence of structured innovative doctoral training programmes in Germany can be seen in the Initiative for Excellence. Under this scheme, significant (extra) funding is provided for graduate schools, clusters for excellences, and forward-looking concepts of universities. Hence, running innovative doctoral training programmes turns to be one of the evaluation criteria which may lead in case of selection to extra-funding for the corresponding university. In other words, the initiative creates incentives for universities to improve its performance in terms of the evaluation criteria, which in turn might be a stimulus towards implementing innovative doctoral training programmes.

Finally, **Action MS 28**, ERA Priority III, sets out to '…create an enabling framework for the implementation of the HR Strategy for Researchers incorporating the Charter & Code'.[105] In general, the Federal Government welcomes the Charter & Code (C&C), though there is seen a need to adjust the C&C for implementation in Germany. In fact, most of the principles of Charter & Code are implemented and applied by German organisations, e.g. through collective agreements, Research-Oriented Standards on Gender Equality by DFG, quality assurance measures and awards such as "family-friendly university" ('*familiengerechte Hochschule*') or TOTAL E-QUALITY award.[106] Among others, the German Rectors' Conference (*Hochschulrektorenkonferenz,* HRK) recommended its 268 member universities to consider the Charter & Code as guiding principles. However, for research institutions it is optional to ratify the C&C. If a host institution decides to implement the corresponding principles, the institutions' official decision, e.g. a rectorate's resolution, can be communicated to the EC (DG R&I) in English. By following this procedure, the institution will be added to the "Signatories List" of the Charta in the EURAXESS-portal. German subscribers of Charta & Code are, for instance, the German Rector's Conference (HRK), the Alexander von Humboldt-Foundation (AvH), the German Academic Exchange Service (DAAD) as well as the Universities of Freiburg and Erlangen-Nürnberg.

The situation for researchers in Germany and the way forward with regard to generating an enabling framework for the implementation of the HR Strategy for Researchers incorporating the Charter & Code is outlined, for instance, in BMBF, 2010 (<link>) and also in the 'Report on the Promotion of Young Researchers' (BuWin 2013)[107]. In general, the plan is to improve social security and adapt pension schemes to the situation (of internationally mobile) researchers. Besides

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104 From 2008 till 2010, grants amounted to €384m for Research Training Groups and €138m for graduate schools. In 2011, €143m were provided for Research Training Groups and €50m for Graduate Schools. In addition, International Max Planck Research Schools (IMPRS) provide a structural doctoral training (since 2000). Currently, there are 61 IMPRS.

105 In 03/2005, the EC published the European Charta for Researchers and the Code of Conduct for the Recruitment of Researchers <link> as a recommendation to improve employment and working conditions for researchers in Europe. This recommendation was particularly welcomed by the EU-Council of Ministers. Charta & Code should contribute to establish "best practice" in the European Research Area. The EC's efforts focus on the optimization of research and working conditions of researchers as well as the future development of a job market for researchers in the ERA.

106 The WZB received the HR Excellence in Research award as first institution in Germany in June 2013. Four universities are currently in the application process for the HR Strategy for Researchers.

107 The BuWiN Report identifies deficits and formulates possible courses of action in reforming relevant areas. Since it first appeared in 2008, it has contributed significantly to improving the situation of young researchers in Germany.

adapting national systems, Germany seeks to strengthen cooperation between the national supplementary insurance funds responsible for researchers with the aim of improving the dissemination of information to mobile scientists in the European framework. The Pension Institution of the Federal Republic and the *Länder* (VBL) has already introduced measures along these lines via its European umbrella organization. Other points considered as vital are the provision of private pension insurance for scholarship-holders in the post-doc phase through the research funding organizations and extending bilateral social insurance agreements to include further states where this is politically and economically possible. Further efforts concern the attractiveness of scientific/research careers in general and thus in particular performance-related and market-oriented payment, improvements in career prospects for young researchers, flexibility in contracts, administrative regulations and relevant national legal provisions for experienced researchers and retired and end-of-career researchers, and, however, promoting women, dual-career couples and work-life balance (see ERA Communication Fiche 2012, p. 18 – 26 for more details in this regard).

5.4 Gender equality and gender mainstreaming in research

German government agrees that forward-looking policy must create the preconditions necessary for women to be represented in all fields and at all levels, particularly in managerial positions. Different perspectives and approaches of both women and men must be utilized - in the interest of progress in areas such as education, research, industry, and society as a whole. This has been made to be one of the BMBF's central tasks. In fact, excellence, quality, and equal opportunity are the integral parts of future-oriented policy in Germany. Continuous attention to gender-specific aspects is a strategy aimed at achieving equal opportunity for women and men in all areas of politics. In general, the focus on equal opportunities is to be included as a universal guiding principle in all political decisions, measures, and activities. This is to be taken likewise into account in the development of programmes and measures, in the allocation of funding, and in implementation and evaluation procedures. In this regard, key strategic areas are:

- Women in academia
- Business start-ups by women
- Research on gender related issues in education and research
- International issues

The BMBF has created an 'Equal Opportunities in Education and Research Division', which seeks to implement these key strategic areas with the help of its own budget. The Division is part of the BMBF's Strategies and Policy Issues Directorate-General and supports equal opportunities in all fields of work. It analyses the need for action in education and research, supports strategic measures and projects, and works closely with all the BMBF's specialist directorates-general and divisions, as well as with all stakeholders in this area in order to address the ERA Priority IV objectives concerning gender equality and gender mainstreaming in research.

Moreover, the BMBF has initiated a series of measures to improve equal opportunities at institutions of HEI as well as PROs. Improvement of equal opportunities has indeed been included as a central goal of all large-scale initiatives of the BMBF: the Initiative for Excellence, the Higher Education Pact 2020, and the Joint Initiative for Research and Innovation. Furthermore, the General Anti-Discrimination Act in Germany is set up to help avoiding any discrimination and to provide support in case discrimination may happen anyhow. In addition, comprehensive funds were made available for equal opportunity measures in all collaborative projects of the DFG. This ring-fenced funding can be used to increase the number of women researchers at project manager level, support young women researchers involved in research collaboration in pursuing their research careers, or making researchers' workplaces more family-friendly. In addition, funds to compensate for the loss of working hours resulting from maternity leave, parental

leave or nursing care leave can be applied for in all DFG research projects. The DFG addresses the efforts of universities with regard to equal opportunities measures and the compatibility of work and family life when evaluating collaborative projects, particularly within the Initiative for Excellence. Individual circumstances (such as longer qualification phases or periods of time without publications as a result of time spent caring for children) are also taken into account when assessing researchers' performance. It is common understanding that implementing equality also means improving the framework conditions for reconciling an academic career and a family. Accordingly, meanwhile, all facilities of the Helmholtz Association of National Research Centres (HGF), the German Research Association (DFG), and increasingly the facilities of the Max Planck Society offer their employees childcare facilities. The BMBF has made this possible by authorizing the provision of budget funds for childcare facilities on a cost neutral basis.

Further and with particular respect to the intention of creating a '…legal and policy environment to remove barriers related to recruitment, retention and career progression of female researchers, …, addressing gender imbalances in decision making processes, and strengthening the gender dimension in research programmes' (**Action MS 39**, ERA Priority IV), Germany has already kicked off a number of initiatives. For instance, under the heading 'Women at the Top ('*Frauen an die Spitze*'), the BMBF has initiated interdisciplinary research on a number of related thematic fields in order to develop new insights into the causes why the number of women in academia as well as in leadership positions in general does not yet match the number of well qualified women. Moreover, processes in career orientation and possible vocational guidance are due to be studied. In fact, even in fields with high numbers of women, it is rare for women to advance to the upper positions of an organization - or an academic institution. For this reason, the factors that prevent career development with equal opportunities need to be examined - also within non-traditional employment models - in order to develop new means of action. In other words, gender-specific issues are to be appropriately considered in various fields of research, particularly in MINT disciplines (Mathematics, Informatics, Natural Sciences, Technology). Integrating gender aspects will raise the innovative strength of research and initiate a rethinking. According to BMBF, around 70 projects are currently funded (thematically focused on: (i) Gender specific career orientation, (ii) Organizational Structure and Career Paths in Academia/Industry, (iii) Gender issues and leading positions ('*Geschlecht und Führungspositionen*'), (iv) Work/Life-Balance in research and economy, and (v) Gender aspects in medicine.[108] <list of projects>.

The general aim of all these efforts is to enforce gender specific research/research on equal opportunities and, based on the corresponding results, to develop new instruments for action that aim at improving gender balance and gender mainstreaming in research and society.

Besides stimulating research on gender issues, the German government has implemented a series of programmes/initiatives seeking to address existing imbalances. For instance, 'Research Cooperations / Networking ('*Forschungskooperationen / Netzwerktätigkeit*'): towards strategies for enforcement of equal opportunities for women in education and research,[109] the Female Professors'

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108 See for instance: epimedGender: Gender Sensitive Research. In the medical network "Gender sensitive Research in Epidemiology, Neurosciences and Genetics/ Tumor Research," researchers are addressing questions such as why thyroid carcinoma develops more frequently in women than in men, or what influence hormones have on (healthy) women's memories The results of such research projects can offer important help with treatments tailored to men and women suffering from illness or with medication dosages. <more>

109 The BMBF supports activities seeking 'Strategies for enforcement of equal opportunities for women in education and research' (*Strategien zur Durchsetzung von Chancengerechtigkeit für Frauen in Bildung und Forschung*) and is thus aiming to stimulate innovative research and cooperation on the matter, national and international collaborations, the exchange of competence and knowledge and, in this regard, the thematic networking (including organisation of thematic workshops, etc.). For more details see <link>. Budget available for this line of funding will be minimum two million Euros. <link>

Programme ('*Professorinnenprogramm*'),[110] Woman at the Top ('*Frauen an die Spitze*'),[111] Power for female funders ('*Power für Gründerinnen*'),[112] and the National Pact for Woman in MINT careers ('*Pakt MINT*'/'*Go MINT!*').[113] Further, the Center of Excellence Women and Science (CEWS) was initiated as the national hub for the realization of equal opportunities for both women and men in science and research in Germany. CEWS serves as a think tank for this political field and is offering impetus for new ideas, initiating processes of change in support of science, and actively creating and engaging in the necessary exchange between science and politics. The centre offers comprehensive knowledge in the areas of sociological research on equal opportunity for men and women in science, policy consultation, knowledge transfer, and the monitoring and evaluation of equality measures in science. As a science and research-based service provider, CEWS makes its services available to scientists, universities, research and scientific institutions, and political committees. General aims are, for instance, to increase the number of women in leading positions at universities and research institutions, to raise the efficiency of political measures aimed at equality and to introduce gender mainstreaming in all areas of science and research. The FemConsult database (which contains current profiles of several thousand women academics) is a central instrument for increasing the number of women in leading positions. Since 01/01/2006, CEWS has been part of the GESIS Leibniz Institute for Social Sciences. Every two years since 2003, CEWS issues rankings of HEIs based on equality aspects (6th edition released in 2013), and this has become an established instrument of equal opportunities quality control within the higher education system. Since 2009, rankings have also been offered in relation to other equal opportunity evaluations, such as those of the Federal and State Programme for Women Professors, the Total-E-Quality Advisory Service (established in 2001), and the Family Friendly University Audit (established in 1998).

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110 In order to increase the number of women professors at German HEIs, the BMBF together with the *Länder* started the Programme for Women Professors in 2007. The continuation of the programme was agreed upon in 2012. The first and second rounds of the program, each with a total budget of 150 million Euros, were financed equally by the BMBF and the *Länder*. On the basis of a positive appraisal of their equality policies, universities and advanced technical and artistic colleges have the opportunity to receive funding for up to three tenure-track W2 and W3 professorships for women. On 27/12/2012, funding regulations for the second Programme for Women Professors (PPII) were announced. The next deadline is the 28/03/2014. The funding regulations can be found here (in German only).

111 Under this general heading, for instance, the BMBF and the European Social Fund (ESF) have jointly funded a study (conducted by HU Berlin, the TU Hamburg-Harburg, and the RWTH Aachen) which was analysing the situation of highly qualified women with foreign degrees and the difficulties they have with entering the labour market in Germany. Evidence suggests that the move to Germany often means interrupting their careers or even accepting employment far below their level of qualification. The Study "Job Market Integration of Highly Qualified Immigrant Women - Career Paths in Natural Sciences and Technology" is available here (in German only).

112 In order to mobilise the potential of women start-ups in industry and on the market, Germany supports women entrepreneurs. The National Agency for Women Start-ups Activities and Services (bga), which is sponsored by the German Federal Ministry for Education and Research, the Federal Ministry for Family, Senior Citizens, Women and Youth and the Federal Ministry of Economy and Technology, represents a first step towards increasing the number of businesses started by women. The bga offers political, business, academic and public sectors a platform for information and services related to women entrepreneurship in all areas and phases of company foundation, consolidation and succession. According to the BMBF, so far, 20 projects with about 40 individual activities / events have been supported. The coordination and the linking of the individual activities is done by the bga (http://www.gruenderinnenagentur.de/). For an overview of activities / project examples see e.g. <link>, <link> (in German only).

113 The National Pact for Women in MINT Careers was launched in 06/2008 as part of the Federal Government's 'Get Ahead Through Education' qualifications initiative. The aim is to build on earlier successes and, together with partners from politics, business, science and the media, combine efforts and utilise the wealth of diverse experience accumulated in encouraging young women's interest in MINT.

In sum, gender equality is among the top priorities of the German policy. A broad range of activities and measures have been kicked off to ensure gender equality. Equal opportunity officers are appointed at each institution and have the task to monitor and to ensure equal opportunities for women and men in recruitment processes at their corresponding institution. All legal bases regarding equal opportunity are outlined in a brochure by the BMBF. The development of women in science is monitored by GWK (under the heading 'Equal Opportunities in Science and Research'). There is moreover a ranking of universities concerning their treatment of equal opportunities (*Hochschulranking nach Gleichstellungsaspekten 2013*).[114] However, the winner does not receive any financial award. Nevertheless, there are some funds which are allocated based on equality objectives. For instance, the North Rhine-Westphalian Equal Opportunities Act (paragraph 5) allows performance-oriented allocation of funds with regards to advances in achieving the equality directive Article 3, Paragraph 2 in the constitution.

In 2008, the DFG implemented Research-Oriented Standards on Gender Equality which contain a collection of equal opportunity measures, providing practical examples and many helpful tips. Equal opportunity concepts are also considered in the selection process within the Initiative of Excellence or within coordinated programmes by DFG. Finally, also with a view to achieving a work-life-balance, several measures are in place, for instance, the parental leave programme (*Elternzeit*) and parental allowance programme (*Elterngeld*) introduced in 2007. Moreover, temporary work contracts can be prolonged in case of parental leave (see *Wissenschaftszeitvertragsgesetz*, Art. 2(5)) and absolute age limits in DFG funding programmes were abolished. Working arrangements such as agreements on flexible working time are institution-specific.

All activities mentioned above with regard to ERA Priority IV and especially Action MS39, however, are set up to involve any relevant stakeholders, such as funding agencies, research organisations (PROs), HEI, etc. Accordingly, all measures appear equally relevant for **Action MS40,** with a view '…to engage in partnerships with funding agencies, research organisations and universities to foster cultural and institutional change on gender'. Exemplary might be named Research Cooperations/networking, the Female Professors' programme, Woman at the Top, National Pact for Woman in MINT careers, and Power for Female Funders (please see details above). Moreover, with regard to Action MS40, see also the discussion of ERA Priority III, esp. Action MS28, on increasing the attractiveness of scientific/research careers for women. Indirectly, also the National Agency for Woman Start-ups - Activities and Services contributes to ERA Action MS40: While the funding of this scheme aims to mobilise the potential of woman start-ups in industry and on the market, it can also be considered as an initiative towards knowledge diffusion and facilitating partnerships with funding agencies, thus bringing in a gender component. The Agency, in general, seeks to increase the number of business start-ups by women and to increase the number of female entrepreneurs, i.e. to exploit and advance the economic potential of women and in this regard to address the needs of female entrepreneurs who may approach business differently from their male counterparts and may have therefore somewhat different needs.

Further, as outlined above, the CEWS serves as a think tank, offers impetus for new ideas, and initiates processes of change in support of science. It also actively creates the necessary transfer processes between science and politics. The Equal Opportunities in Education and Research Division within the BMBF pays special attention to gender-specific aspects and aims at achieving equal opportunity for women and men in all areas of politics (budget €23m in 2012). Within the

[114] Rankings of HEIs based on equality aspects are released every two years since 2003 by CEWS, and this has become an established instrument of equal opportunities quality control within the higher education system. Since 2009, the rankings have also been offered in relation to other equal opportunity evaluations, such as those of the *Bund* and *Länder* Programme for Women Professors, the Total-E-Quality Advisory Service (established in 2001), and the Family Friendly University Audit (established in 1998).

National Pact for Women in MINT Careers, partners from politics, business, science, and the media combine efforts in order to encourage young women's interest in MINT.

In sum, Germany seeks to ensure societal engagement in research and innovation by enabling all societal actors to interact in the innovation cycle and to increase the quality, relevance, acceptability, and sustainability of innovation outcomes by integrating society's interests and values. This requires developing specific skills, knowledge and capacities at individual and organizational as well as at national and transnational levels. A scientifically literate, responsible and creative society will be nurtured through the promotion of and research on appropriate education methods. Gender equality will be thus promoted by supporting changes in the organization of research institutions and in the content and design of research activities. In order to improve knowledge circulation within the scientific community and the wider public, the accessibility and use of the results of publicly funded research is due to be further developed. An Ethics Framework for research and innovation, based on the fundamental ethical principles including those reflected in the Charter of Fundamental Rights and all the relevant Union laws and Conventions, will be promoted in coordination with relevant international organizations (see in this regard the proposal to the specific programme drafted for implementing Horizon 2020, chapter 6.2.3; <link>).

Finally, by addressing **Action MS 41**, ERA Priority IV, Germany aims at '…ensuring that at least 40% of the under-represented sex participates in committees involved in recruitment/career progression and in establishing and evaluating'. First of all, there is no national quota or target. However, the 'Appointments to Federal Bodies Act' (*Bundesgremienbesetzungsgesetz*), since 1994 aims at equal representation of men and women in bodies appointed by the federal government. PROs defined own flexible targets based on a cascade model. Moreover, Germany has – in particular in the public sector – already a rather long tradition of establishing 'Equal Opportunity Commissioners' (in German this is called in different ways, for instance: *Frauenbeauftragte(r), Gleichstellungsbeaufragte(r), Beauftragte(r) für Chancengleichheit, Frauenbüro, Gleichstellungsamt, Gleichstellungsstelle, FrauenvertreterIn*). They involve in questions of recruitment (especially gender balance in this regard) and career progression. Moreover, they advise and support staff in individual cases, particularly with regard to professional advancement, overcoming disadvantages and questions of the compatibility of family and job. In general, equal opportunities and thus also the responsibility for Equal Opportunity Commissioners in Germany falls into the competence of the Federal Ministry for Family, Senior Citizens, Women and Youth (*Bundesministeriums für Familie, Senioren, Frauen und Jugend*). The German government has set out the plan to regularly conduct and publish (once per legislation period) a comprehensive report on equal opportunities (*Gleichstellungsbericht der Bundesregierung*). The first report was published in summer 2011 (<link>).[115]

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

Circulating research knowledge and transferring it into markets and products will be crucial to maintain the productivity of the German economy, creates and preserves jobs, and thereby ensures Germany's prosperity. Knowledge and technology transfer, and thus shaping innovations, is a process that is not yet sufficiently fostered in academia. For instance, Germany's 'Focus of Research on Innovation' funding area <link> supports non-university research institutions in developing new instruments and methods of technology transfer and in designing concepts and

115 Please note that currently there are more women than ever working as professors at German institutions of higher education. According to the Federal Office of Statistics, around 7,945 women professor were employed as teachers and researchers in 2010. The number of women chairholders has increased from 8 to 19 per cent since 1995, although the numbers vary considerably between individual disciplines: In linguistics and cultural studies, around 30 per cent of professors are women. In engineering, women make up only around 9 per cent of professorships, and around 12 per cent in mathematic/natural sciences. <more>

testing strategies and structures for sustainably integrating a culture of transfer into the work of research institutions. Germany has launched and/or is internationally involved in a series of activities which tackle optimal circulation, access to and transfer of scientific knowledge.

With specific regard to **Action MS 45**, ERA Priority V, the German government seeks to '… define and coordinate their policies on access to and preservation of scientific information'. In fact, recent developments in information technology and the Internet are opening up new possibilities for science to create a comprehensive research infrastructure that not only provides the necessary resources and tools, but also enables new forms of collaboration among scientists and scholars and new research methods. For instance, networking computing power allows enormous amounts of data to be processed and instantly applied in the research process. While the natural sciences have been working with networked research environments for some time already (national and international), more and more humanities and social sciences disciplines are recognizing this potential for their areas of application. In this regard, the BMBF supports e.g. several projects to develop innovative research infrastructures for the 'enhanced humanities'[116], thus stimulating both access to and preservation of specific (scientifically relevant) information.

There are several ongoing activities in terms of Open Access. The Berlin Declaration on Open Access to Scientific Knowledge has been introduced by MPG in 2003 and is signed by various institutions from Germany. Signees are obliged to support Open Access.[117] The Federal Council (*Bundesrat*) recently agreed on a second publication right for researchers at HEIs and PROs (03/05/2013). For this purpose, the Copyright Act (*Urheberrechtsgesetz*) needs to be adjusted. Simultaneously, the federal government introduced a similar draft law (04/2013), which tackles research activities within project funding and especially PROs. The BMBF apparently plans to add a clause on Open Access to the auxiliary terms and conditions governing its project funding.

In general, Germany seems to be in an excellent position with its repositories and Open Access journals.[118] The federal government has initiated a number of activities to promote Open Access such as a dialogue between science organizations and scientific publishing companies and by launching a number of projects which are ex-/implicitly addressing the issue of Open Access and/or facilitating knowledge transfer. The German research organizations are actively promoting Open Access, for example through the Priority Initiative 'Digital Information'.

Besides, a joint initiative of the Alliance of Science Organisations (*Wissenschaftsrat*, WR) aims at improving the provision of information in research and teaching by promoting funding for the 'golden road'. Further objectives are to define criteria for the adoption of Open Access publication fees, to increase the content of Open Access repositories, and to collaboratively support international Open Access infrastructures. Science Europe supports both approaches - gold and green - in their position statement 'Principles for the Transition to Open Access to Research Publications'. DFG, HGF, MPG and WGL are members of Science Europe.

There are a number of initiatives/projects, which generally aim at supporting knowledge and/or technology transfer and by that means seek to help getting access to and preserving (scientific) information; i.e. they address explicitly or implicitly the subjects of the ERA Actions MS45 and MS46. For instance: Research Campus[119], Research at Universities of Applied Sciences[120], Net-

116 Humanities and social sciences are referred to internationally as 'enhanced humanities'.

117 An internet platform for information on Open Access is http://open-access.net/de_en/homepage/.

118 According to BASE, there are 233 repositories in Germany. In addition, there are 25 Research Data Centres accredited by the German Data Forum (*'Rat für Sozial-und Wirtschaftsdaten'* – RatSWD). See Aschhoff, 2013.

119 Up to ten partnerships between universities, non-university PROs and private companies may be funded for up to 15 years with an annual public funding per partnership of €1m to €2m. Partnerships are aiming to develop new technologies in areas with high technological complexity and a great potential for radical innovation. Implicitly, this project is tackling generation and/or access to as well as preservation of knowledge.

works of Competence[121], Innovation Competition Industry meets Science[122], '*go-innovativ*'[123], and Validation of Innovation Potentials (part of HTS 2020: Stimulating Knowledge Transfer).[124]

Related to all these initiatives are those set out to achieve the objectives of **Action MS46**, ERA Priority V: '…Ensure that public research contributes to Open Innovation and foster knowledge transfer between public and private sectors through national knowledge transfer strategies…'. In general, the development of knowledge transfer strategies (at federal/regional level) in Germany is embedded in the High-Tech-Strategy 2020. Currently, in Germany, a large number of initiatives ex- and/or implicitly seek to foster exchange and collaboration between public and private research. See exemplary the measures mentioned above with regard to Action MS45, Germany's new ICT Agenda – Digital Germany 2015, and – with a wider focus – the activities undertaken with regard to ERA Priority 1: More effective National Research Systems (e.g. the initiatives: 'Pact for Research and Innovation', 'Initiative for Excellence', HTS 2020, etc.). Efforts are also being made (<link>) to implement the Commission Recommendation on management of intellectual property in knowledge transfer activities and on a Code of practice for HEIs and other PROs (IP Charter) by the Joint Science Conference (GWK). See in this regard the GWK Monitoring Report 2013 (<link>) and in particular the federal government's Position Paper concerning the communication from the European Commission on 'A Reinforced European Research Area Partnership for Excellence and Growth', released in 02/2013, <link> (see esp. point (12), p. 9). Moreover, there is a series of regional laws tackling knowledge and technology transfer. In fact, the Higher Education Laws in all 16 *Länder* have now identified knowledge and technology transfer as a task for HEIs. The *Länder* Hesse, Lower Saxony, North-Rhine Westphalia (NRW) and Thuringia have taken up the development of an intellectual property strategy in the target and performance agreements between the *Länder* and the universities.

Several institutions are devoted to knowledge transfer to the business sector, such as Fraunhofer, technical universities, and universities of applied sciences. The programme 'FHprofUnt' (by BMBF) supports R&D collaboration between universities of applied sciences and private firms. The programme 'Research at Universities of Applied Sciences' aims at improving knowledge transfer capacities at these institutions. Besides, a prerequisite for becoming a professor at universities of applied sciences is usually three years of work experience outside the higher education sector. Moreover, a large share of projects funded within thematic R&D programmes is jointly conducted by the science and private sector. Each project is based on a contract.

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120 The programme funds R&D projects at about 190 universities of applied science ('*Fachhochschulen*') in order to improve transfer capacities at these institutions. The programme has four funding lines: (1) cooperative R&D with enterprises, (2) profiling of research strengths, (3) research-oriented curricula, and (4) social innovations.

121 This is basically a non-financial measure (rather a cluster framework policy) that stimulates the establishment of sectoral networks to promote cluster building and international awareness of industrial networks in Germany. However, by that means access to and preservation of knowledge arguably can be improved.

122 Targeted at PROs to improve their transfer abilities and raise their relevance for the regional firm populations.

123 Vouchers for Innovation Consulting and Management: Parts of the programme date back to the 1980s. In 2011, the programme has been redesigned and support to SMEs for innovation management consulting services was changed to a voucher system in order to increase competition among the organisations that provide the consulting services. The sub-programme TOP is an initiative to foster learning from successful innovators and is a non-financial measure. However, by learning from the top performers, access to valuable information is provided.

124 By means of this initiative contract research, licences, research and IPR issues in public/academic/non-profit institutes were made subject of a validation seeking to assess the corresponding innovative potentials. The programme, with a last call in 2012, was targeted at public research organisations to improve their knowledge transfer abilities.

Several measures support the creation of spin-offs or technology-oriented start-ups. On national level, examples are the EXIST programme and the High-tech Start-Up Fund. ERP Start-Up fund provides venture capital for young innovative technological companies. The website of the federal government provides an overview of funding opportunities. There are also programmes on state level such as FLÜGGE or HOCHSPRUNG in Bavaria. Further examples for projects and programmes in place addressing the public~private nexus and thus in particular the networking and communication are 'Research Campus' (*Forschungscampus*), Leading-Edge Cluster Competition (*Spitzencluster-Wettbewerb*), Innovation Alliances (*Innovationsallianzen*), 'Twenty20 - Partnership for Innovation' (*Zwanzig20 - Partnerschaft für Innovation*), Networks of Competence (*Kompetenznetze*), 'go-cluster', and Industrial Collective Research (*Industrielle Gemeinschaftsforschung – IGF*). Besides, there are programmes directly supporting knowledge transfer from science to business such as the VIP programme ('Validating the Innovation Potential of Scientific Research', *Validierung des Innovationspotenzials wissenschaftlicher Forschung - VIP*). The SIGNO programme provides support for IPR activities, including patenting.

In general, for Germany as a high-tech location, information and communication technologies (ICT) play a decisive role. They are the key to productivity in all industries. Measured by gross value added today, the ICT industry itself is ahead of mechanical engineering and motor-vehicle manufacturing already. Hence, **Action MS47**, ERA Priority V, which sets out to '…Harmonise access and usage of 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...' is of outmost relevance. In fact, Germany needs to better harness the large potential of ICT for growth and employment. Smart networking through modern ICT in traditional sectors, such as energy, transport, health, education, leisure, tourism and administration, affords new opportunities but also poses new challenges, especially in data protection. This is why the federal government has developed a new ICT strategy for the digital future of Germany: Digital Germany 2015 <link>. It sets out the government ICT policy framework, i.e. the priorities, tasks and projects for the period up to 2015. The ICT strategy 'Digital Germany 2015' will be carried out in close interaction among policymakers, industry and scientists. The Federal Ministry of Economics and Technology (BMWi) is in charge of coordinating the implementation under the specific purviews of the various ministries. A major role here is played by the National IT Summit, which has already provided a key impetus and will continue to perform a function in future strategy implementation. The ICT Strategy sets out the following (main) objectives:

- Strengthen competitiveness through the use of ICT
- Expand digital infrastructure and networks to meet future challenges
- Safeguard protected and personal rights of users in the future Internet and in the use of new media
- Step up R&D in the ICT sector and speed up the translation of research findings into marketable products and services
- Strengthen education and training and thus competencies in handling new media
- Make consistent use of ICT to cope with social problems, including sustainability and climate protection, health, mobility, administration and the improvement of the quality of life of citizens

With the implementation of the ICT strategy, the federal government seeks to promote sustainable economic growth, to create new jobs and to bring about social benefits. It is also aware of the social-policy significance of Internet and ICT, will continue to engage in dialogue on the prospects of German Internet policy and the appropriate role of government in the future organisation of the Internet, and channel the outcomes into improving the regulatory policy framework. The federal government's ICT strategy is thus aligned with the goals of the Digital Agenda for Europe and will further enhance Germany's international competitiveness as a business location.

In implementation, it will take account of both activities at European level (including the EU Strategy for Key Enabling Technologies and the Innovation Union) and projects and developments at international level and in multinational organisations. Modern and efficient federal government IT will thus lay the foundation for the effective organisation of Germany's digital future. Stringent joint IT use in the federal administration and for large-scale government projects is a benchmark for Germany as an IT location. The future development of federal IT will be steered by the inter-ministerial Chief Information Officers Council together with the Federal IT Management Group chaired by the federal government Commissioner for Information Technology. Core tasks include framing architectures, standards and methods for IT and providing the necessary infrastructure. With the entry into force of Section 91 (c) of the Basic Law in 2009 and the appointment of the IT Planning Council, the foundation and capacities were put in place for the efficient and purposive development of public-sector IT and federal e-government.

Finally, with a view to **Action MS 48**, ERA Priority V: '…Adopt and implement national strategies for electronic identity for researchers and giving them transnational access to digital research services', in 11/2010, the federal government introduced an electronic ID card with several new functions: The electronic authentication and electronic signature helps to ensure secure identification on the Internet. Biometric features – like those of the electronic passport – are intended to protect the document against abuse by unauthorized persons. These biometric functions are (in theory) accessible only to the authorities. The identification data are stored on a chip, allowing document holders to identify themselves also on the Internet. In this way, the function of the paper document is currently available also for e-government and e-business, creating a basis of trust for electronic business transactions. Innovative security technologies are used for the new ID card, which also help to modernize public administration and strengthen domestic security. Accordingly, the new German electronic ID, although first of all being a national ID, can be used also internationally to identify oneself – especially in online/Internet based platforms (with restricted access) – and thus also to get access to digital research services. However, even the new ID card cannot be seen as an equivalent of a full electronic identity that allows accessing all digital research. In fact, technological boundaries (equal compatibility, i.e. lack of common technological standards) and security issues prevent a wider (electronic) use as an identifier.[125]

For next generation electronic ID's in Europe, and thus also for the benefit of researchers seeking to get better/transnational access to digital research services, see for instance the results of the BIOP@SS project (Europe's largest chip reader research project)[126]. In this regard, the Germany-based partners Giesecke & Devrient GmbH, Infineon Technologies AG and NXP Semiconductors Germany GmbH, along with another eight companies from six EU Member States, investigated how to best develop high-security chip card technologies. The objectives of the BIOP@ASS project were the development of advanced (microelectronics and embedded software) secure and interoperable smart card platforms for required e-administrative applications requested at the European level: e-identity, e-health, and residence permits. The project was grounded on the results of the former MEDEA+ project called ONOM@TOPIC+; it provided a full technical platform and framework enabling European governments to issue interoperable documents or electronic identification or authentication and access to e-services <link>. Thanks to the chip card operating system that was developed by Giesecke & Devrient, the future use of electronic ID documents on the Internet is becoming a reality. An added advantage is that no extra software components need to be installed on the PC. Countries planning to introduce the electronic ID cards in the near future include Bulgaria, the Czech Republic, France, Greece,

125 There is also some ongoing activities regarding electronic identity, e.g., a workshop took place on ORCID by HGF or DFG participates in the network 'Knowledge Exchange' that discusses, among others, 'Digital Author Identifiers'.

126 BIOP@SS is supported by the EUREKA network that promotes advanced cooperative research and development in microelectronics; around EUR 6 million of the funding is covered by the EUREKA clusters CATRENE/MEDEA+.

Hungary, Poland, Romania and Switzerland. The cards, which can be equipped with the technologies developed by the BIOP@SS team, will comply with international standards.

ANNEX 1: PERFORMANCE OF THE NATIONAL AND REGIONAL RESEARCH AND INNOVATION SYSTEM

Feature	Assessment	Latest development
(1) Importance of the research and innovation policy	(+) Research and innovation policies are at the top of the policy agenda which was reinforced in July 2010 by a new white paper of the federal government, the High-Tech Strategy 2020. The HTS is a comprehensive, coherent and long-term strategy for research and innovation that uses a cross-departmental approach, involving several ministries and policy areas. The HTS defines the priorities in Germany's R&I policy with a particular focus on the solution of the grand challenges. (+) There is public action in all relevant policy areas including education and skills. In fact, research and innovation is seen as a cross-cutting issue. (+) Policy initiatives at all levels are designed and implemented in a strategic, widely coherent and integrated framework geared towards fostering innovation and strengthening the knowledge base and fundamental research (+) Where policies and funding are focused on specific priorities, in general, these are increasingly oriented towards addressing major societal challenges, such as resource efficiency, climate change, and health and ageing, and towards deriving competitive advantage from finding new solutions to tackle them. For instance, greening the economy is one of the key challenges and policy is geared towards stimulating R&D in this regard. (-) The HES, which is widely in the responsibility of *Länder*, is considered to be underfinanced, given the recent strong increase in student numbers. In order to enable additional federal funding, the *Hochschulpakt* (higher education pact; i.e. voluntary agreements between the federal and the *Länder* levels), have been set up. This pact was renewed in 2009 and additional resources were allocated in March 2011. However, HEIs budgets (especially for research) are still considered to be comparably tight.	▪ Steadily raising budget of the Federal Ministry of Education and Research (BMBF). ▪ Reform of the Immigration Act to facilitate processing of residence permits, and on an action programme to ensure an adequate supply of labour, and on programmes for enhancing international mobility. ▪ The legal parameters for the employment of foreign graduates of German universities have been improved and the recognition of qualifications acquired abroad is being facilitated by new initiatives. This could help e.g. to increase the still relatively low share of foreign professors. ▪ Researcher salaries in Germany are above the EU average, but lag behind those in the US and CH. Recently, the Constitutional Court issued a ruling on minimum wages for full professors in universities that could lead to increased salaries for those at the lower end of the wage scale.
(2) Design and implementation of research and innovation policies	(+) The main priorities in Germany's R&I policy have been pursued over the last couple of years. The same holds for the set of policy instruments in place. Thus, the key priorities of R&I policy rely on a multi-annual strategy and are subject to regular evaluation (international benchmarking of strengths and weaknesses, see e.g. e-fi reports). (+) R&I strategy for Germany duly reflects EU priorities, i.e. (i) keeping pace with global technology trends (envisage to be technological frontier setter), (ii) ensuring sufficient funds for public and private R&D and thus keeping research excellence at a top international level, (iii) maintaining and further improve the industry-science link (i.e. enabling knowledge flows at the public~private nexus), and (iv) strengthening the education sector (at all levels) in or-	▪ HTS 2020: for details on content see above point 1 (assessment). On 28.03.2012, the federal government has adapted an Action Plan for the HTS-2020 and thus formulated 10 future-oriented projects (Zukunftsprojekte) which aim at addressing the grand societal challenges. The federal government thus seeks to bundle the innovation relevant policies and initiatives of all federal resorts and also to

	der to stimulate knowledge creation, capability building, absorptive capacities and ultimately a qualified workforce. (+) Sophisticated monitoring and R&I review system in place (–) RIS3 strategies elaborated at *Länder* level without a clear mechanism that ensures compatibility and mutual reinforcement of the individually developed strategies. Corresponding mismatch and eventually 'frictional losses' might be possible (and may thus require some further coordination efforts at either at regional and/or at federal level).	bring together the efforts made at HEI/PRO and business sector, particularly in the fields of clime/energy, health/healthy food, mobility, communication, and security. ▪ New National Research Strategy BioEconomy 2030 <link> which aims at reducing oil dependence by use of renewable resources.
(3) Innovation policy	(+) Innovation policy is pursued in a broader sense thus going beyond technological research and its applications (+) Demand-side innovation policies are an integral part of the innovation policy mix in Germany, comprising legislation and standardisation as well as lead-market initiatives (+) Shifts in R&I policy priorities / individual initiatives towards mission-oriented approaches in technology policy are reemphasised e.g. by the definition of future-oriented projects as part of the HTS-2020' Action Plan. (+) In the light of the global challenges, the need of a more forward-looking research and innovation policy emerged which should be set up to stimulate private and public actors to develop ways to meet these objectives. The general aim is to further intensify links between science and industry in order to reap the full potential of the German research and innovation system.	▪ Example: BMBF innovation initiative 'Entrepreneurial Regions' (*Unternehmen Region*) stands for innovation-oriented regional alliances which develop a region's identified core competences to clusters on a high level and with strict market orientation. The programmes' aspirations are generally based on the fact that the most innovative products and applications are almost exclusively the result of highly specialized and integrative knowledge from many sources, minds and organizations of widely varying origins and orientation. In "Entrepreneurial Regions", this philosophy is closely tied to an entrepreneurial approach.
(4) Intensity and predictability of the public investment in R&I	(+) Investment targets set out for public and private R&I investments are both about to be achieved (+) Public investment in R&I was not decreased during the years of crisis and expanded significantly since, thus providing adequate and predictable funding which is inter alia focused on leveraging private investment (–) General level of 'Finance and Support' is evaluated as comparably low. Innovative financing solutions for R&I remain to be insufficiently exploited (e.g. crowd funding). Moreover, there is a comparably low level of VC and no tax incentives for investments in R&D, which altogether holds back the German RIS from unfolding its full potential.	▪ Steadily raising overall public spending on education and R&I (even in times of budgetary consolidation and austerity measures)
(5) Excellence as a key criterion for research and education policy	(+) The overwhelming importance of excellent public research and education has been emphasized by continuing and expanding the 'Higher Education Pact', the 'Initiative for Excellence', and the 'Pact for Research and Innovation'. Furthermore, there is the 'Qualification Initiative', which addresses all areas of education from early-childhood education to lifelong learning, and since 2010 the 'Quality Pact for Teaching' that aims at improving the study conditions and teaching quality. (+) 'Initiative for Excellence': Joint programme of the federal government and the *Länder*, which provides funding in a competitive way according to excellence criteria. In three funding lines funding is granted on the basis of peer review	▪ The legal parameters for the employment of foreign graduates of German universities have been improved and the recognition of qualifications acquired abroad is being facilitated by new initiatives. This could help to increase the still relatively low share of foreign professors. ▪ Recently, the Constitutional Court issued a ruling on minimum wages for full profes-

	in a two-phase procedure supervised by the DFG and the German Council of Science and Humanities (WR). (+) The selection of proposals within thematic R&D programmes is generally based on peer-review, i.e. purely grounded on scientific technical quality of research concepts and the targeted level of innovativeness. (+) The DFG supports excellence in academic research by offering grants for bottom-up research projects on a competitive basis according to scientific excellence and quality criteria based on peer review. (+) Excellence in research is monitored by regular evaluations (this holds basically for all research performers that received public funds). (–) Researcher salaries in Germany are above the EU average, but lag behind those in the US and e.g. CH. (–) General attractiveness of the research system is ranked comparably low	sors in universities that could lead to increased salaries for those at the lower end of the wage scale (which could work as an incentive to attract international talents).
(6) Education and training systems	(+) strong vocational training system (+) In terms of 'innovators' Germany is at the top in Europe (IUS-2013) (+) A national pact to attract more women to science and engineering ('*Komm mach MINT-mehr Frauen in MINT-Berufen*') was set up on the initiative of the BMBF in June 2008 and a second phase of this pact was launched in December 2011. (–) Germany exhibits significant challenges in ensuring a throughout high level of education and the right mix in terms of appropriately skilled workforce. Insufficient supply of qualified labour is a constant challenge. (–) The separation of educational competencies between federal and state level does not necessarily follow arguments of optimal policy allocation. In particular, HEI funding received from *Bund* (federal government) is limited to temporary, scientific and research projects. The banning of cooperation between the federal and the state level regarding permanent research funding of universities is being advocated. Various experts and politicians call for the abolishment of the ban but the responsible 16 state ministries of education and cultural affairs fear losses of competence.	▪ 'Higher Education Pact 2020' continued and further expanded in 2011: It aims at creating 327,000 additional places for university entrants (compared to 2005) expected between 2011 and 2015. ▪ Foreign Skills Approval / Recognition law: Aims at facilitating the immigration of qualified personnel. The new law came into force on 01/04/2012 and creates a legal entitlement to claim for recognition of foreign vocational education. The newly founded institution IHK FOSA (Foreign Skills Approval) carries out the assessment and decides about recognition <more info>
(7) Partnerships between higher education institutes, research centres and businesses, at regional, national and international level	(+) A broad range of links between science and industry are supported, such as cooperation, clusters, networks, alliances, and most recently public-private partnerships (+) Several institutions are devoted to knowledge transfer from the research to the business sector (+) Co-operation and knowledge sharing is generally encouraged and creating a more favourable business environment for SMEs is among the top policy priorities in Germany (+) Two comprehensive instruments for establishing networks between industry and science in key technologies have been introduced already in 2008 and received meanwhile increasing attention: The '*Spitzencluster-Wettbewerb*' (Leading-Edge Cluster Competition, which funds regional networks) and the 'Innovation Alliances' initiative, which provides public funding for large-scale, long-term projects that are assumed to be critical for developing breakthrough technologies. (–) However, there is still an untapped potential to link	▪ Several new measures have been implemented recently. For instance, 'Validation of Innovation Potentials of Scientific Research', which aims at facilitating the transfer of scientific knowledge into commercial applications by offering grants to researchers at PROs and HEIs. ▪ 'Forschungscampus' programme: Provides funding for long-term oriented partnerships between HEIs, PROs and companies. Aim: Developing new technologies in areas with high technological complexity and significant potential for radical innova-

	research results to commercialization. Expanding technology and knowledge transfer mechanisms is suggested (with a view to stimulate / improve effectiveness of public~private nexus).	tion.
(8) Framework conditions promote business investment in R&D, entrepreneurship and innovation	(+) The stability of the German R&I policy is seen as a necessary prerequisite in order to give enterprises and research organisations planning reliability and to pursue long-term oriented goals. (+) The majority of support measures address R&D performing / innovative firms and encourage public-private collaboration. (+) Several initiatives are in place seeking to further improve the framework conditions for private investments, which range from strengthening the start-up culture to facilitating access to venture capital (+) Investment in knowledge, technology-intensive clusters, innovation and the upgrading of the manufacturing sector are determinants of a country's competitiveness in global export markets. The relatively high contribution of high-tech and medium-tech products to the German trade balance is an indication of specialisation and competitiveness in these products. (+/–) Framework conditions for entrepreneurship in Germany have improved as indicated by an improved ranking for Germany in the World Banks Ease of Doing Business Index. Germany has also made progress in reducing the administrative burden related to reporting obligations in the business sector. In 2011, The 'Bureaucracy Reduction and Better Regulation programme' has been extended to cover other compliance costs. However, Germany remains at around the EU average regarding the administrative burden of the regulatory framework. (–) Access to finance for R&D and innovation in Germany has to be improved significantly (especially for SMEs). This point is seen as one of the main threats to the German system. Opportunities for further improvements remain in particular for the provision of equity to companies and in terms of simplifying the general legal framework and the tax system.	▪ Example: 'go-innovativ' programme (launched in 2010) aims at improving innovation management in SMEs. ▪ 'Federal Research and Innovation Funding Advisory Service' established as the central point of contact for any questions concerning research and innovation funding. Relevant information about public support programmes is accessible through the internet. Applications can also be submitted online. However, the transparency about the broad range of existing support schemes needs to be improved. A first approach has been undertaken by bundling programmes, for instance, within the 'Central Innovation Programme' (ZIM).
(9) Public support to research and innovation in businesses is simple, easy to access, and high quality	(+) In general, relative abundance of national funding for research, i.e. for public and private sector R&D alike (+) Public support to research and innovation in businesses in Germany is conceptually rather simple (although in practise not always as simple to operationalise), comparably easy to access and of high quality. However, improvements in all these dimensions appear to be feasible and desirable (+) Funding schemes are regularly evaluated and benchmarked against comparable schemes in other countries; participation is aligned with EU programmes (i.e. applying for international funding and transnational cooperation is encouraged); and the selection criteria for national and regional support measures are transparent and rather straightforward (+/–) General administrative burdens and bureaucracy are comparably low (seen at about the EU average), i.e. certainly not at a minimum.	
(10) The public sector itself is a driver of inno-	(+) The public sector generally aims at providing incentives to stimulate innovation within its organisations and in the	

vation	delivery of public services. (+) The use of public procurement as an instrument to stimulate innovation and R&D is gaining ground (–) A binding strategy for innovation-oriented procurement across all public bodies and on a wider thematic scope is still missing	

Source: Own compilation / authors' assessment.

ANNEX 2: NATIONAL PROGRESS ON INNOVATION UNION COMMITMENTS

		Main changes	Brief assessment of progress / achievements
1	**Member State Strategies for Researchers' Training and Employ ployment Conditions**	(+) Foreign Skills Approval and Recognition Law (2012)´ (+)Skills Development Initiative (2013), set out to strengthen training (+)Blue Card directive: realigning of German immigration policy in 2012 with the Act to Implement the EU Directive on the Conditions of Entry and Residence of Third- Country Nationals for the Purposes of Highly Qualified Employment (+) MobiPro-EU programme activated in 2013: promoting professional mobility of young people in the EU who want to work in Germany	(+) Main initiatives are well established already since years, such as e.g. Qualification Initiative (2008), Higher Education Pact 2020 (from 2007) and Excellence Initiative (2005) (+) Principles of Charter & Code are widely accepted and considered in nat. legeslation (-)Germany is still lacking behind other EU countries in terms of 'human resources' and the 'open, excellent and attractive research system' (-) Although immigration for high-skilled personnel lately has become somewhat easier, immigration barriers remain relatively high (-) Rather inflexible salary schemes in the public (research) sector tend to limit the attractiveness of Germany as a place for doing science (for both German and foreign researchers) (-) Ratification of Charta & Code is voluntary for HEIs/PROs (left at their individual decision)
4	**ERA Framework**		
5	**Priority European Research Infrastructures**	(+) National Research Infrastructure Roadmap (2013) (+) Initiative on Multilateral Research Funding (2012)	(+) Planning of new RI's (esp. large scale/costly installations) are due to be coordinated in the light of the ESFRI and the corresponding roadmaps (+) Thematic R&D support programmes increasingly aligned to the ESFRI roadmap (+) D-A-CH agreement (2003) can be seen as a good example for opening up national RIs (+) Internationalisation Strategy and High-Tech Strategy incorporated the idea of open / efficient use of RI since their corresponding first drafts (i.e. no substantial change in emphasis needed!)
7	**SME Involvevolvement**	(+)ZIM-programme focussing on innovation in SMEs 2008 - 2014	(+)SME involvement and 'thinking small first' is a core principle of econ / R&I policy making (+) ZIM: addressing any aspects that may hamper innovative activities in SMEs, estimated budget ca. €600m/year (+) German SMEs are well above EU average in terms of innovation, collaboration of innovative SMEs is even rapidly increasing (thus indicating success of corresponding policy support)
11	**Venture Capital Funds**	(+) High-Tech Start-up Fund (expanded to €300m end of 2011) (-/+)Germany is one of the few countries that has not introduced R&D tax credits. However, the introduction of R&D tax credits is currently being considered at federal level as such credits tend to be requested by large international companies. In this context, by amending the corporate tax laws, VC	(-) Low overall VC volume (IUS: only 61% of Eu-27 average) and even negative trend acc. to IUS 2013 (-) Although there are a number of measures in place which are trying to address Germany's weakness in terms of VC, evidence suggests that they are so far altogether insufficient

		might be stimulated too.	
13	**Review of the State Aid Framework**	(+) Substantially raising budget of the Federal Ministry for Education and Research (BMBF) up to €14b in 2014 (+) Entrepreneurial Regions initiative: 'Zwanzig20 – partnership for innovation' (operational in 2013) (+)New National Research Strategy BioEconomy 2030 (presented 2013) (+)New National Roadmap for Research Infrastructures (2013)	(+) Comprehensive framework for public support to R&D and innovation activities (+) No cuts in the light of the crisis (R&D and education were explicitly exempted from austerity measures), increasing budgets since 2010 (-) Although some recent efforts in cutting red tape and reducing bureaucracy have been successful (simplifying 330 regulations and thus saving the industry ca. €7b), State Aid still needs to be further streamlined and access facilitated especially for SME participation
14	**EU Patent**	(+) Agreement on Unified Patent Court signed in 02/2013 (-) Ratification of agreement by national parliament still pending	(+) Overall, the situation concerning patents and IPR in general in Germany is fairly good (acc. IUS 2013; Germany ranks 2nd behind DK)
15	**Screening of Regulatory Framework**		(+) all measures in place (as the entire German R&I system) are subject to regular evaluations and in this regard (ex-post) to a critical questioning of their corresponding impact (-) With regard to new legislation, a more systematic (and compulsory) ex-ante impact assessment appears to be needed, thus especially taking into account the degree of target achievement, additionality and whether eventually un-desired side-effects may occur
17	**Public Procurement**	(+) On behalf of BMWi, a competence center for innovative procurement ('Kompetenzzentrum innovative Beschaffung', KO-INNO) is due to be created and leaded by the (BME) 'Bundesverband Materialwirtschaft, Einkauf und Logistik e.V.' (+)Federal government formed an Alliance for Sustainable Procurement (platform of experts providing corresponding intelligence and advice)	(+)The federal government's policy for awarding procurement contracts pays increasingly attention to the use of new products and technologies. (+)The following Ministries and subsidiary institutions have committed themselves to increasingly apply procedures that foresee using innovation-oriented procurement: BMWi, BMBF, BMVBS, BMVg, BMI and BMU (-)However, Germany is not yet sufficiently exploiting the potential of innovation-oriented procurement. It is too often the case that public procurement makes use of established solutions or solutions with minor innovative potential, thereby disadvantaging or inhibiting the development and distribution of innovative products and services by German firms (see EFI)
20	**Open Access**	(+) Priority Initiative 'Digital Information', 2nd phase 2013 – 2017 (+) Higher Education Laws in all 16 Länder tackle knowledge and technology transfer (as a task for HEIs). Hesse, Lower Saxony, NRW and Thuringia are developing intellectual property strategies in the target and performance agreements between the Länder and the HEIs. (+) BMBF plans to add a clause on open access to the auxiliary terms and conditions governing its project funding	(+)Open access to scientific knowledge is a high priority for policy making in Germany and generally seen as a precondition for a flourishing R&D system (+) German research organizations are actively promoting open access (+) Efforts are being made to implement the EC Recommendation on management of intellectual property in knowledge transfer activities and on a Code of practice for HEIs and PROs (IP Charter) by the Joint Science Conference (GWK), see GWK Monitoring Report 2013
21	**Knowledge Transfer**	(+) Validation of Innovation Potentials (VIP) programme (last call in 2012) targeting especially PROs & HEIs with a general aim at improving their knowledge transfer abilities (+) ICT Agenda –'Digital Germany 2015'	(+) Supportive with regard to KT are basically all activities undertaken in terms of ERA Priority 1: More effective National Research Systems (e.g. Pact for Research and Innovation, Initiative for Excellence, High-Tech-Strategy 2020, etc.) (+) BMBF launched in 2010 the initiative VIP (validating the innovation potential of scientific research), which aims at validating ex-ante the innovative commercial potentials of ideas and to this end facilitates KT. Acc. to a recent programm evaluation, the initiatives seems to be working well (and is about to be further

			expanded) (+) full online availability of any reports / results of BMBF financed projects (+) There are several tools and instruments which aim at facilitating KT, e.g. Service point for R&D support (ELFI), 'ForschungsPortal.Net', 'Research Explorer', info service of the Germanys science sector (idw), See also all activities concerning IU commitment 20 (Open Access), which contribute to facilitating knowledge transfer. (+) Overall Germany is comparably advanced in terms of OA and KT.
2 2	**European Knowledge Market for Patents and Licensing**	(+)'TechnologieAllianz': German-wide network of more than 200 scientific institutions, agencies and stakeholders dealing with patents, commercial use of IPRs, and technological transfer. (+)Patentserver of the BMWi: aim is leveraging the number of good ideas being commercially exploited by making this database available to everybody who deals with patenting and the commercial use of inventions. Thematic subjects covered are IPR, exploitation of patents, support and guidance and overall patent policy.	(+)'SIGNO - Protection of ideas for commercial use' initiative: Valuable advice is provided on issues relating to patents and IPR. (+) VIP – programme helps identifying 'high value' patents. Both initiatives are place already since years and appear to be working fairly well. (-) Expected introduction of unitary European patent and the corresponding delay in the ratification is causing uncertainties
2 3	**Safeguarding Intellectual Property Rights**		(+) see all supporting measures mentioned in terms of IU commitment 22 (SIGNO, VIP, …)
2 4	**Structural Funds and Smart Specialisation**	(+) RIS3 strategy of Saxony released (2012), currently under peer review (~) Most RIS3 strategies developed by the *Länder* are still in the making and little is known about the exact state of play. It is therefore still too early for assessing progress	(+) There are 17 regional development programmes in Germany (elaborated with regard to the EC programming period 2007–13 and the ERDF, link), This underlines common awareness of the high importance regional development issues (and specialisation) tend to have. (-) However, most of these programmes are expiring soon and not all regions appear to be developing smart specialisation strategies (at least several *Länder* have not yet announced to do so) (-) There is no National Smart Specialisation Strategy in Germany. *Länder* take responsibility for elaborating their own RIS3 strategies and conceptualise explicit smart specialisation strategies widely independently, i.e. there is no coordinating mechanism at federal level aligning individual concepts and evidence suggest that the *Länder* are not due to be closely collaborating with regard to the drafting of their individual strategies. (-) *Länder* should be collaborating / developing regional innovation concepts jointly in order to ensure adapting and ideally complementing their individual RIS3 strategies in a way that allows dovetailing for the mutual benefit. (-) A coordinating mechanism at federal level could be helpful and may likely be found to be necessary once all or at least a significant number of regions will have released their strategies. But, to install such a mechanism will be difficult in the light of the constitutional distribution of responsibilities for R&D and innovation in Germany especially with a corresponding regional focus such as in the case of RIS3

25	**Post 2013 Structural Fund Programmes**		(~)'Operationale Programmes' at *Länder* level are mostly still in the making, in the phase of ex-ante evaluation, or still to be discussed / adopted by the corresponding ministries / regional parliaments. See further comments above with regard to IU com. 24
26	**European Social Innovation pilot**	(+) BMBF provides funding for "World Vision Centre for Social Innovation" (initially 2 years for research on the challenges and chances of social innovations in Germany; launched 08/2011) (+) 'Open Social Innovation Platform' initiated in 04/2012 www.oursocialinnovation.org (target groups are NGOs, entrepreneurs, policy makers, etc.)	(+) Germany steps up efforts to promote social innovation through the ESF (new 'Operational Programmes' for period 2014 – 2020 are currently elaborated). Thus, in contrast to ERDF (see IU com. 24, 25), the lead is primarily at federal level (although some regions moreover develop own / complementary ESF concepts and strategies). (+) With a view to define the thematic emphasis for the new ESF Operational Programme, the federal government organised in 2012 and 2013 a comprehensive online-consultation and two consultation events, thus opening the process for any potentially interested participant. (+) Support to social innovation (including living labs, design innovation, creative labs, crowd-sourcing, etc.) is an integrated part of the German R&I system (irrespective whether funding at federal or regional level is concerned)
27	**Public Sector Innovation**		(+) In Germany, efforts are being made e.g. to increase the level of innovation-oriented procurement (see IU 17) and in this light to stimulate also public sector innovation. However, as illustrated by the Public Sector Innovation SB2013 - EPSIS Scorecard, p. 54, currently Germany is showing a below average performance on 10 or more indicators and is therefore classified as 'below average performer'
29	**European Innovation Partnerships**		(+) Germany participates intensively in all multilateral joint initiatives and in most ERA-Nets, in all joint research programmes undertaken under Article 185 of the Treaty of Lisbon (European and Developing Countries Clinical Trials Partnership, Ambient Assisted Living, EUROSTARS, EMRP and Bonus), in the EIPs and in most Joint Programming Initiatives.
30	**Integrated Policies to Attract the Best Researchers**	(+) Germany has taken measures to remove restrictions on in–bound researcher mobility in view of a skills shortage in some science and technology domains. The federal government recently decided on a reform of the Immigration Act to facilitate the processing of residence permits, and on an action programme to ensure adequate supply of labour, and on programmes for enhancing international mobility. (+) The legal parameters for employment of foreign graduates of German universities have been improved and the recognition of qualifications acquired abroad is being facilitated by new initiatives. (+) MobiPro-EU programme activated in 2013 to promote professional mobility of young EU citizens who want to work in Germany (+)Mobility Strategy 2020 (draft): Goal is creating a more open labour market	(+) Germany is generally a good location for doing high quality research and therefore in principle attractive for any researcher. Recent changes in the immigration rules (esp. for highly skilled people) facilitate mobility / immigration (+) An array of efforts have been made towards modernizing the German science system (in light of the Excellence Initiative, the Higher Education Pact 2020, the Joint Initiative for Research and Innovation, etc.). Moreover, the international dimension has been expanded e.g. by implementing the Internationalization Strategy (-) Relative weaknesses are commonly seen in terms of 'human resources' and concerning 'open, excellent and attractive research systems'. However, corresponding IUS indicators are rising, i.e. Germany is catching up and accordingly seems to be gaining attractiveness (-) University system, which is the responsibility of the *Länder*, is considered to be underfinanced, given the recent strong increase in student numbers. (-) Rather inflexible salary schemes applied to the German public sector (and in this regard to most of the visiting scientist that may want to come to Germany) reduce attractiveness of Germany for top researchers (not only from abroad). In fact, German HEIs are bound by a number of rather restrictive rules when trying to attract top talents.

		for researchers and to facilitate mobility (+) Vacancies and grants are increasingly announced internationally (+) Adjustment of existing social security systems, tax and pension schemes to create more mobility-friendly conditions (esp. for highly skilled personnel from abroad)	
3 1	**Scientific Cooperation with Third Countries**		(+) Germany is highly active in promoting S&T and thus collaborates with many regions, MS and third countries. For instance, currently there are 19 'Cross-border, transnational and interregional co-operation agreements'. R&D and science collaboration is a vital part in most of them.
3 2	**Global Research Infrastructures**		(+) Germany participates in all major international projects developing large scale RI (such as CERN, ITER, etc.) and has moreover signed a number of bi-/multilateral cooperation agreements which inter alia focus on financing R&D activities, alignment of national support programmes and/or on access to or creation of relevant RI in either country (done individually or jointly).
3 3	**National Reform Programmes**	(+) NRP 2013: investing in education and research has top priority for both federal government and *Länder*	(+) budget for education and research increased (+) national targets (compared to EU-wide indicators) go partly beyond / appear to be more ambitious (-) several national targets (e.g. R&D spending) appear not ambitious enough given that the anticipated level is almost achieved already

Source: Own compilation / authors' assessment.

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	Measures taken to address ERA Action 01 and 02 are closely linked and therefore have to be seen jointly. ▪ Qualification Initiative ▪ 'Initiative for Excellence' extended for the period 2012 to 2017 (total funding volume of €2.7b) and Continuation of the 'Pact for Research and Innovation' ▪ Academic Freedom Act (12/2012) led to increased budget flexibility for PROs. However, no changes for HEIs! ▪ Performance contracts between government and HEIs	(+) Improving effectiveness of national RIS has high policy priority and performance based allocation of funds plays an increasing role (+) Project funds are provided by a rather complex system of programmes and agencies; involving both *Bund* and *Länder* (+) Performance based funding and corresponding evaluations both established already for long time; improvements are made continuously by 'fine tuning' rather than by radical/ad hoc changes (+) Transparent /objective indicators for allocating funds
	Action 2: Ensure that all public bodies responsible for allocating research funds apply the core principles of international peer review	During the recent years, no significant changes to the mechanism of peer-reviewing and evaluations of R&D and innovation funding bodies (and programmes) has occurred; mainly as the system has proven to be working fairly well. The evaluations of the PROs and HEIs have a significant control and re-allocation function. Evaluation mechanisms for supra-national funding decisions still need to prove appropriateness	(+) High level of compliance with international peer-reviewing principles and standards (+) Comprehensive multi-layer system established to evaluate individual proposals as well as funding bodies, thus bringing in increasingly the spirit of competition while relying on appropriate forms of peer reviewing, benchmarking, and impact assessment analyses. (+) Assessments are performed at the level of individual research performers, at programme as well as at research institutions' level.
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	▪ Over recent years, a strategic thinking and action towards ERA has been developed; i.e. there is (now) a strong involvement of national policy makers into European issues. ▪ EU level instruments are being used for national goals, and there are attempts to influence the EU level policy with core ideas as set out in the Internationalization Strategy and the HTS 2020. In other words, European involvement is becoming part of the strategic thinking and there is a stronger awareness of European issues across all ministries	(+) Germany has been part of all relevant European initiatives to support international collaboration from their early years (–) However, no explicit strategy towards ERA yet

	Action 2: Ensure mutual recognition of evaluations that conform to international peer-review standards as a basis for national funding decisions	(DFG led) Initiative on Multilateral Research Funding: Researchers of an international consortium can apply jointly for funding in one country. Evaluation of proposals is done in one country, but funding of participating researchers is provided by their respective national funding organisation acc. to their normal terms/conditions for project funding (i.e. mutual recognition of evaluations). First projects have started in 03/2011	(+) Key policy strategies and initiatives address explicitly this ERA Action, e.g. HTS 2020, Internationalization Strategy, Initiative on Mutual Research Funding (+) D-A-CH Agreement on the mutual opening of the respective funding programmes ('Lead Agency' process) and cross-border funding ('Money Follows Cooperation Line') simplifies mobility of researchers and the execution of cross-border research projects (among the participating countries). Accordingly, it can serve as an example for mutual recognition of evaluations based on international peer review standards for funding decisions
	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	▪ Initiative on Multilateral Research Funding and D-A-CH Agreement: both seek to remove legal and any other barriers to the envisaged cross-border interoperability of national programmes (among EU partners in general and/or between Germany, Austria and Switzerland, respectively). ▪ Germany has moreover signed a number of bilateral agreements with EU and non-EU countries in order to launch and/or further intensify co-operations in research and education, thus removing barriers for and/or explicitly permitting joint financing of projects and programmes	(–) Although there is a declared intention to increase internat. participation in national programs, a clear strategy and/or general rules concerning the opening up of the national programs are still lacking. The final decision lies with the parties responsible for the individual programs. (+) Several programs are dedicated to support research collaborations. These are usually specific collaboration programs aiming at specific countries or regions. (+/–) BMBF has a guide on transnational collaboration that provides principles to achieve cross-border interoperability. But, selection process, eligibility and assessment criteria have to be set in each joint programme by the participating partners
	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	▪ National Research Infrastructure Roadmap (published 04/2013) ▪ Currently, 27 projects/RIs are included in the roadmap for Germany; 24 projects are under implementation, 3 new projects are intended to be funded. The budget contributed by Germany to realize 16 of these projects is about €3.5b Euro (see p. 14 in the roadmap).	(+) Germany runs already since many years (1957) comprehensive thematic R&D support programmes and thus provides direct support to business R&D by means of grants and loans, which are increasingly aligned to the ESFRI roadmap
	Action 5: Remove legal and other barriers to cross-border access to RIs	▪ Germany is continuously expanding internat. links by adopting bi-/multilateral cooperation agreements. The overall objective is thus i.a. 'removing legal and other barriers' to R&D and innovation (with special regard to financing R&D activities, alignment of national support programmes, access to/creation of relevant RI, etc.)	(+) Removing legal and other barriers to R&D and innovation is a core objective of the German policy. (+) The overall idea is thus joining the forces and resources, using infrastructures most effectively and to the mutual benefit.

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	▪ *Länder* Ministries are increasingly transferring the right to appoint staff to the respective universities and research institutions. ▪ *Länder* Higher Education Laws stipulate the traditional supra-regional and public advertising of vacancies, but also explicitly demand that vacancies are advertised internationally (allow exceptions in special cases only).	(+) The constitutional principle of the 'selection of the best' ensures openness of the recruitment procedures, aided by the provisions of equality legislation (gender mainstreaming) and the General Anti-Discrimination Act (+) There are no obvious barriers to the application of open, transparent and merit based recruitment of researchers
	Action 2: Remove legal and other barriers which hamper cross-border access to and portability of national grants	▪ In Germany, scholarships are increasingly advertised internationally. The eligibility and portability of grants commonly depend on the programme. A wide range of funding programmes exists for non-residents to work in Germany. This has led to an increasing number of applications from abroad ▪ '*Anerkennungsgesetz*' from 04/2012 facilitates immigration of skilled foreigners to Germany	(+) Theoretically there is no difference in terms of grant accessibility between foreigners and Germans working at HEIs or PROs located in Germany. (+/–) The conditions for grant portability are characterized by moderate complexity (+) D-A-CH agreement seeks mutual opening of the respective funding programmes and leveraging cross-border funding
	Action 3: Support implementation of the Declaration of Commitment to provide coordinated personalised information and services to researchers through the pan-European EURAXESS3 network	The EURAXESS Germany Portal makes it possible to advertise every research vacancy internationally. However, evidence suggests that – relative to its size as a science location – Germany tends to make too little use of this portal compared with its European partners. Given the number of vacancies entered into the data bank, Germany is just ranked at 7th position.	(+) The growing international competition for excellent researchers is prompting the increasing internationalization of recruitment efforts in Germany. (+) Individual internationalization strategies introduced by many HEIs and PROs. (+) Service centres at numerous HEIs support mobile researchers by providing counselling and information services.
	Action 4: Support the setting up and running of structured innovative doctoral training programmes applying the Principles for Innovative Doctoral Training.	There is (still) no systematic initiative at federal or regional level. Nevertheless, in a report released in 11/2010, the federal government pointed out that it seeks to stimulate (literally "continue ...") a reform of the doctoral training in Germany in order to ensure a higher share of structured promotion trainings and a further improved supervising of doctoral students. On the state of play of this intention is currently, however, no information available	(–) Setting up uniform rules concerning innovative doctoral training programmes across regions will be difficult in Germany as this is in the responsibility of the *Länder* (–) Moreover, launching doctoral training programmes, defining corresponding rules and structures is to a major extent up to each individual university; i.e. this may even differ from faculty to faculty within a certain university (i.e. it is subject to the University Constitutions)
	Action 5: Create an enabling framework for the implementation of the HR Strategy for Researchers incorporating the Charter & Code	▪ Most of the principles of Charter & Code are already implemented and applied by German organisations. There is a rising number of German institutions among the 'Signatories List' of the Charta in the EURAXESS-portal ▪ The general plan in Germany is	(+) Federal government welcomes the Charter & Code (C&C), though there is seen a need to adjust it for implementation in Germany (–) Although recommended (e.g. by HRK), for research institutions it is optional to ratify the C&C

		to improve social security and adapt pension schemes to the situation (of internationally mobile) researchers to rise attractiveness of scientific careers and facilitate researchers' mobility	
ERA priority 4: Gender equality and gender mainstreaming in research	Action 1: Create a legal and policy environment and provide incentives	▪ Substantial funds for gender-related research ▪ Dedicated division at BMBF for 'Equal Opportunities in Education and Research' and Centre of Excellence Women & Science (CEWS) as corresponding national hub ▪ Several Programmes/initiatives implemented that seek to address existing imbalances; e.g. 'Research Co-operations / Networking , 'Female Professors' Programme, Woman at the Top, Power for Female Funders, and the National Pact for Woman in MINT careers	(+) 'Equal opportunity' is the universal guiding principle in all political decisions, measures, activities, and is taken into account when allocating funds and in evaluations (+) With a view to work-life-balance, several measures are in place e.g. the parental leave (*Elternzeit*) and parental allowance programme (*Elterngeld*) introduced in 2007. (+) Moreover, temporary work contracts can be prolonged in case of parental leave and absolute age limits e.g. in DFG funding programmes were abolished.
	Action 2: Engage in partnerships with funding agencies, research organisations and universities to foster cultural and institutional change on gender	▪ In order to improve knowledge circulation within the scientific community and the wider public, the accessibility and use of the results of publicly funded research is due to be further developed.	(+) Germany seeks to ensure societal engagement in R&D and innovation by enabling all societal actors to interact in the innovation cycle and to increase the quality, relevance, acceptability, and sustainability of innovation outcomes by integrating society's interests and values.
	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	First comprehensive report on equal opportunities released in 2011 (further reports are scheduled to be issued once per legislation period).	(–/+) No national quota or target! (+) But, the 'Appointments to Federal Bodies Act' (since 1994) aims at equal representation of men and women in bodies appointed by the federal government. (+) PROs define own flexible targets based on a cascade model. (+) Long tradition (and wide acceptance) of establishing 'Equal Opportunity Commissioners'
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	▪ The BMBF plans to add a clause on Open Access to the auxiliary terms and conditions governing its project funding	(+) The *Bund* has initiated a number of activities to promote Open Access such as a dialogue between science organizations and scientific publishing companies (+) The German PROs are actively promoting Open Access e.g. through the Priority Initiative "Digital Information"
	Action 2: Ensure that public research contributes to Open Innovation and foster knowledge transfer between public and private sectors through national knowledge	▪ Knowledge & technology transfer is now stipulated as a task for HEIs (within relevant *Länder* laws)	(+) A large number of initiatives ex- and/or implicitly seek to foster exchange and collaboration between public and private research (+/–)Germany has a large number of scientific publications repositories as well as research data repositories and

	transfer strategies		research data centres. However, corresponding access is not harmonized (yet). (+) A significant share of projects funded within thematic R&D programmes is jointly conducted by the academic and the private sector
	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	In implementation, the German ICT Strategy 2015 will take account of both activities at European level (including the EU Strategy for Key Enabling Technologies and the Innovation Union) and projects and developments at international level and in multinational organisations	(+) The new ICT Strategy for the digital future of Germany: 'Digital Germany 2015' sets out the (federal) ICT policy framework, i.e. the priorities, tasks and projects for the period up to 2015.
	Action 4: Adopt and implement national strategies for electronic identity for researchers giving them transnational access to digital research services	In 11/2010, a new electronic ID card with several new functions was introduced.	(+) The new German electronic ID, although first of all being a national ID, can be used also internationally to identify oneself – especially in online/Internet based platforms (with restricted access) – and accordingly also to get access to digital research services. (–) However, even the new ID card – although having a number of relevant e-features – cannot be seen as an equivalent of a full electronic ID that allows accessing all digital research. In fact, technological boundaries (equal compatibility, i.e. lack of common technological standards) and security issues prevent a wider (electronic) use as an identifier

Source: Own compilation / authors' assessment.

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LIST OF ABBREVIATIONS

AiF	Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von "Guericke" (German Federation of Industrial Research Associations)
AvH	Alexander von Humboldt Foundation
BERD	Business Expenditures for Research and Development
BMBF	Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMWI	Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
BMI	Bundesministerium des Inneren
BMU	Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit
BMVBS	Bundesministerium für Verkehr, Bau und Stadtentwicklung
BMVg	Bundesministerium der Verteidigung
CDU	'Christlich Demokraische Union'
CHE	Centre for Higher Education
CEWS	Center of Excellence Women and Science
C&C	Charter & Code
ERA	European Research Area
DAAD	Deutscher Akademischer Austausch Dienst (German Academic Exchange Service)
D-A-CH	Deutschland – Austria – Switzerland
DG	Directorate General (of the European Commission)
DESY	Deutsches Elektronen Synchrotron (German electron synchrotron)
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DWIH	Deutsche Wissenschafts- und Innovationshäuser
EC	European Commission
ECB	European Central Bank
EFI	Expertenkommission Forschung und Innovation (Experts Commission for Research and Innovation)
EIB	European Investment Bank
EPO	European Patent Office
ERA-NET	European Research Area Network
ERDF	European Regional Development Fund
ESIF	European Structural and Investment Fund
ESF	European Social Fund
ESFRI	European Strategy Forum on Research Infrastructures
ETP	European Technology Platform
EU-27	European Union including 27 Member States
FDP	'Freie Demokratische Partei – Die Liberalen'
FhG	Fraunhofer-Gesellschaft (Fraunhofer Society)
FAIR	Facility for Antiproton and Ion Research
FP /	European Framework Programme for Research and Technology Development /

FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GG	Grundgesetz (Germany's Basic Law)
GOVERD	Government Intramural Expenditure on R&D
GWK	Gemeinsame Wissenschaftskonferenz (Joint Science Conference)
HEI	Higher education institutions
HERD	Higher Education Expenditure on R&D
HES	Higher Education Sector
HGF	Helmholtz-Gemeinschaft Deutscher Forschungszentren (Helmholtz Association)
HRK	Hochschulrektorenkonferenz (German Rectors' Conference)
HRST	Human Resources in Science and Technology
HTS	High-Tech Strategy
ICT	Information and Communication Technology
ID	Identification
IGF	Industrielle Gemeinschaftsforschung (industrial collective research)
IP / IPR	Intellectual Property / Intellectual Property Rights
ISCED	International Standard Classification of Education
IU	Innovation Union
IUS	Innovation Union Scoreboard
KET	Key Enabling Technologies
MINT	Mathematics, Information technology, Natural sciences and Technology
MPG	Max-Planck-Gesellschaft (Max Planck Society)
NTBF	New Technology Based Firms
NRP	National Reform Programme
NRW	North Rhine Westphalia
OECD	Organisation for Economic Co-operation and Development
PRO	Public Research Organisations
PVA	Patentverwertungsagentur (patent commercialisation agency)
R&D	Research and Development
R&D&I	Research and development and Innovation
RI	Research Infrastructures
RIS3	Regional and/or National Research and Innovation Strategies on Smart Specialisation
RIS	Regional Innovation System
R&I	Research and Innovation
SB	Scoreboard (of not otherwise mentioned here stands for "EU Industrial R&D Investment Scoreboard")
SPD	'Sozialdemokratische Partei Deutschlands'
S&E	Science and Engineering
S&T	Science and technology
SME	Small and Medium Sized Enterprise
VC	Venture Capital

VDI	'Verein Deutscher Ingeneure' (Association of German engineers)
VIP	Validation of Innovative Potential of Scientific Research
WGL	Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (Leibniz Association)
WR	Wissenschaftsrat (German Council of Science and Humanities)
XFEL	European X-Ray Laser Project
ZIM	Zentrales Innovationsprogramm Mittelstand (Central Innovation Programme for SMEs)

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