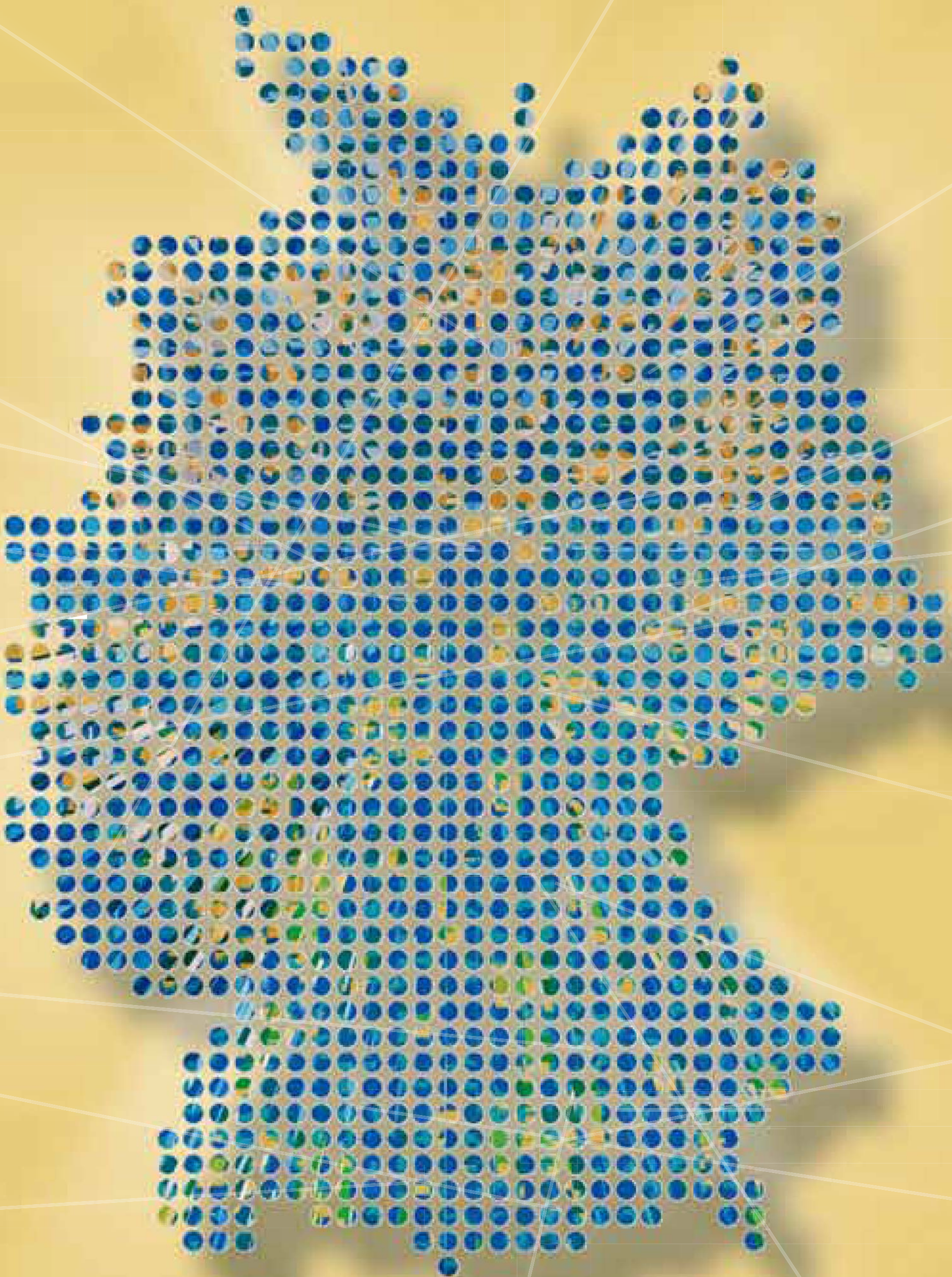
Federal Ministry
of Education
and Research

Federal Report on Research and Innovation 2012

Abstract



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Foreword

What will Germany be like in 2020? How can we secure a future worth living for our children? How should we deal with demographic change? How should we cope with climate change? How can we feed the growing global population? These and other questions are being discussed in a dialogue with German citizens and are being explored by scientists.

This Federal Report on Research and Innovation addresses these questions and at the same time confirms the central results of the survey on research, innovation and technological performance issued by the Commission of Experts for Research and Innovation. The result: Given Germany's position as a research and innovation location, we are justified in expecting answers to these pressing issues!

Investments in our research and innovation system have ensured that the German economy has continued to develop positively despite the European debt and financial crisis. Research and development are important factors for prosperity and the standard of living in Germany. The federal government is therefore investing more money in education, research and development than ever before.

In doing so, our investments are concentrated on long-term structures and strategies. The effect of the Higher Education Pact is reflected in the continuously growing number of graduates. Likewise, the High-Tech Strategy is also paying off because the focus behind the federal government's research and innovation policy on human needs enables us to focus on markets with potential, thus ensuring that Germany remains a country where the future is at home!

Federal Minister of Education and Research

Contents

Introduction

This abridged version of the Federal Report on Research and Innovation 2012 provides an overview of the German research and innovation system. It contains selected texts, figures and tables from the report.

Part I details **the German Federal Government's research and innovation policy objectives and measures.** It illustrates how research and innovation function as a driving force of sustainable growth for Germany, how the federal government is promoting the High-Tech Strategy 2020 for Germany, strengthening science, further developing education in the knowledge society and intensifying European and international cooperation.

Part II contains five chapters about the structures, resources and funding measures of the German research and innovation system.

The first chapter **The German research and innovation system** introduces the structures of the German research and innovation system. Three questions are posed: "Where do research and development take place?", "Who funds research and development?" and "How does government funding for research and innovation work?"

The second chapter **Federal Goverment's research and innovation policy** outlines the main focal points of the federal government research funding.

The third chapter **Research and innovation policies of the *Länder* governments** provides an introduction to the funding priorities of the *Länder*.

The fourth chapter **International cooperation on research and innovation** looks at the international focus of the German research and innovation policy and provides an overview of the internationalization strategy as well as important bilateral and multilateral collaborations.

The fifth chapter presents **selected data and facts on the German research and innovation system.** A variety of tables rounds out this chapter.

The long version of the report offers more details regarding activities undertaken by the federal government and the *Länder* governments, and also information about their research and development organisations and facilities, the research and development activities in the economy and international cooperation. The long version can be ordered via the Internet and is also available as a download (www.bmbf.de/publikationen).

Part I: The German Federal Government's research and innovation policy objectives and measures

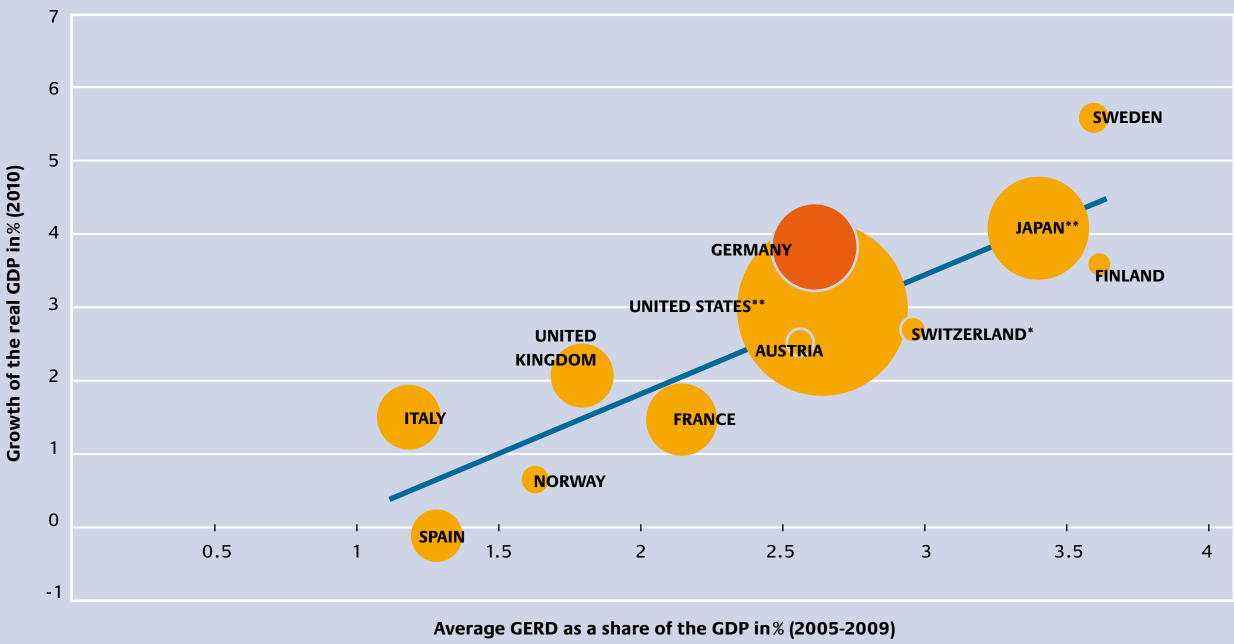
1 Research and innovation as a driving force of sustainable growth

"Made in Germany" – Germany's innovative power as an international model for success

The world is fascinated by innovations "Made in Germany". Be it the development of climate-friendly energy or mobility, artificial intelligence or virtual reality: Germany is extremely successful in utilising innovative technologies, products and services for the benefit of mankind and – based on a strong industrial prowess – in maintaining a leading position in the global competion as well as in creating secure jobs for the future.

- With a world trade share of almost 12 % for research-intensive goods, Germany is one of the leading exporters of technological goods.
- In the global market for environment technology and resource efficiency, Germany even boasts a trade share of 15 %.
- Lots of companies, particularly small and medium-sized enterprises, are global technology and system leaders in their sectors. According to an innovation survey by the Centre for European Economic Research (ZEW) in 2011, almost every second German company is 'innovation active'. Also, many international companies have large research and development centres in Germany.
- Compared to other countries, Germany is also well-positioned in terms of the transfer of knowledge and technology; companies and research facilities work hand-in-hand. For example, in the case of external funding that universities solicit from the business enterprise sector, Germany leads the top group.

Fig. 1 **Gross domestic expenditure on research and development (GERD) by the Federal Republic of Germany 2005-2009 and economic development in 2010**



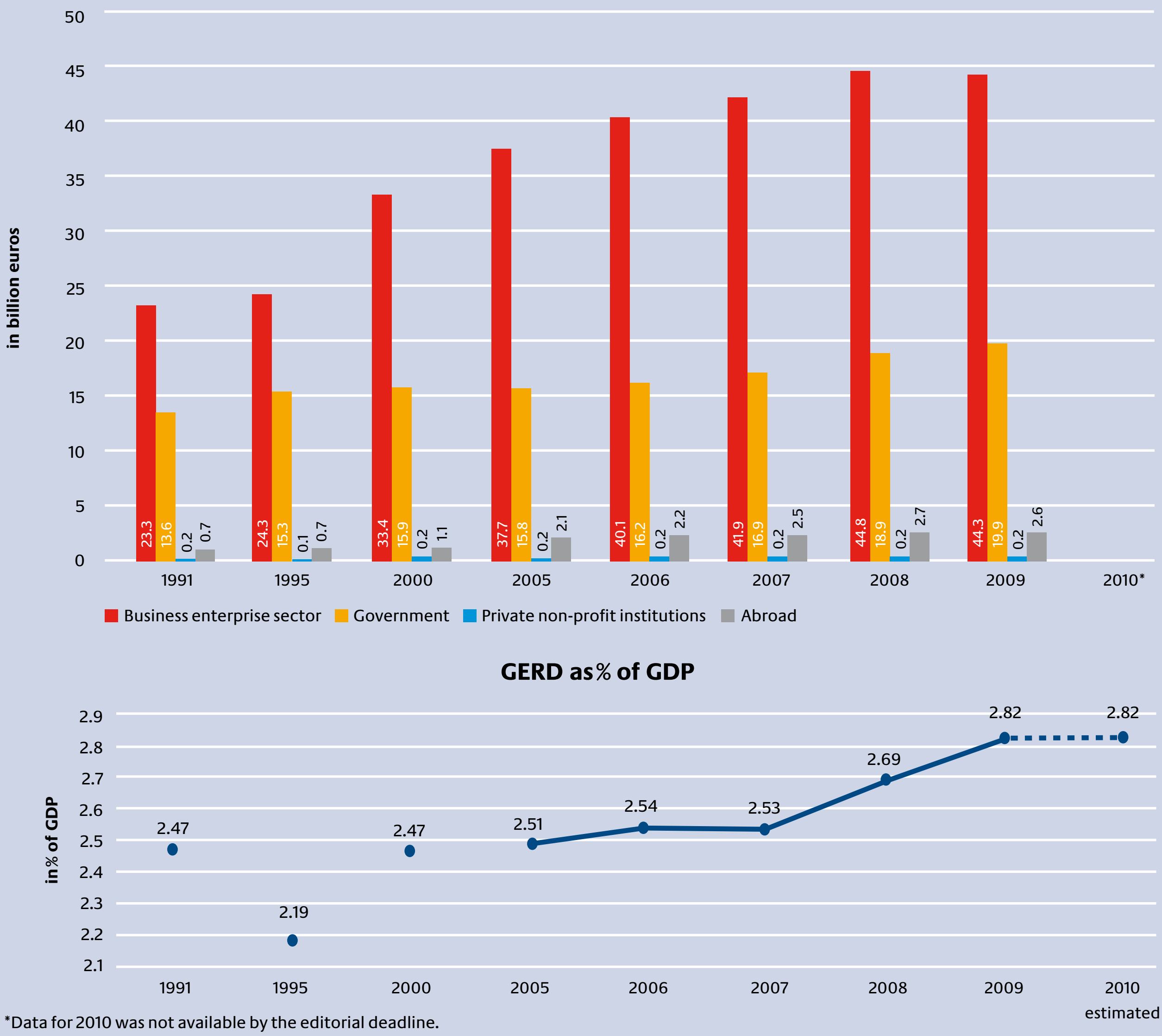
Basis of data: Eurostat
* Swiss values GERD 2005 and 2008
**United States and Japan values GERD 2005-2008
The size of the circles represents the GDP (absolute) in the year 2010.
Calculated by VDI/VDE-IT

By virtue of the innovative power of companies, universities and research institutes, Germany is the stability anchor within Europe. Equally, innovative companies, especially small and medium-sized enterprises, are important driving forces of growth and employment. Germany's positive economic development – despite the European financial and debt crisis – is the direct result of the investments made in its innovation system as these have given the country a head start in terms of competitive ability and innovation (see Figure 1). This is reflected by the great importance placed on research and development for employment, prosperity and the quality of life in Germany.

"Made in Germany"– Germany's success story as a stable, commercially successful, innovative and socially strong country, where engineering and inventiveness play a large role, have to be continued. This is a huge challenge because the world is changing dramatically. We are facing the start of a decade of fundamental technological, ecological and social change:

- The structure of the world population is changing. Whilst in most European countries less and less children are born, the populations of other countries in the world continue to grow.
- These profoundly different demographic developments will lead to a shift in power: The growth markets of the future lie outside Europe in Asia, Africa and Latin America.
- Global competition in innovation is increasing rapidly. New commercial and technological centres are developing across the world, challenging the previous world elite of

Fig. 2 Gross domestic expenditure on research and development (GERD) in the Federal Republic of Germany by funding sectors (implementation view) and GERD as a percentage of the gross domestic product (GDP) over time



*Data for 2010 was not available by the editorial deadline.
Basis of data: Table 1

research and innovation in Europe, East Asia and the USA. New policy shapers[1] such as Brazil, China, India or Mexico are investing more heavily in research and development than ever before. The number of students in China alone tripled between 2001 and 2010.
- The technological and commercial boom in the new policy shapers goes hand-in-hand with an increase in the pro capita consumption of energy, other raw materials and food. The intensive use of the earth has led to a dramatic loss of biodiversity and a significant increase in ground, air and water pollution.
- Climatic change is accelerating. The 2000s decade was the warmest on record. Previously, this statement had been made for the 1990s, and before this for the 1980s. According to current scientific data, global warming will continue. Effective climate protection faces the challenge of trying to meet growing global demand for energy despite the fact that fossil energy sources are nearing depletion.

As a great knowledge and commercial nation in the heart of Europe, these developments will hit Germany in a number of ways. Germany has the potential to make a substantial contribution to solving global challenges, further consolidating its position in the world as one of the leading innovation centres and therefore securing prosperity and social cohesion in the long term. But what is the best approach?

The debate surrounding new economic models is controversial. Some are demanding "prosperity without growth" because traditionally more growth – every car, every trip, every refrigerator – always involves greater consumption of resources and more environmental damage; others want to maintain the current growth paradigm in order to avoid falling behind the new policy shapers. The government is clear about one thing: The solution for dwindling resources, the risk of climate change, the loss of biodiversity, the demographic change, the growing national debt levels and the uncertainty about the way in which the global economy will grow lies in a sustainable growth strategy.

Sustained growth involves breaking the correlation between growth, resource consumption and the emission of pollutants and CO_2. It means meeting the needs of today's generation without endangering the options open to future generations to satisfy their needs. It means bringing together environmental protection, economic performance and social responsibility in a way that allows viable and long-term decisions to be made that take all three of these factors into account – in a global context. Maintaining the Earth's supporting capacity is the decisive goal. The federal government has taken important steps for this purpose, including the initiated change in energy policy, the resource efficiency programme and the debt brake that is anchored in the constitution. It is important to remain on this course.

1 See infobox page 44

Education, research and innovation as the key to sustainable growth

Education, research and innovation are essential features of a high-quality, long-term growth strategy and form one of the principles of policies aiming for sustainability. Technologies and innovations "Made in Germany" are necessary to fight climate change, to preserve resources and to make our economy on the whole more sustainable. New technical solutions and innovations are required not only to maintain Germany's ability to compete in the global market, but also to develop it further. They play an important role in finding answers to these and other global challenges, whilst at the same time strengthening Germany's economic and innovative power.

Research and innovation are the keys to ensuring that we will still be able to develop those products, services and technologies with which we can create sustainable individual well-being and social prosperity – for example:

- Selling "green technologies" domestically and abroad whilst at the same time improving the carbon footprint;
- Improving the quality of life and social participation of older people by means of age-appropriate technical and social innovations whilst at the same time shaping new lead markets;
- Using Germany's leading role in satellite-supported earth observation for sustainable use of resources and climate protection across the world.

In recent years, the federal government has consistently focussed its policy on education, research and innovation. The growing importance of research and development in Germany is shown, among others, by the following indicators:

- Despite the financial and debt crisis in 2010, expenditure for research and development within the German economy rose to around 47 billion euros. This is an increase of 20 % compared to 2005. In total, the expenditure for R&D in the German economy was 1.89 % of the GDP, which is more than fifty per cent higher than the average for the European Union (1.16 %).
- The federal government is investing more money in education, research and development than ever before (see Figure 3). The BMBF (Federal Ministry of Education and Research) budget for 2012 has risen by 11 % compared to the previous year to a total of 12.9 billion euros. The BMWi (Federal Ministry of Economics and Technology) budget for research and technology policy measures in 2012 rose by around 8 % to 2.8 billion euros. Despite pressures to consolidate the budget, the federal government has kept its promise to spend an additional 12 billion euros on education and research in this legislation period.
- In total, the percentage of research and development in relation to the gross domestic product has increased significantly – from 2.51 % in 2005 to 2.82 % in 2010 (see Figure 2). As confirmed by the Commission of Experts for Research

Fig. 3 **Expenditure on research and development by federal government and *Länder* governments over time (financing view)**

*Expenses by the federal government 2012, estimated, 2009-2011 including economic stimulus package II, 2011 and 2012 including energy and climate funds
**Expenses by the *Länder* governments 2010, estimated
Source: Federal government: Data from Table 4, *Länder*: Table 14 (cf. long version, in German only) plus estimate for 2010 by the Federal Statistical Office

and Innovation, this is a good interim result. Therefore, the goal that the state and the economy would invest 3 % of the gross domestic product in research and development is well within reach.

- Consequently, the number of people working in research and development has also risen. Between 2005 and 2010 there was an increase of 72,000 full-time equivalents in the R&D sector. Today's figures of more than half a million means that there are more people working in research and development in Germany than ever before. They are producing ideas aimed at improving the future quality of life and prosperity.
- International comparative studies confirm Germany's innovative power. In the "Innovation Union Scoreboard 2011" drawn up by the European Commission, Germany holds 3rd place (behind Sweden and Denmark) and is therefore one of the group of "innovation leaders" in Europe. Compared to 2009, Germany has also moved up from midfield to 4th place in the current innovation indicator by the Telekom Stiftung. One of the prime reasons for these good results is the additional investment from the public purse in science and research.

All these indicators show: Our country has significantly improved its position over the past few years.

Germany is one of the most attractive and dynamic research and innovation locations in the world. We therefore have every reason to be optimistic that we will continue to improve this position and use Germany's ideas of today for ensuring prosperity tomorrow. To achieve this goal, it is important to consistently concentrate on four points of focus:

1. Promoting the High-Tech Strategy 2020 for Germany
2. Strengthening science
3. Increasing training within the science community
4. Intensifying European and international cooperation

2 Promoting the High-Tech Strategy 2020 for Germany

To boost Germany's innovation power, that is the aim of the High-Tech Strategy. Since 2006, the federal government has bundled its research and innovation activities into this national innovation strategy across all political fields, themes and departments. In the High-Tech Strategy, all process steps from basic research through invention to innovation are seen in context. This will strengthen Germany's position as one of the most attractive and dynamic research and innovation locations in the world. The integrative approach of the High-Tech Strategy has found widespread support from science and business and has also been well received internationally.

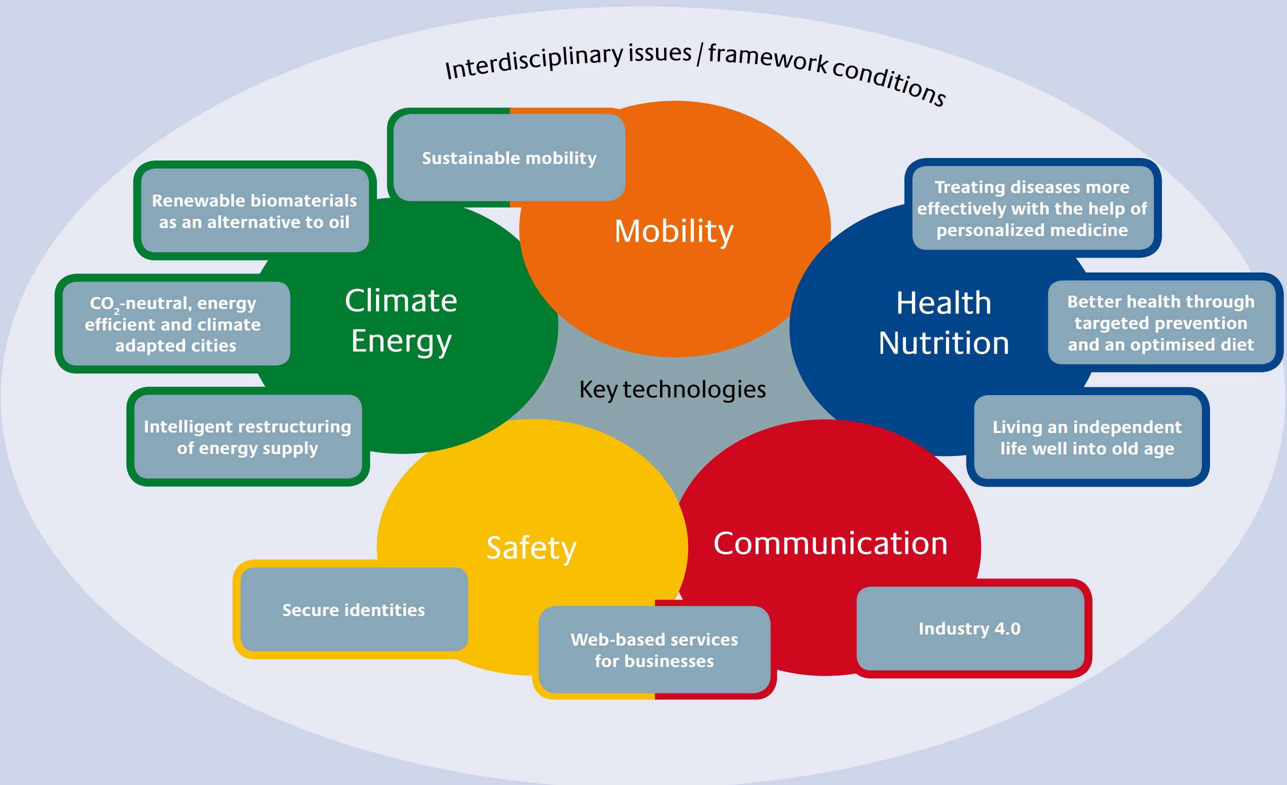
The High-Tech Strategy has been further developed during this legislation period. It concentrates on global challenges that are highly relevant for human well-being and Germany as an innovation location. Between 2010 and 2013, the federal government intends to invest almost 27 billion euros in the five demand fields of climate/energy, health/nutrition, communication, mobility and security, and in the promotion of key technologies.[2]

The High-Tech Strategy measures are funded as part of the respective departments' financial plans. This comprises programmes and action by the individual departments and funds from the Energy and Climate Fund (EKF). The money that flows into the EKF depends on the revenue from the certificate trade and is therefore subject to unpredictable fluctuations. Once again, financing in this area is realised as part of the respective financial plan relevant for the EKF.

The High-Tech Strategy also aims to create underlying conditions favourable for funding innovation, allowing ideas to become innovations more quickly. This will, for example, facilitate the funding of innovations – in particular for small and medium-sized enterprises (SME) – and improve the conditions

2 Determined based on the government's planning system.

Fig. 4 The High-Tech Strategy: foreward-looking projects and demand fields



for setting up innovation-orientated companies. In the foreward-looking projects of the High-Tech Strategy, this integrated approach is based on specific goals and is designed based on a cooperation by various specialist departments with the help of representatives from science and business (see Figure 4).

Key technologies

Likewise, the funding of important key technologies is targeted toward progress in the five demand fields because key technologies such as biotechnology and nanotechnology, microelectronics and nano-electronics, optical technologies, microsystem technology, materials and production technology, energy technologies, efficient drive technologies, aerospace technology and information and communication technology are prime drivers of innovation and form the basis for new products, procedures and services. They also make a decisive contribution to solving global challenges and their usefulness depends on the success of endeavours to transfer them into commercial applications. Therefore, the focus of the funding of key technologies is placed on application fields.

Foreward-looking projects

A central concern of the High-Tech Strategy 2020 is aligning the research and innovation policy to central missions. Increasingly, socially and commercially relevant advances in innovation take place at the interfaces between technologies and disciplines. Shared efforts in networks of public research institutes and companies that devise comprehensive solutions are subsequently growing in importance.

Also, central challenges require systematic approaches involving various technologies in order for complex solutions to be devised. Innovation policy therefore also needs to go beyond research and include realisation and implementation steps.

This is why the federal government has developed ten mission-oriented foreward-looking projects. Within these foreward-looking projects, systemic solutions are devised to counter urgent social challenges of a global nature whilst at the same time contributing to the competitiveness of the German economy. Foreward-looking projects convey comprehensible and marked focal points of the innovation policy. They also provide the opportunity to not only coordinate research funding but also to establish an innovation-friendly framework. The federal government described in detail the planned implementation of these ten foreward-looking projects in its report “Foreward-looking Projects of the High-Tech Strategy (HTS Plan of Action)”.

Framework conditions

The High-Tech Strategy not only considers specific research and development funding and the implementation of foreward-looking projects, it also focuses on the overriding framework conditions and cross-cutting issues. It is consistently reviewed and adapted in terms of innovation friendliness.

To ensure positive conditions for establishing companies, it is imperative to improve the financial situation of the company founders and young innovative companies by strengthening the venture and investment capital market. The investment allowance for venture capital financing of young innovative companies, which was announced during the innovation dialogues in February 2012, is an important step in this direction.

Business model innovations are important for the technological and service-based future of Germany as a business location from both a commercial and also scientific point of view because they can change the character of entire industries and therefore have a similar quality to scientific technological innovations. This is why the federal government is devoting special attention to this subject.

In line with the specifications of the coalition agreement, the federal government will make a decision about the introduction of tax benefits for research and development, taking into account the offered fiscal consolidation and the economic outlook. In light of the requirements of Article 115 of the constitution and European requirements pertaining to budget discipline, there is little room to absorb structural tax reduction measures at this time.

Norms and standards guarantee transparency and comparability, high quality, security and sustainability of products and services. They open up markets and create equal conditions of access, in particular for small and medium-sized enterprises. Standardisation in Germany is increasingly becoming an integral part of the research and innovation process because, if introduced early enough, it promotes the transfer of research results into marketable products and services and also ensures that the innovations reach the market quickly. Active participation in standardisation activities also helps the German economy to achieve global economic advantages. We will therefore make greater use of the potential of standardisation by means of targeted integration in research funding when implementing the standards-related concept of the federal government.

The federal government will place more emphasis on innovation aspects when awarding funding in the future. On the one hand, innovative solutions may comprise efficiency in the administration system or on the other, the demand for new products, services and technical solutions, thereby effectively supporting the innovation activity of the economy. The purchase of an innovative solution is often connected to saving effects in terms of sustainability and energy.

Turning ideas into innovations more quickly

Building a bridge between science and business is one of the core elements of the High-Tech Strategy for Germany. Research results with innovative potential need to be recognised and implemented quickly and successfully in the market to ensure sustainable growth and jobs. At the same time, it is also important to formulate research questions that are relevant for the future and to devise appropriate solutions. This is only possible if all those participating in the process work together in a strong partnership. One example of this are the German Centres for Health Research that, working on the principle of translation, link activities ranging from basic research through to the development of innovative therapies. The Centres act as an interface between research, clinics and business to ensure that the transfer of research results from the laboratory to marketable medicines and treatment procedures can be achieved even more quickly and efficiently in the future.

Scientific institutes and companies in Germany work hand in hand. 58 % of companies that enter into research cooperations in Germany also work with universities, around 26 % with non-university research institutes. More and more universities and research institutes consider the issue of cooperation and the exploitation potential early on in the research and development process as a relevant part of their mission. Nevertheless, there is still untapped potential in the transfer of knowledge and technology within the context of global challenges and growing competition.

The BMBF launched the *Leading-Edge Cluster Competition* in 2007 to consolidate and expand the link between science and business. After the selection of the third and final round in January 2012, 15 Leading-Edge Clusters were named that are either about to enter the top international group in their technology fields or have consolidated their place within this group. The clusters are involved in a diverse and forward-thinking range of areas – alongside the demand fields of the High-Tech Strategy and make important contributions to the foreward-looking projects. Up to 350 partners from reputed research institutes, universities, companies and representatives in a region work together on a joint strategy in these clusters. They also get other protagonists involved – in particular SMEs. It is the fast-growing young companies in particular that find ideal framework conditions in the Leading-Edge Clusters; these clusters are crucial growth engines, even beyond the borders of their regions.

The partners of the cluster develop new technologies and services, and also close innovation chains. The results of their projects help to process tasks in the fields of energy, resource efficiency or health. They are also a source of new professions and innovative study programmes that meet the requirements of the future labour market. Steps are being taken to invest in Germany as an innovative location; there is a funding volume of 40 million euros per cluster over a period of 5 years – i.e. a total of 600 million euros – and funds from the participating companies of the same amount, coming to a total of 1.2 billion euros.

The Initiative Networks of Competence Germany (Initiative Kompetenznetze Deutschland) by the BMWi combines the 100 strongest technology networks in Germany, which have a combined total of 9,000 members. In a further step, the BMWi financed targeted support for the cluster managers aimed at professionalising their work via the Kompetenznetze Germany project office. Membership was subject to the satisfaction of demanding quality criteria. In a performance comparison with 140 European clusters, the activities and services of the cluster managers of the initiative networks were deemed highly effective for the business and R&D activities of small and medium-sized member companies. The BMWi is currently reviewing its cluster policy. One of the goals is to continue developing the national innovation clusters to turn them into excellently managed clusters as specified by the European quality criteria.

BMBF and BMWi aim to work cooperatively in order to build on previous experience and, by involving the *Länder*, to create a permanent platform for the mutual exchange about cluster topics and cluster policy. This will also include a cluster portal in the Internet which will allow an attractive central access to the various initiatives and participants at various levels – even for interested parties from abroad.

In August 2011, BMBF launched the *Research Campus initiative* as a new tool for funding innovations; it focuses on a new, very tight-knit and longer-term form of cooperation between science and business – for shared strategic basic research. As part of the competition, up to ten innovative and forward-thinking Research Campus models for longer-term,

Infobox

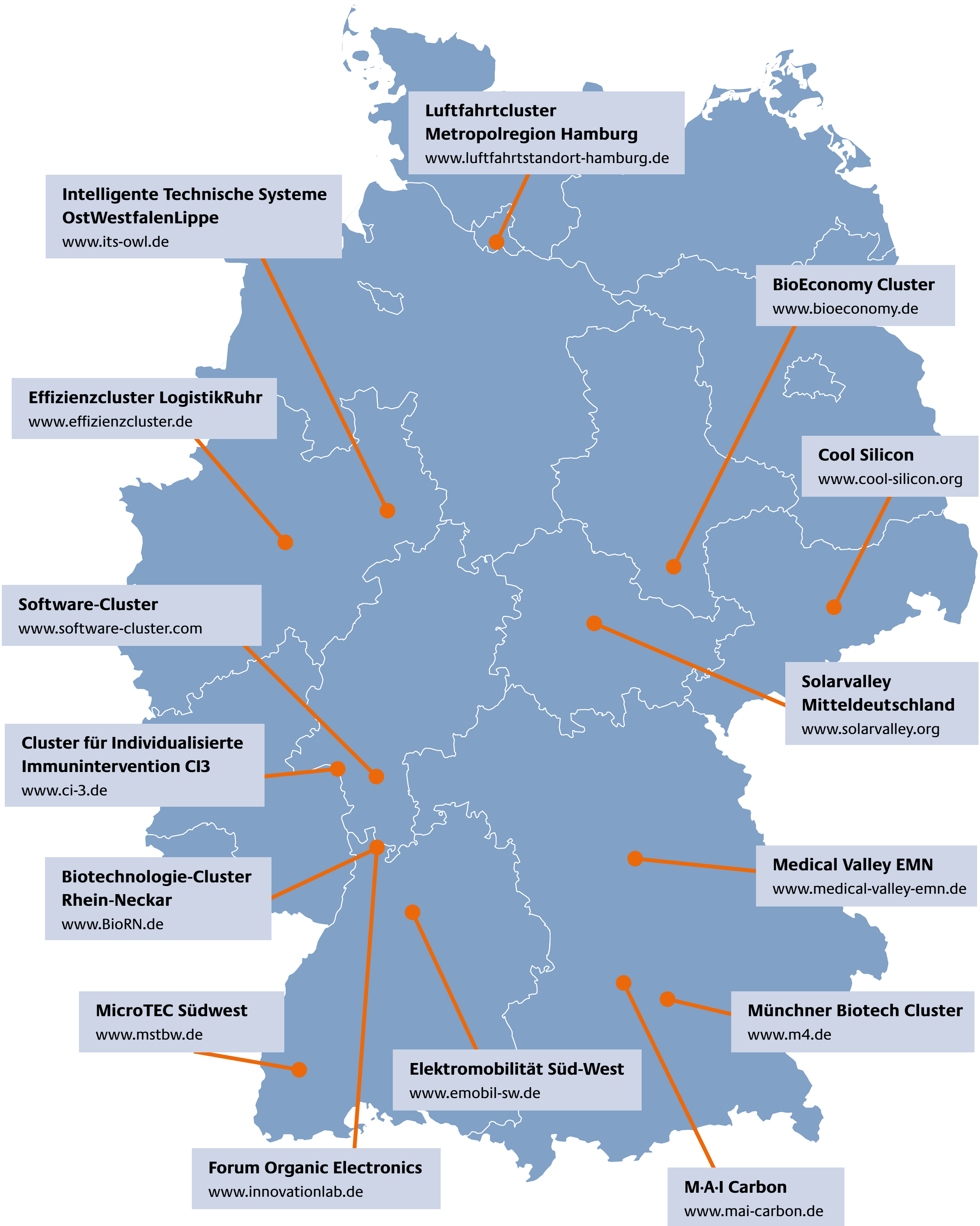
An overview of selected Leading-Edge Clusters

By virtue of their focal points and projects, the 15 Leading-Edge Clusters are structured to address future topics. Likewise, the design of the framework conditions is part of the Leading-Edge Cluster strategy. Further education and professional training issues are especially important for meeting the demand for specialists. Examples from the 10 Leading-Edge Clusters of the first two rounds are:

- *Cool Silicon* in Saxony with more than 100 companies and research institutes is a pioneer in the field of highly energy-efficient micro-electronics. Semiconductors for computer systems and broadband radio systems and also wireless and energy self-sufficient sensor nodes are developed, e.g. a self-sufficient sensor node for monitoring aircraft structures made of carbon fibre reinforced plastic (CFK). Younger scientists are also targeted, for example, via the newly launched English language Masters study programme “Nanoelectronic Systems”.

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

Fig. 5 **Locations of the Leading-Edge Clusters**



Source: BMBF

binding and equal partnerships between science and business, which are at the same level and with cooperation under one roof, will be selected and supported. Particular attention will be paid to very complex research fields with a high research risk and special potential for breakthrough innovations to produce the innovative products and services needed for tomorrow and beyond. The initiative targets models that have been recently planned or are currently in the planning phase. The competition has already contributed towards promoting the joint development of new ideas by partners from science – universities and also non-university research institutes – as well as companies. An independent jury will select Research Campus models that are to be funded over a period of 5 to 15 years with a sum of up to 2 million euros per year respectively.

Furthermore, the BMBF is funding technology projects without thematic restrictions with the programme *Validation of the Innovative Potential of Scientific Research – VIP* from the academic science field, to review the results of the public research in terms of their technical feasibility and commercial potential and allow them to be further developed for application purposes. Preliminary results of the funded projects show that scientists who work in basic research particularly profit from the support and are motivated to think about taking the step from the research process toward commercial exploitation at an early stage and then to actually follow this course of action. This opens up a variety of utilisation options.

The small and medium-sized enterprises (SME) and their participation in the innovation process is of particular importance. The BMWi has a range of supporting measures that are realised as early as the start-up phase because for a successful innovation policy, it is important to also set new impulses for the start-up dynamics and to permanently improve the conditions for setting up companies in Germany. The *University-Based Business Start-ups programme (EXIST)* supports steps taken to improve the conditions for setting up companies at universities and non-university research institutes, as well as the number and quality of technology-orientated and knowledge-based company start-ups. A further financing instrument is the *High-Tech Gründerfonds (HTGF)* which provides risk capital for new technology company start-ups. Together with the KfW bank group and 13 private investors, the BMWi also launched the HTGF II, furnished with 291 million euros, in autumn 2011.

The *Central Innovation Programme for SMEs (ZIM)* in particular funds cooperative projects between companies and research institutes, but also innovation projects by individual companies. The funding for research and development projects allows companies to directly implement innovative ideas for new products, production procedures or services, thereby realising innovation profits quickly. *Joint Industrial Research* supports research projects that are relevant for entire industries. Funding for innovation and efficiency counselling via BMWi-innovation vouchers and long-term low-interest loans for marketable innovation projects complete the service package. Cooperation projects are also funded as part of the specialist programmes run by the BMWi and BMBF; SMEs play a key role in this. To facilitate access to these complex programmes for SMEs, particularly for first-time applications, the BMBF has set up the *KMU-innovativ* funding initiative which offers specific, need-dependent access to the technology fields. The funding triggers additional investment in R&D in companies, which subsequently has a positive effect on the market and jobs in the medium to long-term.

Despite the creation and development of regional clusters in the new *Länder* via the BMBF funding programme *Innovation Initiative for the New German Länder (Entrepreneurial Region)* and the measure *Cutting-edge Research and Innovation in the New Länder*, limits are set for the further development of regional innovative initiatives through economic structures in the new *Länder*. Therefore, the regional focus of the innovation funding in the eastern part of Germany requires a supraregional expansion approach. In the future, the BMBF wants to compress the spatially diversified competences spread across the eastern part of Germany into sectorial clusters, support the further development of independent technological specialisations in the eastern part of Germany as well as develop strong supraregional and internationally visible innovation structures.

The BMWi has set up the *Innovation Competence East (INNOKOM-Ost)* to support the transfer of research results by external non-profit industrial research institutions, particularly with regards to SMEs, because they dominate the East German industrial research sector.

During the implementation of the High-Tech Strategy, all instruments and activities that are established for all the targeted technologies and across all demand fields of the High-Tech Strategy interconnect closely with the programmes of the theme-specific funding of research and development projects. This strengthens the innovation system as a whole.

Joint responsibility for research and innovation

Research and innovation need to maintain a dialogue with society because new technologies can make decisive changes to our everyday life. These changes will only be accepted if there is widespread consensus about their benefit. The central goal of the federal government is therefore to strengthen the dialogue with the general public in the field of research and innovation.

More in-depth debate is needed, especially in terms of socially controversial future technologies, which is why the BMBF initiated the *civil dialogue "future technologies"* as part of the implementation of the coalition agreement of October 2009. This provides the general public with a dialogue platform, where discussions can be initiated with experts and decision-makers from science, business and society. The resultant recommendations also impact upon the design of future research and innovation policy.

The BMBF is drawing up the strategy for the *Science Years* within the scope of the *Science in Dialogue* initiative. The partners want to work together to increase public interest in science, to make developments in research more transparent and in particular to motivate young people to choose research subjects, especially in terms of their choice of profession. Since 2010, the science years have moved away from only addressing specific disciplines toward more interdisciplinary topics of major social importance. In addition to communicating the topics and scientific content, the science years will initiate and promote social debate about developments in research and science.

The *Haus der Zukunft (House of the Future)* will be erected next to the new BMBF building on the Kapelle-Ufer in Berlin and will function as a display window, promoting Germany as a science and innovation location. The objective is to realise this exhibition, event and conference centre as a public-private cooperation together with business and science. Visitors from across the world will be given the opportunity to take a look at the future and converse with representatives from science and research.

Research and innovation advisory service

In light of the scientific-technical progress, the need for reliable reference information is growing. Political decisions are becoming increasingly complex, scientific advice is now more necessary than ever before. The federal government has a differentiated policy advisory system.

Politics and society in general need well-founded scientific advice in order to face the educational, medical, technical, ecological, social and economic challenges in our society and to design future cooperation schemes. This advisory function is assumed by the federal institutions with research and development asignments – both nationally and internationally. They provide sound scientific information to aid decision-making and offer services to facilitate political action.

In the Innovation Dialogue, high-ranking representatives from science and business discuss new strategic approaches in innovation policy with the Chancellor, the Federal Minister of Research and the Federal Minister of Economics. Since 2010, the important topics of innovation financing, cluster and network-funding as well as technologies with a high potentioal for value creation in Germany have been addressed. The federal government uses this dialogue to discuss the strategic direction of its policy together with science and business at an early stage.

The Commission of Experts for Research and Innovation (EFI) advises the federal government in research, innovation and technology policy issues with internationally recognised expertise. The independent experts bundle the latest scientific insights in terms of innovation research and analyse the strengths and weaknesses of the German innovation system in their annual expert report. Their comments and recommendations form a valuable base for further innovation and research-policy decisions.

The Industry-Science Research Alliance (Forschungsunion) plays a decisive role in the High-Tech Strategy. It forms the forum for an intensive exchange between business, science and politics. This offers business and science the opportunity to put forward and discuss their ideas and concepts. The promoters of the Industry-Science Research Alliance are multipliers for the results of these discussions and, as partners, play an important role in further developing the High-Tech Strategy by implementing their own contributions.

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

Science academies: The German Academy of Natural Scientists Leopoldina – National Academy of Sciences – represents scientists from Germany in international committees and is also involved in providing science-based advice about everything from research and innovation to society and politics. It works closely here with the National Academy of Science and Engineering (acatech), the Berlin-Brandenburg Academy of Sciences and Humanities (BBAW) and the federal state academies, making use of their expertise. The National Academy of Science and Engineering – acatech e.V. – promotes the dialogue between science, business, politics and society and also advises and informs politics and society at a science-based level about engineering-related future issues.

Technology foresight: information about social and technological developments needs to be collated and interpreted at an early stage in order to design the future. To this end, the BMBF started the second cycle of its Foresight process, to obtain renewed insight into the future (10 to 15 years). In an intensive two-year search phase, social trends and technological developments are recorded, analysed and linked to scenarios to allow early reference knowledge to be collated for future research and innovation policy.

Playing an active role in designing European innovation policy

The commission's proposal for the new framework programme for research and innovation "Horizon 2020" incorporates various structural elements which had a positive impact in Germany as part of the national High-Tech Strategy. "Horizon 2020" forms the core of the European Innovation Union that has set itself the objective of developing a sustainable, economically strong and innovative Europe. Germany's exertions in terms of its national High-Tech Strategy are strengthened and supplemented at the European level. The synergies needed to achieve the objective of the Europe 2020 strategy are created by means of the political prioritisation of research and innovation, the interlocking of their funding instruments and the strategic agenda of research topics. Research and innovation are important levers for securing the future of Europe in the long term and promoting prosperity and jobs.

3 Strengthening science

Objectives and approaches of the science policy

Germany is a leading location for science, research and innovation. The objective for the future is to maintain this position and at the same time to further raise the international profile of our excellent research. This requires outstanding locations, an overall high performance capability and an attractive package that appeals to the best minds. The German research landscape is also characterised by a large number of participants. Following a new direction in the cooperation between the best participants is an important step in strengthening leading science locations in Germany. The federal government is also striving to expand the cooperation possibilities between the government and the *Länder* in the science field. To this end, a proposal has been made to amend the constitution in the field of joint tasks as stated in Art. 91 b of the German Constitution (Grundgesetz – GG), in which the government and also the *Länder* would not only be able to work together on projects but also in the field of institutional funding of science and research facilities at universities of supraregional importance. Against the background of growing internationalism in the science system in an increasingly global world, Germany depends on permanent supraregional structures with supraregional visibility.

The business world too, which is more involved in application-orientated research, needs to add a new element of commitment to the already in part excellent cooperations that exist with science in order to establish long-term strategic cooperations. In the future, those universities that sharpen their profile by concentrating equally on research, teaching and exploitation of the research results will be particularly successful internationally. In this connection, the Commission of Experts for Research and Innovation highlights the progress made in financing research at universities since 2006, a process strengthened in particular by steps taken by the federal government.

The three large reform initiatives by the federal government and the *Länder* – the Higher Education Pact that includes a quality pact, teaching, the Excellence Initiative and the Joint Initiative for Research and Innovation – have played a major role in achieving these science policy goals (see infobox).

The science system is one of the top priorities of the federal government and the *Länder*. The reform initiatives will be continued by the federal government and the *Länder*.

Further expansion of the freedom and incentives for scientific initiatives

The Excellence Initiative and the Joint Initiative for Research and Innovation are important for providing impetus for more excellence, more competition, better profile building, more dynamism and also more cooperation and networking in the science system. The Commission of Experts for Research and Innovation has confirmed that the Excellence Initiative has a differentiating and profile-building effect that has, above all, raised the international visibility of the German university landscape. With the third round of the Excellence Initiative, successful projects from the first two rounds can be continued and new projects expanding cutting-edge research. This raised the international profile of cutting-edge research at universities can be started.

The Joint Initiative for Research and Innovation enables research organisations to continue and further develop strategic measures, build on the quality and quantity of existing instruments and develop, test and establish new ones.

For the future the international charisma of our excellent research capacity has to be increased. Following a new direction in the cooperation between universities and research institutes is an important step.

The Scientific Freedom Act aims to help install more attractive framework conditions in non-university research. In the fields of budget, personnel, funding and construction procedures, the aim is to anchor the greatest possible autonomy for the science institutions in order to create competitive statutory framework conditions. Important goals are:

- In the budget field: The law grants science organisations necessary autonomy over the independent use of personnel, materials and equipment, and investment funds. Introducing global budgets means that the institutions can work in a more efficient and targeted way, taking into account the principles of economy and efficiency.

- In the personnel field: The science institutions have more freedom which will allow them to continue attracting top candidates despite the international competition. It will allow private funding from commercial revenue, donations or private equity to be used for competitive salaries or salary components.

Infobox

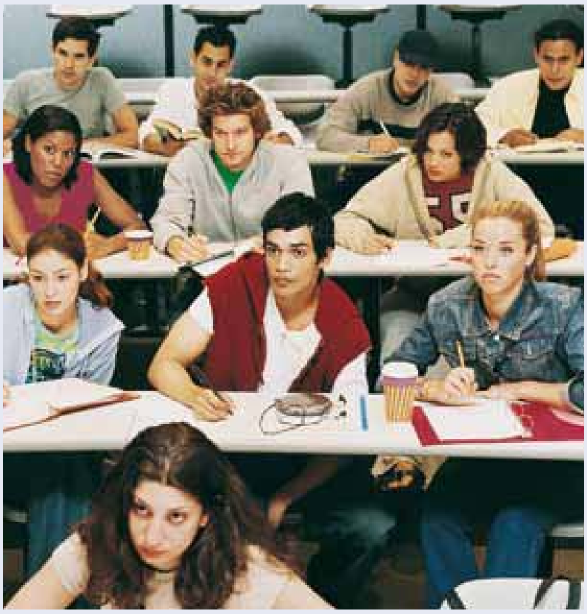
The three reform initiatives of the federal government and the *Länder* governments

The Excellence Initiative

- The Excellence Initiative with a funding volume of approx. 1.9 billion euros for both selection rounds 2006 and 2007 did not just raise the profile of the funded universities, its science-led and competitive procedures also received widespread international recognition.
- In the 39 graduate schools, junior scientists are promoted and work is performed in cross-faculty and interdisciplinary teams.
- International cutting-edge research takes place in 37 excellence clusters. They usually integrate at least two specialist fields.
- Nine universities will implement successful concepts with which they will endeavour to position themselves among the international leading-edge group.
- The expansion of the international network into an interface and management task plays a major role in all of the concepts.
- In all three funding lines, the universities cooperate with regional, national and international partners from both science and business. To date, around 4,200 scientists have been recruited, of which approx. 25 % from abroad.
- The federal government and the *Länder* have decided to continue the Excellence Initiative into the third round with a total of 2.7 billion euros.

Higher Education Pact

- The federal government and the *Länder* create a needs-based range of study programmes thereby ensuring the quantitative expansion of the academic training. Between 2007 and 2010, 185,000 new college places were created, twice as many as originally agreed. In total, around 320,000 to 335,000 additional college places will be created in the second phase of the programme. The federal government alone will provide at least 4.7 billion euros for this purpose between 2011 and 2015.
- Record student numbers were reached in Germany in 2011, with almost 516,000 new students and a grand total of 2.4 million. Academic training is gaining in popularity, a fact that the MINT subjects have also profited from.
- The federal government and the *Länder* have also decided to participate in the overhead financing as part of the research funding programme by the German Research Foundation (DFG). Universities that are very active in the research field can further strengthen their strategic manoeuvring capability thanks to the introduction of the DFG programme lump sum, which totals 20 % of the direct project funds. Until 2015, the federal government will continue to bear these costs alone, which total around 1.7 billion euros.



- The Teaching Quality Pact, which forms the third pillar of the Higher Education Pact, supports 186 universities from all 16 *Länder*, helping them to improve their study conditions. The federal government will invest a sum of around 2 billion euros for this purpose by the year 2020.

The Joint Intiative for Research and Innovation

- The Joint Intiative for Research and Innovation will strengthen and accelerate dynamic development in the non-university research field. The non-university research institutes HGF, MPG, FhG, WGL and the DFG as the funding organisation of university research can secure their position among the best in the world in the long term.
- Between 2011 and 2015, payments to the partners of the pact will increase by 5 % each year.
- The pact is linked to mutually agreed research policy goals that are laid down in an annual monitoring report by the pact partners and evaluated by the federal government and the *Länder* at the Joint Science Conference. In addition to the early and systematic identification of future-orientated research fields, the promotion of junior scientists and the inter-organisational network and internationalization, the main goals of the pact are the transfer of knowledge and technology and the formation of sustainable partnerships with commercial partners. The pact partners have collected a lot of reference data for this field that is included in the monitoring reports as part of a qualitative general overview.

- If the science institutions decide to participate in investment projects, the Scientific Freedom Act establishes an approval procedure that accelerates the process by means of clearly defined deadlines.
- Also, construction work is designed more efficiently. The science institutions are granted more independence and self-responsibility if they have the necessary construction expertise and an adequate internal controlling process.

The scope of the act will encompass those science institutions institutionally funded by the government or jointly by the federal government and the *Länder* pursuant to Art. 91 b of the German Constitution. In the case of federal institutions with research and development asignments, the federal government is striving toward making both the Scientific Freedom Act and previous measures of the Scientific Freedom Initiative more flexible in the budget, personnel and construction process fields starting with the Budget Law 2013.

Further development of departmental research as part of the science system

Departmental research undertaken by the government is an indispensable part of the science system.

Departmental research adopts a problem-orientated, practical and interdisciplinary approach to covering a broad range of tasks: in addition to the scientific processing of statutorily assigned tasks, the portfolio of departmental research also includes developing and updating statutory regulations and standards, maintaining databases, expert systems and measuring networks.

Departmental research is carried out by 40 federal institutions with research and development asignments and 6 non-university R&D institutions in continuous cooperation. The research and development activities are carried out by the institutions themselves in cooperation with other research institutes, or by contracting out research orders to external research organisations (extramural research). The unique feature of these R&D institutions is that the scientific expertise for urgent governmental issues can be called upon at short notice and at the same time, longer-term scientific tasks can be processed at a high level comparable with international standards.

This means that the federal institutions with research and development asignments face the challenge of striking a balance between offering political advice and assuming science-based tasks and also maintaining their position within their special legal framework conditions as public authorities in the national and international competition among all research institutes. The scientific and topic-related orientation of federal institutions with research and development asignments is therefore set against a background of the original tasks and needs of the departments.

The need for high-quality, science-based results for the correct perception of the departmental tasks is rising continuously. Therefore, one of the federal government's main goals is to further develop those federal institutions with research and development asignments and to promote a high level of scientific excellence in the long term as equal partners in the science system. The following initiatives and measures scheduled for the years 2012 and 2013 specifically target these goals: raising the profile and visibility of departmental research, strengthening the interdepartmental coordination and swapping experiences, improving competitiveness, intensifying the quality assurance and evaluation steps specific to the institute, the introducing research programmes in all institutes and consistently promoting internationalization.

4 Further developing education in the knowledge society

Good education as the basis for science and research, prosperity and social cohesion

Good education right from the start is a central prerequisite for a successful science and innovation system and also forms the basis for prosperity and social cohesion. Good lifelong education and further training options are indispensable if the requirements of a dynamic knowledge society are to be satisfied. Science and research require people that are willing to ask new questions and search for innovative answers.

Against the background of demographic change, securing a good skilled labour basis – in particular concerning highly qualified personnel – is essential for maintaining and further expanding our high-performance science system and thereby the innovation and competitive ability of our country. The majority of the forecasts come to the conclusion that there will be a shortage of skilled workers in Germany in the long run.

The future prosperity of our country will primarily depend on ensuring that young people are adequately qualified and that new potential for creating a skilled labour basis can be tapped. This is the reason why in summer 2011 the federal government devised a skilled labour concept that is directed at all target groups in the labour market. It comprises both the training of young people and also the qualification of older people. The concept structures the objectives and measures taken by the federal government in the policy for securing experts into five channels: activation and securing jobs, better reconciliation of work and family, education opportunities for everyone right from the start, qualification: vocational education and training, integration and qualified immigration.

The focus of the concept of securing skilled personell will lie in qualifying those people that already live in Germany. It is necessary here to adopt a very long-term approach when securing the skilled labour basis. The process starts in the pre-school education phase, continues at school and the subsequent vocational training and continues into professional further training. The service and funding offered by the local employment agencies and job centres are extremely important, in particular in the job starter field. These services have been made more transparent by the introduction of a law which improves prospects in the labour market via the merging of the career selection and vocational training sections. These can be applied precisely depending on life situation and needs. Measures taken by the BMBF include, e.g. education chains, the JOBSTARTER programme, an increase in the number of university places in cooperation with the *Länder* or the National Pact for Women in MINT professions. The importance of the "Law on improving the assessment and approval of professional qualifications earned abroad" should also be highlighted. This ensures that clear and uniform assessments of professional qualifications earned abroad are available for employers and companies. The law of approval plays an important part in granting better access to the labour market for people with migration background also within the fields of science and research. It caters for a transparent and fast approval procedure and came into force on 1st April 2012. At the same time, steps need to be taken to attract qualified people to come to Germany.

It is imperative that all responsible parties on all levels work hand-in-hand in order to strengthen the education system. The federal government and the *Länder* jointly address the challenges faced by the education system in the Qualification Initiative for Germany that was launched in 2008. Via the agreed measures defined in the Qualification Initiative, the federal government and the *Länder* have already taken visible steps as reflected in the increase in the number of new students and the reduction in the number of school drops-outs.

Good education requires investment in educational quality. The *Länder* and the municipalities bear 86.3 % of the public education expenditure as stipulated in the education budget and 68.1 % of the overall education budget, i.e. 104.6 billion euros (2008). The heads of the federal government and the *Länder* have agreed to reach the national goal of 10 percent of the GDP for education and research by 2015, of which 3 percent of the GDP is designated for research and development. The share of education and research as a ratio of the gross domestic product rose from 8.6 % to 9.3 % between 2008 and 2009. The share for education alone as a ratio of the gross domestic product rose from 6.2 % to 6.8 % between 2008 and 2009. The continuation of the three science pacts, which were agreed by the federal government and the *Länder*, namely the Higher Education Pact 2020, the Excellence Initiative and the Joint Initiative for Research and Innovation, mean that the federal government and the *Länder* make an enormous contribution to achieving the 10 percent goal agreed in the Qualification Initiative. In total, the federal government and the *Länder* are investing around 23 billion euros in the three science pacts, of which the government bears 15 billion euros.

Promoting qualifications and talents

In light of the demographic change and the trend toward activities of a more knowledge-intensive nature, children and teenagers need early educational support. The way children are supervised, taught and educated at an early age sets the course for the development of their further educational biography. Promoting language skills is therefore of particular importance in all educational areas, which is why the federal and state governments have launched a joint initiative in the field of language teaching, language diagnostics and reading skills. The BMBF will be underscoring the research into language teaching by means of a new research programme that will start in 2012 in the context of a supporting programme for promoting empirical education research. The "Little Scientists House" programme aims to introduce children in day-care centres to science and technical topics. The supporting programme for promoting empirical education research develops scientific principles for ensuring the quality of the education system, e.g. for the language skills and language assessment initiatives and for scientific results-orientated control throughout the education system.

Young people need school qualifications and good vocational training in order to successfully commence their working lives. The federal government is therefore focussing all its efforts on early vocational orientation. The mentoring system in the standard funding, pursuant to the employment promotion laws, is of paramount importance here. The *Qualification and Continuation initiative – Educational Chains through to Completion of Training* – accompanies young people throughout their schooling until completion of their vocational training. Since the initiative began at the end of 2010, 13,000 young people have been counselled by skilled personell who have accompanied them between leaving school and starting their apprenticeships. Agreements have been made with the *Länder* of Baden-Wuerttemberg, Hesse and Thuringia to continue the initiative. The federal government also offers young people services from the education and participation package for children and teenagers in need.

The federal government promotes attractive vocational training and has started the campaign "Vocational training – practically unbeatable" in cooperation with business and social partners.

Starting in 2013 as part of the *Education Alliance programme,* the federal government intends to support educationally disadvantaged children and teenagers with extracurricular activities, in particular in the cultural development of their personalities.

The federal and state governments have formulated a common policy in the Qualification Initiative of attracting at least 40 % of an age cohort to start a degree and further improving study conditions. It has been possible to raise the share of first-year students from 37.1 % (2007) to 45.2 % (2010). According to forecasts presented by the Conference of Education Ministers, the number of new students looks set to rise again significantly by the year 2025. The federal and state governments have therefore created a further 320,000 to 335,000 university places as part of the second programme phase of the Higher Education Pact.

In the Quality Teaching Pact, which is financed by the federal government, 2 billion euros will be spent by the year 2020 on measures that will improve the staffing situation at universities, help the teaching staff gain further qualifications and also secure and further develop the high quality of teaching at universities.

The 19th BAföG Report (2012) states that expenditure for the BAföG programme in 2010 reached a record level of 2.9 billion euros (2008: 2.3 billion euros). This represents a further increase in the number of students that received funding and an increase in monthly grant payments. In addition, the federal government also supports young people with special talents via a variety of scholarship programmes. The number of scholarships granted by the federal government to students in Germany has more than doubled in just six years. Whilst around 16,400 mostly young people received scholarships in 2005, this figure increased to around 37,000 by 2011. Amongst other things, 2011 saw the introduction of the Germany Scholarship that offers talented and high-performing students a grant of 300 euros every month, half of which is provided by private funding agencies and the other half by the federal government. In 2011, the Germany Scholarship was able to raise around 10 million euros of additional private funds to support talented students. The government is also involved in funding vocational training via vocational training grants and apprenticeship benefits.

In 2011, the federal and state governments launched the competition *Advancement through Education: Open Universities.* The competition also aims to remove artificial barriers between work and universities, thereby permanently securing a pool of skilled personnel. The funding of the first wave of the competitions started in October 2011. The public tender for the second competition round starts in 2014.

More vocational further training is an imperative part of mastering the challenges presented by the demographic change in the expert market. The federal and state governments therefore intend to increase the further education ratio to 50 % of the working population by 2015. The willingness to attend further education courses will be encouraged via funding by the federal employment agency and the job centres, measures such as the successfully introduced education bonus and the Upgrading Scholarships programme for particularly talented professionals.

Developing foreign potential

The utilisation and funding of domestic potential alone will not be enough to counter the effects of the demographic change. The federal government therefore wants to facilitate the immigration of qualified experts by implementing the EU highly-qualified persons directive (Blue Card). The federal cabinet passed a draft of this law in December 2011 to improve, among other things, the legal residence rights and prospects of foreign graduates of German universities.

5 Intensification of European and international cooperation

Growing importance of international cooperation

Science and research play an important part in mastering major global challenges. The growth in the number and depth of the international interlocking of many social fields enhances the value of international cooperation in science and research. This is particularly prevalent in the search for scientific answers to global challenges, for instance climate change; the quality of the answers is highly dependent on the cross-border cooperation of international research and expert teams.

Research and education are the most important drivers for the development of innovations and for coping with social and scientific structural change – in Germany as well as in its partner countries. Research and education are growing in importance in the field of international cooperation in terms of the overriding goals of foreign policy, be it in the areas of commerce, security, European integration or global cooperation for finding solutions to global challenges such as climate and environmental protection, health, migration or demographic change.

The federal government's research and innovation policy objectives, in conjunction with Europe's declared intention to become the world's most competitive science-based economy, calls for better exploitation of the opportunities presented by increasing internationalism. The federal government has responded to these challenges in its strategy to internationalise science and research. The combination of the High-Tech Strategy, the Joint Initiative for Research and Innovation and the Excellence Initiative makes this Strategy of the Federal Government for the Internationalization of Science and Research a core element of German research policy.

Strategy of the Federal Government for the Internationalization of Science and Research

The Strategy of the Federal Government for the Internationalization of Science and Research has four designated priority fields that form the central theme of the international activities of German science and research. The strategy aims to identify the best knowledge, the optimal structures and the most appropriate processes by means of continuous international comparison and to exploit these for Germany as a science and research location. They should act as guidelines and also the starting point for cooperation with all those involved in the German science and innovation system, support the goals and the impact of the tasks and missions of the German science, research and intermediary organisations in the international environment through improved coordination and exchange of information, and thereby tap previously inadequately used synergy potential.

Strengthen cooperation with the world's best

Germany wants to further develop the quality of its education and research landscape to achieve the very highest level. All efforts here focus on strengthening national excellence by, amongst other things, further developing and intensifying cooperation with the world's best scientists, experts and institutes. Today Germany is one of the most attractive study and research locations; German researchers are popular partners throughout the world. These two factors are closely interlinked and need to be consolidated and further developed to a very high level.

Developing innovation potential at an international level

Help is provided to companies, research institutes and universities when developing their international innovation potential, allowing them to improve their position in the global competition. The innovation policy has two key focuses: The effective use of global knowledge for own research-driven innovations and facilitating the access of innovative German products and services to international markets. This includes the design of innovation funding framework conditions for international cooperation and funding the creation of a network between German innovation organisations and partners across the world.

Strengthening the cooperation with developing countries in education and research in the long term

The Strategy of the Federal Government for the Internationalization of Science and Research aims to give a new quality to the cooperation with developing countries in the fields of education, science and research by further expanding vocational training, tertiary education, science and research, in particular with a view to their overall correlation. At the same time, this cooperation also affords the development and expansion of capacities in developing countries. As a result, this gives German education, science and research institutes the opportunity to network with partners in developing countries, thereby creating the necessary basis for addressing joint solutions to global issues.

Assuming international responsibility and coping with global challenges

At the start of the 21st century, humankind faces immense and globally-impacting challenges: resource consumption, climate change and a loss of biodiversity threaten our future. Supplying citizens and commerce with safe, inexpensive and environmentally-friendly energy, food and other resources has become a systemic transformation task. Coping with these challenges requires effort in all political areas. By virtue of its research and innovation capacities, Germany is in a position to make a significant contribution toward finding evidence-based solutions to global challenges.

Implementation of strategic goals

To implement the Strategy of the Federal Government for the Internationalization of Science and Research, the federal government is committed to achieving political consensus and cooperation in the fields of education, science and research at an international level within this legislation period. This includes, for instance, government consultations in which education and research play an important role (e.g. with Russia in July 2011, China in June 2011, India in May 2011, Israel in January 2011 as well as the government consultations with France that take place regularly every six months). It also includes negotiations as part of the Science Technology Cooperation (WTZ). Since the end of 2010, the BMBF has been negotiating this Cooperation on behalf of the federal government with seven partner countries (China in November 2010, USA and Canada in September 2011, Russia in October 2011, Chile and Mexico in November 2011, Vietnam in November 2011). The consolidation of international cooperation is also furthered in the so-called "research forums" – in 2011 with partners such as Israel (June 2011) and France (October 2011).

Implementation in bilateral cooperation

Bilateral cooperation with important partner countries throughout the world is a key part of Germany's international cooperation in the field of research and consequently raises the profile of Germany's research policy. In particular, this applies to countries with a high level of development dynamism and important future markets and it is also strategically important in terms of attractive science and technology resources. Bilateral cooperation is usually organised within the scope of the Science Technology Cooperation, although the focus remains on long-term exchange programmes and joint research projects. New approaches evolve via the interlocking of networks and clusters and better inclusion of small and medium-sized enterprises in the field of technology cooperation. For example, Germany cooperates with Israel as part of the Central Innovation Programme for SMEs (ZIM).

Further examples of bilateral cooperation are the German-French research projects in the field of "Genomics and Pathophysiology of Cardiovascular and Metabolic Disease". Another German-French research cooperation that has proven successful is the DEUFRAKO scheme that promotes a large number of strategically important traffic projects.

Another scheme worth mentioning is the German-Brazil Year of Science, Technology and Innovation 2010/11 (DBWTI). The DBWTI also played an important role in implementing the Strategy of the Federal Government for the Internationalization of Science and Research and contributed towards better cooperation whilst at the same time raising visibility. Under the joint motto "sustainably innovative", over 100 German-Brazilian events relating to the overriding issues of sustainability and innovation took place up to April 2011. The plans for a German-Brazilian research fund also highlight the intention to maintain these bilateral activities in the medium to long term. Against this background, a joint declaration of intent was signed by the research ministries of both countries in April 2011. The BMELV and BMBF 2011 also signed a "Memorandum of Understanding" with the Brazilian state agricultural research organisation Embraba, which serves to further strengthen bilateral cooperation of both states in the field of agricultural research.

A further example that highlights the importance of bilateral research cooperation is the "Memorandum of Understanding" between Germany and China for scientific cooperation in electro mobility basic research which coincided with a visit by the federal minister Schavan to China in June 2010. This paved the way for a union of German technical universities (TU9) and a group of Chinese universities headed by the Tongji University to start basic research cooperation for electro mobility. Also, the first foreign investment in China's manned space programme in 2011 and the fact that the German research system SIMBOX was taken on board the space capsule Shenzhou-8 reflects the international recognition of German research work.

The Commission of Experts for Research and Innovation also emphasizes the challenge presented by the emergence of China for Germany as an economic location and welcomes the many existing cooperations between the two countries.

The most important instrument of the bilateral and regional cooperation has proven to be the projects by the agency establishment teams of the German Centre for Research and Innovation (DWIH) in New York, Sao Paulo, Tokyo and Moscow in 2011. The establishment and operation of the DWIH or centres is realised in cooperation with the Federal Foreign Office, BMBF and the "Alliance" of the science organisations since 2009.

European implementation: Expanding Europe

Germany is playing an active role in designing the development of the European Research Area (ERA). The start of the five ERA initiatives in 2008 (1. Better career opportunities and more mobility: a European partnership for researchers, 2. Research infrastructures: ESFRI and Legal framework for a European Research Infrastructure Consortium – ERIC, 3. Knowledge transfer: European Charter on handling intellectual property, 4. Joint programme planning: coping better with joint challenges, 5. European strategy framework for international scientific and technological cooperation) represent the start of key structural elements that will clearly define the profile of the ERA. When coordinating national activities and programmes in terms of the ERA, the principles of spontaneity and variable geometry are central factors. As a supplement to national research programmes, the 7th European framework programme for research, development and demonstration (research framework programme) has now become the world's largest programme in this field. To fully exploit the opportunities presented by this programme, German applicants are offered a very broad range of advisory services. The federal government contributes to this research framework programme via the Network of National Contact Offices (NKS). European intergovernmental initiatives, such as EUREKA and COST, also provide an open framework for applied research and development. European research organisations such as CERN form the institutional basis of research in Europe.

Germany has played an active role in drafting position papers and issuing statements in the run-up to the coming research framework programme for research and innovation, "Horizon 2020" which will start in 2014. The federal government is in particular committed here to the principle of excellence as a criterion for funding, the simplification of the funding procedures, the greater weighting of funding for cooperation projects and strengthening key technologies. The integration of the European Technology Institute (EIT) in "Horizon 2020" and the expansion of the basic-research orientated European Research Council (ERC) are special priorities for the further expansion of the European research area.

European cooperation is particularly important with regard to energy technologies. The federal government supports the European Commission's Strategic Energy Technology (SET) plan and is involved in its implementation. The goal is to strengthen applied energy research in key technologies of a European dimension; this includes network technology, wind energy and biomass.

Implementation on a global level: assuming responsibility for research policy on global issues

Germany wants to assume greater responsibility for research policy at the international level, allowing it to contribute to solving global challenges such as climate change, resource scarcity and the spread of infectious diseases. This calls for multilateral initiatives by various research policy shapers and the involvement of the new powerful policy makers. Within the framework of the G8 and the OECD, the BMBF is striving to improve multilateral cooperation and the steering of research policy.

This applies, for instance, to securing the supply of food throughout the world despite the increase in the global population. More food needs to be produced on less and less land. Climate change has also impacted on the supply of food. Droughts and flooding have led to failed harvests, which in turn leads to an increase in prices and food scarcity. Both have the potential to cause regional civil unrest. Research must lead to sustainable and higher agricultural productivity, a higher yield potential of plants in various climatic conditions and in various soil conditions, as well as to the development of innovative agricultural equipment.

One example of a scientific contribution made to solving global problems is the climate competence centres that were opened by the BMBF in 2010. Working with partners from southern and western parts of Africa, this initiative concentrates on setting up Regional Science Service Centres that address the issues "climate change and adapted land management in Africa".

At the OECD, an international research network, under the auspices of the German Institute for Development Policy (DIE), started in 2010 to analyse, at the initiative of BMBF, what kind of multilateral cooperation is best suited to address global challenges such as climate change, energy scarcity, food crises or international infectious diseases. These scientific insights will be used to draft and specify OECD guidelines for multilateral research cooperation.

FOREWARD LOOKING PROJECT

CO_2-neutral, energy-efficient and climate-adapted cities

Cities are the biggest consumers of energy and resources in Germany. Cities and urban areas therefore play a key role in mastering the huge challenges we face in the 21st century. Owing to the significant and continuously growing need for adjustment and the various ways in which the cities are affected by climate change, all participants in society and all political fields are called upon to work in an interdisciplinary manner and to merge their endeavours both in practice and when drawing up concepts.

Realising the future vision of "CO_2-neutral, energy-efficient and climate-adapted cities" is possible if simultaneous steps are taken to promote the energy-related modernisation of buildings and production plants, the future-proof design of sustainable mobility and the development of intelligent energy networks. Cities must adapt to climate change and also take into account the surrounding regions and diverse city-rural correlations. The activities depend on the widespread participation by all members of society.

The responsible ministries have already looked in depth at the challenge "CO_2-neutral, energy-efficient and climate-adapted cities" which has been identified as one of the most important future political issues. They are supported in their efforts by the Industry-Science Research Alliance. The vast amount of findings and solutions for partial aspects of this complex issue available today at the various levels of action and awareness is impressive. The High-Tech Strategy addresses the numerous innovation and research-policy initiatives run by the responsible ministries today and brings together various approaches. Firstly, the efficiency of important research findings will be tested in practice at an early stage and secondly, steps will be taken to ensure that individual questions arising from the practical tests are re-incorporated into the research work.

Responsible ministries: BMVBS, BMBF
Other ministries involved: BMU, BMWi
Budget: The current budget provides for up to 560 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Renewable biomaterials as an alternative to oil

Crude oil currently forms the basis for the global economy as a fuel and also as a source material for many chemical products; however, sources are rapidly depleting and burning oil is accelerating climate change. Renewable resources that can be used both as a source of energy and also as materials are a promising alternative to crude oil and other fossil fuels such as coal and gas. The aim of this foreward-looking project is to explore and tap their potential and is an integral part of the government's National Research Strategy BioEconomy 2030. The project is accompanied by the Industry-Science Research Alliance. On its recommendation, the federal government set up a BioEconomy Council in 2009.

The foreward-looking project has two major objectives: Firstly, to increase the use of biomass without competing with food production by optimising the yields on existing agricultural areas and also making efficient use of inedible parts such as plant stems. Secondly, similar to the current crude oil refineries, it wants to establish new processes that make full use of biomass: The aim is that in the future, bio-refineries will be able to convert biomass into fuels such as ethanol and into components for chemicals and plastics.

Pilot bio-refinery plants will be commissioned in summer 2012 by the Chemical-Biological Process Centre (CBP) in Leuna and by the company Südchemie in Straubing. The CBP, which is coordinated by the Fraunhofer-Gesellschaft, belongs to the "Bioeconomy" cluster that won the Leading-Edge Cluster Competition run by the BMBF in January 2012.

The government's "Bio-Refinery Roadmap", which it will be presenting in the middle of 2012, shows how well the government is equipped for designing a future ecology-based economy in the face of global competition.

Responsible ministries: BMBF, BMELV
Other ministries involved: BMI, BMU, BMVBS, BMWi, BMZ
Budget: The current budget provides for up to 570 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Intelligent restructuring of energy supply

Opting out of the nuclear energy programme and realising the transition to a new energy era in favour of renewable energies are extremely ambitious tasks, the success of which depends on close cooperation of politics, industry, science and society in general. Science in particular assumes an important role in promptly laying the necessary foundations and achieving technological breakthroughs to secure a sustainable energy supply in Germany. The government's 6th Energy Research Programme, which was started in August 2011, outlines the path of this foreward-looking project. It is the result of an extensive consultation process and was coordinated with research activities by private enterprises and scientific institutes. The Industry-Science Research Alliance will accompany this foreward-looking project.

This foreward-looking project draws its strength from the technical synergies of the ministries involved. This is reflected in the three inter-ministry research initiatives. The first initiative "Energy storage" has already been started. Two further initiatives on the topics of "Networks" and "Solar construction/ energy-efficient cities" will follow. The work group "New Technologies" from the "Future-Proof Networks" platform will also be presenting specific recommendations for setting research and development priorities. The coordination platform "Energy Research Policy" by the ministries will also be established on a national level with the *Länder* and on an international level with European research institutes to optimise the coordination of the research activities in the energy sector.

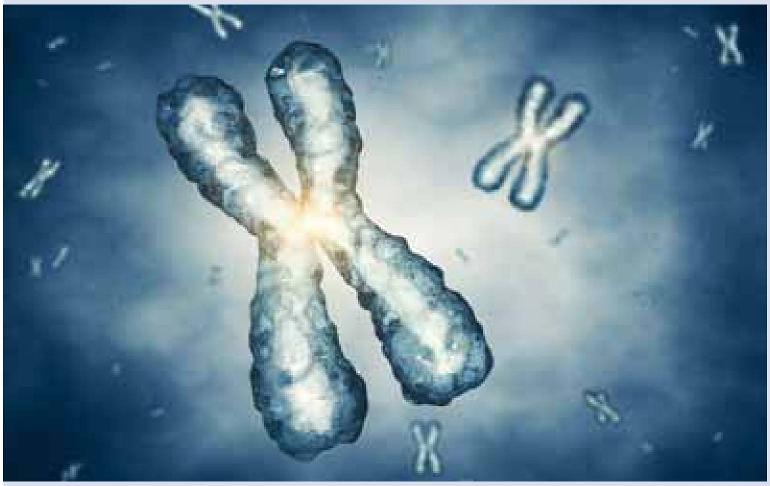
Despite its great commitment to funding research, the government believes that the main responsibility for researching and developing innovative energy technologies to achieve a successful transition to a new energy era lies with private enterprises, which is why they were also consulted when the 6th Energy Research Programme was drafted and will continue to be involved in the further coordination of these activities. The foreward-looking project "Intelligent Restructuring of the Energy Supply" reinforces the government's position that Germany can become one of the most energy-efficient and environmentally-friendly economies in the world.

Responsible ministry: BMWi
Other ministries involved: BMELV, BMVBS, BMU, BMBF
Budget: The current budget provides for up to 3.7 billion euros funding for the 6th Energy Research Programme. These funds will primarily be used to implement the foreward-looking project.

FOREWARD LOOKING PROJECT

Treating diseases more effectively with the help of personalized medicine

Modern molecular biology has inspired health research and opens up new perspectives for evidence-based medicine. Amongst other things, it aims to identify diagnostic markers that allow the risk of disease to be assessed, the success of therapies to be forecast and their progress monitored. Identifying and validating these biomarkers is one of the central objectives of individualised medicine, which was defined a research field for the first time by the federal government in its health research framework programme that was passed in December 2010. It is currently developing a plan of action that will be published in spring 2012 with the support of the Industry-Science Research Alliance and the Health Research Council.



Primarily, the federal government plans to fund research projects that build permanent bridges between basic research, clinical research and practical application in order to facilitate a more efficient medical service that benefits patients. It will therefore be concentrating on projects that are developed and implemented jointly by parties from the fields of science, clinical care and private enterprises. The research work will also be looking at the ethical aspects of individualised medicine, such as the prevention of discrimination. There is a range of information and training courses available to promote patient self-responsibility.

Individualised medicine is not only important for patient care; it is already playing an important role in the private sector. In the tumour therapy field in particular, a diagnostic test that forecasts the positive effect of a medicine is frequently becoming a prerequisite for appropriate treatment. At the end of 2011, there were already 16 active pharmaceutical ingredients in Germany. When developing these kinds of tests, most pharmaceutical companies seek to cooperate with small and medium-sized biotechnology companies as innovation partners.

The importance of individualised medicine has grown significantly in German universities, clinics and large research institutes. The Helmholtz Association wants to make this research field a special strategic cross-cutting task within its centres; the Fraunhofer-Gesellschaft is setting up its own project group; and the biological-medical institutes of the Max Planck Society are carrying out the necessary basic research.

By further networking public and private organisations in the individualised medicine field, the federal government believes it is on the right track to consolidating Germany's position in this rapidly growing global research field.

Responsible ministry: BMBF
Other ministries involved: BMG
Budget: The current budget provides for up to 370 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Better health through targeted prevention and an optimised diet

A healthy lifestyle can help to ward off illness. The future funding will primarily be used for prevention research to better understand modes of action, primary, secondary and tertiary prevention as well as health promotion. Investigating the benefit of preventive action will be of particular importance as well as issues relating to quality, efficiency and specific target group approaches. Prevention also needs to take into account the specific gender differences.

In addition, the demographic change means that more attention will be paid to the better use of preventive potential, also for older people. Alongside other lifestyle factors, correct nutrition also plays an important role. The specific correlations between nutrition, other lifestyle elements, such as sufficient exercise, dispensation with smoking, reduced alcohol consumption, genetic disposition and the environment, have not yet been adequately explored. One special area of research interest is the interaction between the various ingredients of foods and the human organism. As part of the foreward-looking project, the federal government will be presenting a “Prevention and nutrition research plan of action” in autumn 2012 that will outline the need for research into prevention and nutrition and also takes into account interface topics. The project will be accompanied by the Industry-Science Research Alliance.

Diabetes, cardiovascular ailments and cancer are widespread diseases whose cause is primarily put down to poor exercise and diet behaviour, and other lifestyle factors. The epidemiological data base for this hypothesis however is small and shall be improved by developing a “national cohort”. This, Germany’s largest population study to date, will be realised in a network comprising university and non-university research institutes. It will contain more than 200,000 people whose habits and state of health are monitored on a regular basis over a long period of time to identify reliable indicators for early diagnosis and prevention.

At the same time, the federal government wants to ensure greater scientific competence in the Food sector by promoting individual research locations and junior scientists. The current interdisciplinary competition “Innovations and New Ideas for the Food Sector” reflects its commitment in this field. It also wants to encourage the food industry to come up with more health-promoting innovations. Their strategies already pay serious attention to the individual health needs of the consumers. A large number of university and non-university research institutes, also the new German Centres for Health Research, are supplying valuable information for prevention and nutrition research. The foreward-looking project also provides important impulses on an international scale, for instance as part of the European Joint Programming Initiative “A healthy diet for a healthy life”.

Responsible ministry: BMBF
Other ministries involved: BMELV, BMG
Budget: The current budget provides for up to 90 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Living an independent life well into old age

The percentage of older people in the population is growing continuously. In 2030, 22 million people older than 65 will be living in Germany. This equates to 29 % of the total population. The demographic transformation to a society with high life expectancies poses challenges but also opportunities which need to be taken. Consequently, the federal government drafted and passed the research agenda "The New Future of Old Age" at the end of 2011 which will be managed by the BMBF. The lines of action of this foreward-looking project are oriented towards the agenda's six research fields. The Industry-Science Research Alliance will also accompany this project.

This foreward-looking project explores causes and consequences of the demographic change in Germany and how this affects the lives and roles of older people in society. This are basic questions of the first research field, which include the Berlin Aging Study II and the German Ageing Survey. Other lines of action of this foreward-looking project look specifically at issues relating to getting older. The aim is to develop new care concepts, techniques and services that not only take into account the demographic change but also raise the level of appreciation for older people. The project will be examining how older people can make use of their competence and experience in business and society and how their potential can be retained and tapped, for instance in mixed age work groups or in volunteer positions. In parallel to the government's Health Research Framework Programme, investigating the biological mechanisms of ageing will allow more people to age in a healthy manner. A further goal are building solution that allow older people to remain in their own homes safely and independently, barrier-free and possibly supported by age-appropriate assistance systems. To ensure that older people can participate in society, they need to be mobile and in contact with others. This necessitates both age-specific adaption of communal structures and also the development of age-appropriate mobility and communication technologies. It is imperative for the quality of life of older people and their families to develop in-depth concepts that allow dignified care to be administered – preferably in their own homes.

This foreward-looking project reflects the federal government's endeavours to actively and productively address the demographic change that affects most of the developed countries in the world. All generations will profit from the results of this foreward-looking project.

Responsible ministry: BMBF
Other ministries involved: BMAS, BMFSFJ, BMG, BMI, BMVBS, BMWi
Budget: The current budget provides for up to 305 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Sustainable mobility

Mobility is an indispensable prerequisite for personal freedom, social cohabitation and economic prosperity. However the growth in global traffic is taking up more and more space and resources. It creates noise, traffic jams and pollutes the air. In light of climate change, the growing global population and the limited supply of fossil resources, future mobility needs a new sustainable basis. The government has therefore ensured that the objective of this foreward-looking project is to develop highly secure models for sustainable mobility that not only reduce emissions and the impact on the environment, but which also enhance the competitiveness of the German economy. They are advised here by the Industry-Science Research Alliance.

The foreward-looking project is bound to the federal government's energy concept plans to reduce the final energy consumption in the traffic sector by 40 % by the year 2050 compared to 2005. In line with its strategic importance, it bundles the numerous research focal points and initiatives of the various ministries. The aim is to improve energy efficiency and environmental compatibility in the passenger and freight transport sectors. It will make an important contribution to realising innovative forms of private motorised transport, making public transport more attractive, modernising rail traffic, optimising air traffic and creating user-friendly intermodal interfaces. It will also endeavour to adapt the entire traffic infrastructure to the challenges of climate change. Future traffic planning in the cities will be aligned even more closely to the needs of the people.

An important component of the foreward-looking project is the government programme "Electromobility" that was started in 2011 and which aims to ensure that there will be one million electrical vehicles on Germany's roads by the year 2020. This necessitates close cooperation between the automobile manufacturers, suppliers, energy suppliers and ICT companies. Parallel to this, other alternative energy storage systems will be tested such as hydrogen and fuel cell technologies. Driver assistance systems that allow ICT-supported intelligent driving and electronic mobile information and services will further improve traffic safety and lead to additional energy savings. In light of the growing amount of freight traffic, it is extremely important that logistics processes are designed more effectively and transport flows are networked more efficiently.

This foreward-looking project by the federal government underscores its ambition to consolidate Germany's position as a leading supplier of sustainable mobility solutions in the face of the global challenges emanating from the growing traffic and transport flows.

Responsible ministries: BMVBS, BMWi
Other ministries involved: BMBF, BMELV, BMU
Budget: The current budget provides for up to 2.19 billion euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Web-based services for businesses

The Internet has rapidly become more than just a worldwide infrastructure for accessing information; over the years, it has become a platform for services available anywhere, anytime as reflected in the success of hundreds of thousands of different applications for all areas of life. Until now, these applications have primarily targeted private users, although increasingly business applications are also being integrated into the business processes of many companies and administration bodies. Internet-based services open up vast growth potential for both IT suppliers and also IT users. This foreward-looking project by the federal government, which is accompanied by the Industry-Science Research Alliance, takes this into account.

The foreward-looking project builds upon the research programme "THESEUS – New Technologies for the Internet of Services" that was started by the federal government in 2007. Under the auspices of THESEUS, technologies are developed that specifically aim to simplify access to information, to link data to new knowledge and create the basis for new services in the Internet. Decisive for this is the development of semantic technologies that can separate important and non-important information in a specific context. The foreward-looking project also incorporates the Leading-Edge Cluster "Software innovations for digital companies", which underscores Germany's important position in the company software sector. The heart of the further development of the foreward-looking project is the "Cloud Computing Campaign" that was started in 2011. In an open dialogue, parties from industry, science and politics address the challenges existing in the distribution and use of cloud computing. This includes issues such as standards, IT security and the legal framework. Cloud computing represents a paradigm shift for IT suppliers: They need to react with new business models. At the same time, cloud computing offers IT users many new possibilities. In the future, they will be able to design their IT more flexibly and efficiently allowing them to concentrate on their core business. The aim is to help small and medium-sized enterprises make the switch via the technology programme "Trusted Cloud" and the funding initiative "KMU-innovativ scheme: ICT".

The federal government aims to use this foreward-looking project to consistently improve Germany's competitive position in terms of the current rapidly growing Internet of Services.

Responsible ministry: BMWi
Other ministries involved: BMBF, BMI
Budget: The current budget provides for up to 300 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Industry 4.0

The private sector is on the threshold of the fourth industrial revolution. Driven by the Internet, real and virtual worlds are growing more and more into an Internet of Things. The main characteristics of tomorrow's industrial production are the high level of individualisation of the products under the conditions of a highly flexible (large series) production, the extensive integration of customers and business partners in business and value-added processes and the coupling of production and high-quality services that result in so-called hybrid products. The German private sector now has the opportunity to play an active role in designing the fourth industrial revolution. We want to support this process with our Industry 4.0 foreward-looking project.

The foreward-looking project Industry 4.0 is connected to important technology, commercial and socio-political location perspectives. In the field of (software-intensive) embedded systems, Germany assumed a leading position early on in the automotive and mechanical engineering sectors. Growing in importance are the so-called Cyber-Physical-Systems (CPS), i.e. the networking of embedded ICT systems with each other and the Internet. In addition to the rising level of automation in the industry, the development of more intelligent monitoring and autonomous decision processes is important in order to control and optimise companies and entire value-creation networks in almost real-time. The aim is to unlock new kinds of business models and significant optimisation potential in production and logistics. In addition to this, there are new services for important application areas, such as the demand fields of mobility, health, climate and energy identified in the High-Tech Strategy.

The government became proactive in the fields of Embedded Systems and Internet of Things at an early stage: evidence of this are the results of successful initiatives such as Digital Product Memory, Changeable Logistics Systems, Autonomics, NextGenerationMedia and excellence clusters, for instance the "Integrative Production Techniques for High-Wage Countries" and "Cognition for Technical Systems". The latest example is the Leading-Edge Cluster "Intelligent Technical Systems" from Ostwestfalen-Lippe ("It's OWL") that was selected in January 2012.

At the government's initiative, experts presented a "National Roadmap for Embedded Systems" back in 2009.

The new strategic direction for research in the fields of production, services and work design are also addressed in the realisation of the foreward-looking project Industry 4.0. The focal points of the "Smart Factory" issue lie on intelligent production systems and procedures and creating distributed and networked production facilities. Parallel to this, strategic funding will be provided within the foreward-looking project for the Internet of Things and the foreward-looking project Industry 4.0. Under the heading of "Smart Production", cross-company production logistics, man-machine interaction and 3D in industrial applications will also be explored more closely. It is of paramount importance here to encourage the close involvement of small and medium-sized enterprises as suppliers and users of "smart" production methods. The foreward-looking project will be supported by the Industry-Science Research Alliance.

Responsible ministries: BMBF, BMWi
Other ministries involved: BMI
Budget: The current budget provides for up to 200 million euros funding for this foreward-looking project.

FOREWARD LOOKING PROJECT

Secure identities

Trust is priceless and the basis for all dependable relationships. Trust can also be created in the Internet if people can be sure that their own and others' identities are just as safe as in real life. The government has set up this foreward-looking project under the auspices of the BMBF and the BMI to show how this can be achieved. Safe identities will allow users to exercise their right to self determination where information is concerned in the worldwide web and at the same time, form the solid basis for business in the virtual world. This allows web-based business models to enjoy sustained growth and efficiently combat the problems of cyber criminality, such as identity theft and fake websites, which are still widespread today. This foreward-looking project works in close cooperation with the foreward-looking projects "Internet-based services" and "Industry 4.0" and is accompanied by the Industry-Science Research Alliance.

The federal government's Cyber Security Strategy presented in 2011 plans to ensure the highest possible level of security in the Internet in Germany without compromising the benefits and possibilities it offers. In addition to establishing the National Cyber Response Centre and funding three competence centres for IT security research as technological participants, the government will also focus on research and interdisciplinary approaches to socio-scientific issues. First examples, such as the issue of "Safe identities", which have already been started, are the nationwide introduction of the new identity card with its online identity function, DE-Mail for safe electronic communication and the technology programme "Trusted Cloud". A new area is the research into safe cloud computing as a separate line of action within the foreward-looking project. Parallel to this, research at the technology level will focus on security of critical IT infrastructures and basic research in the field of safe, trusting hardware. Funded by the federal government and coordinated by acatech, the interdisciplinary project "Internet-Privacy – a culture of privacy and trust in the Internet" has been started. First recommendations for action will be presented by the project participants at a symposium in March 2012. There can be no national island solutions for safe identities in the global Internet; cooperation at the European and international level is therefore an integral part of the foreward-looking project. The federal government has already appointed a coordination team for cyber foreign policy. In the medium-term, the federal government wants to use this foreward-looking project to claim a "Pole Position" for Germany and set worldwide standards for a trustworthy Internet "Made in Germany".

Responsible ministries: BMBF, BMI
Other ministries involved: AA, BMVBS, BMWi
Budget: The current budget provides for up to 60 million euros funding for this foreward-looking project.

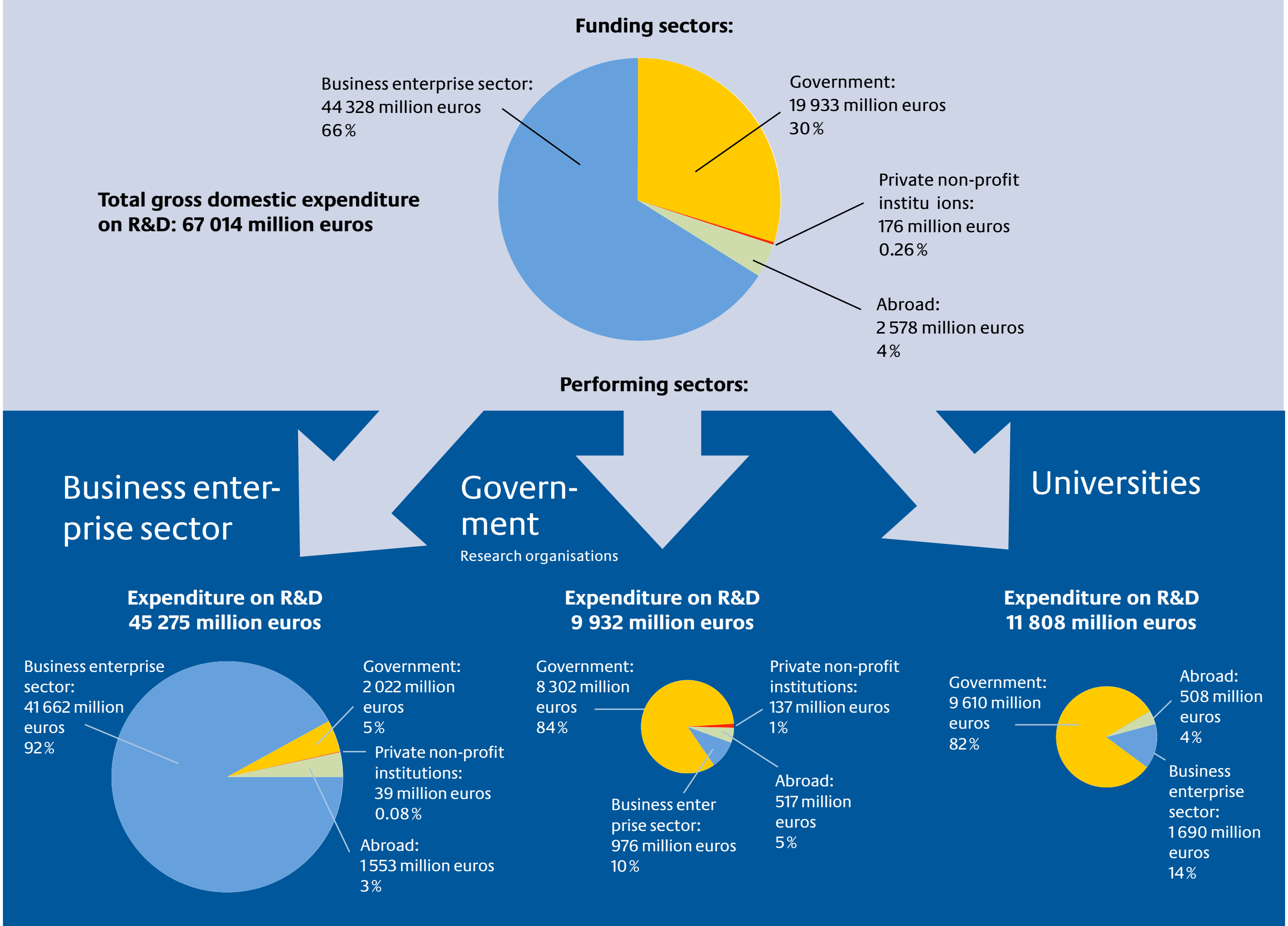
Part II: Structures, Resources and funding measures of the German research and innovation system

The German research and innovation system has an outstanding reputation across the world and can look back on a long tradition. Results of basic research and applied research and development (R&D) have always been the main drivers of social and economic development in Germany.

Although national research and innovation systems share similarities across the world, they are all subject to continuous change to their specific forms, resulting from social, economic and political developments.

The complexity of funding research and innovation is apparent in this context. It is obvious that in the future, Germany's competitive edge will largely depend on the strength of its research and innovation system. In light of social and global challenges, we still need a diverse research landscape that is characterised by a variety of different institutions and participants. Close interaction between basic research, applied research and industrial development is an important requirement for ensuring that research results become innovations.

Fig. 6 **Gross domestic expenditure on research and development (GERD) by the Federal Republic of Germany by funding and performing sectors 2009**



Basis of data: Table 1 – data for 2009

1 The German research and innovation system

There are complex correlations between the sectors that undertake research and development and the financing sectors. Figure 6 outlines these correlations.[3]

1.1 Where do research and development take place?

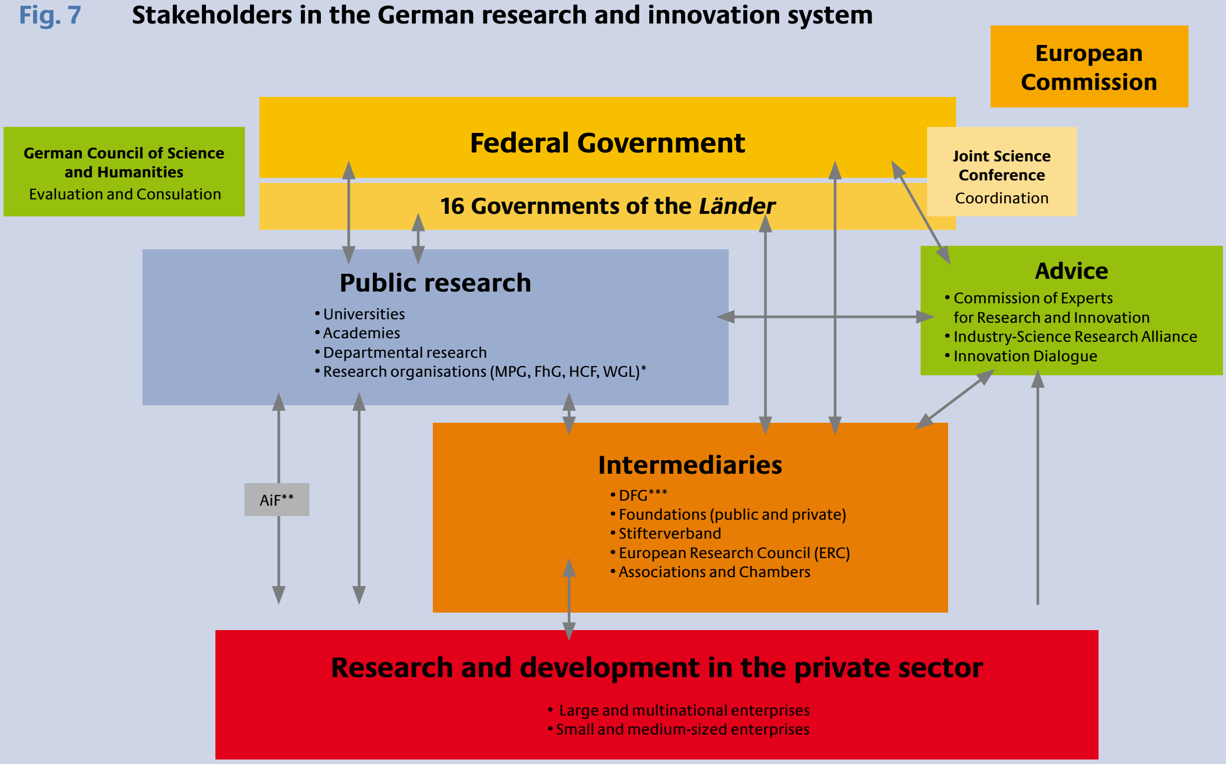
Figure 7 shows where research and development is carried out in various public and private institutions and their interrelationships.

Public institutions, private non-profit institutions

Public facilities are primarily the universities – universities and universities of applied science. Whilst university research is characterised by its thematic and methodological breadth, the universities of applied science tend to concentrate on application-orientated research. One of the main tasks of both types of universities is training junior scientists.

In addition to the research carried out by the universities, there is also a wide range of non-university research carried out by private non-profit institutes. Besides the various academies,

Fig. 7 Stakeholders in the German research and innovation system



* Max Planck Society for the Advancement of Science (MPG), Fraunhofer-Gesellschaft (FhG), Helmholtz Association of German Research Centres (HGF) Gottfried Wilhelm Leibniz Scientific Association (WCL)
** German Federation of Industrial Cooperative Research Associations "Otto von Guericke" (AiF)
*** German Research Foundation

3 Private non-profit institutions: In national reports, this sector primarily comprises non-profit organisations financed by the state (e.g. HGF, MPG, FhG) and the private non-profit organisations that are neither predominantly financed by the state nor business or do not mainly provide services for companies in the economy.

foundations etc., there are four research organisations with various profiles and focal points that play a special role. The institutes of the Max Planck Society (MPG) in particular concentrate on free basic research in innovative fields. The thematic focal points lie in the biological-medical, physical-chemical, social science and humanities fields. The Fraunhofer-Gesellschaft (FhG) focuses more on application-orientated research. In particular, it carries out research for industry, service companies and public organisations. The Helmholtz Association (HGF) comprises 18 natural science, technical and medical-biological research centres which concern themselves with the task of monitoring the long-term goals of the government and society in general. In cooperation with university and non-university institutions, strategic-programmatic leading-edge research is carried out in six fields: energy, earth and environment, health, key technologies, structure of matter and aerospace, space travel and traffic. Also, the Leibniz Association (WGL) comprises 87 institutions that focus on application-based basic research and provide a scientific infrastructure. There are numerous cooperations with universities and companies as well as public administration.

Institutions of the federal government and the *Länder* governments that carry out departmental research

Research and development activities by the federal and state governments serve the preparation, support and implementation of political and administrative action and are linked to accomplishing sovereign tasks. Regardless of whether the issue is health and nutrition, climate protection and energy, mobility or security – political decisions need an in-depth scientific base before decisions can be made. The departmental research organisations work closely with the departments to identify important challenges for tomorrow's society and draft possible courses of action for state measures.

Also, departmental research provides important, in part statutory, research-based services for commerce and society in the fields of testing, approval, the drafting of regulations and monitoring. They are particularly involved in drafting and updating statutory regulations and standards. In addition, federal institutions with research and development asignments support junior scientists and run national, international and supranational expert systems and databases as well as science-based measuring networks.

This complex and broad range of tasks is realised by 40 federal institutions with research and development asignments and a further 6 R&D institutions with which they work on a permanent basis. The addresses and brief descriptions of the federal and state institutions with research and development asignments are provided in the appendix of the full version of the BuFI 2012. This also contains Internet links to research programmes and quality assurance measures carried out by the institutions.

Business

The business sector plays an important role in the German research landscape. Around two thirds of the research funds invested in Germany every year for research and development are provided by the private sector. These funds are used for research within the individual companies and also for joint projects with science partners. The research that is carried out in this sector is by nature strongly oriented toward application and is specifically designed to produce results that can be directly exploited. Basic research plays a subordinate role in the business sector.

The diversity of the German research and innovation system is also a result of the federal structure and size of the country. It is characterised by a broad range of research fields and also allows a high level of specialisation in core areas. A further important factor for the success and performance capability of German research is the willingness of the various participants to cooperate (e.g. by forming research associations between non-university research institutes, universities and companies).

The complementary effect of private and publically funded research and development opens up opportunities for joint research projects and their financing. These kinds of cooperative structures can be considered an important indication of a highly developed and diversified R&D landscape that can truly develop its full potential when all parties work hand-in-hand.

1.2 Who funds research and development?

The sophistication of the German research and innovation system is also reflected in the way it is financed. R&D projects in publically financed institutions are financed using external funds; private research on the other hand is also partially publically funded. Additionally, the research framework programmes of the European Commission are also important for the R&D landscape in Germany.

In total, the share of expenditure for R&D in Germany in 2009 was 2.82 % of the gross domestic product. The BMBF estimates that in 2010 R&D expenditure will total around 2.82 % of the gross domestic product. In absolute figures, the total expenditure for R&D (federal government, states and the business sector) rose from 55.7 billion euros annually to 67 billion euros between 2005 and 2009, an increase of 20 %. It is expexted that the R&D expenditure for 2010 still will be around 70 billion euros. Figure 8 illustrates the expenditure by parties involved in R&D in Germany, their research character and how they are financed.

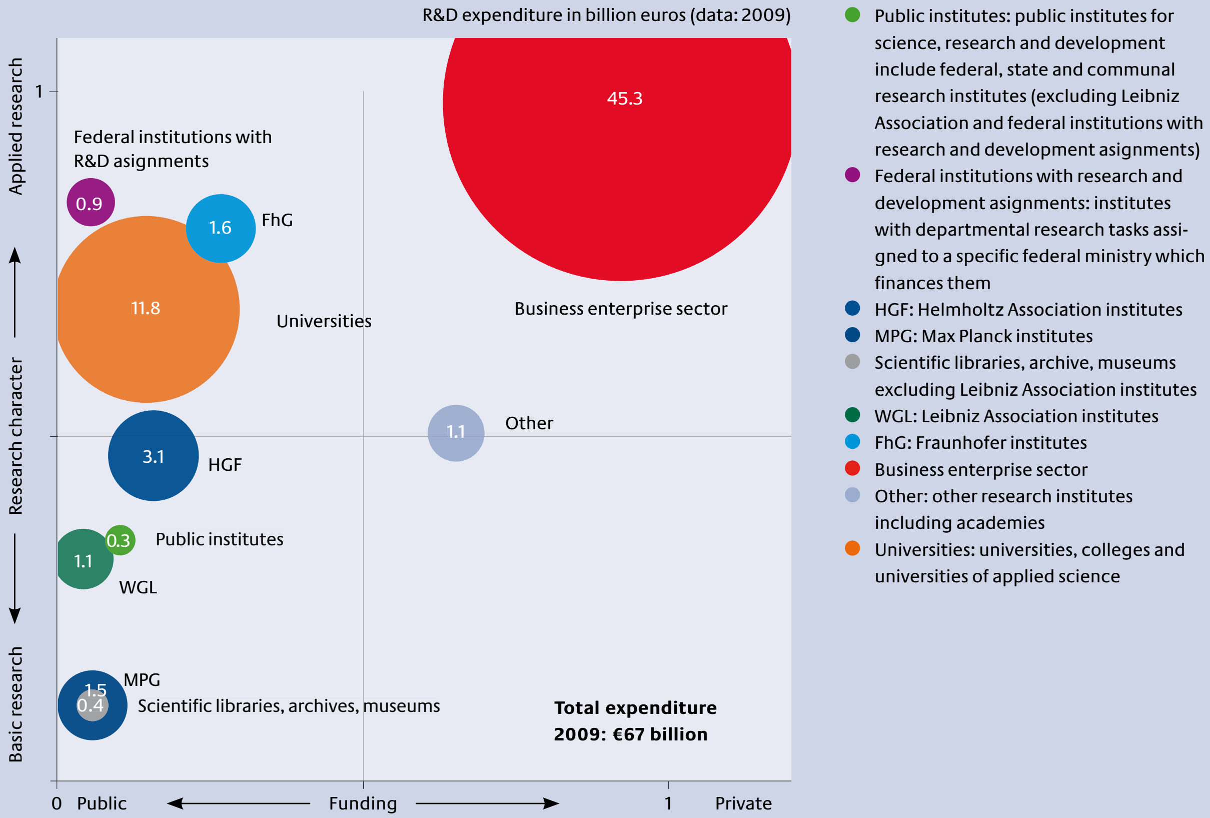
1.2.1 Stakeholders in German research funding

The federal government and the *Länder*

The federal system of the Federal Republic of Germany provides both the federal and also the state governments in their respective spheres of responsibility the opportunity to fund research without the necessity for special funding laws.

Also, the federal government and the *Länder* can cooperate in terms of the funding of institutions and scientific research

Fig. 8 **The German research landscape**



The horizontal dimension "Funding" indicates the share of the business enterprise sector in the funding of the R&D activities of the respective institutes. A value of "0" indicates 0 % funding by the business enterprise sector; a value of "1" indicates 100 % funding by the business enterprise sector. The vertical dimension "Research character" is calculated on the basis of publications (SCI publications per researcher) and patents (patent registrations per 1,000 researchers). An institution group lies closer to a value of "0" (maximum orientation to basic research), the higher its publication rate and the lower its patent rate is. Inversely, an institution group lies closer to the value "1" (maximum orientation to applied research), the higher its patent rate and the lower its publication rate is.
The following values were estimated: "Funding" for HGF, MPG, scientific libraries, archives, museums and "other". "Research character" for public institutes, scientific libraries, archives, museums, business enterprise sector and "other". In contrast to the procedure described above, the research character for the federal institutions with research and development asignments was estimated via the special role of these institutes in the field of standardisation and not via the patent and publication rates.
The dimension "Research character" used the mean values for the universities and universities of applied science. The relative application-related position of the universities is especially due to the very high patent rates in the universities of applied science. The position of the "bubbles" of the individual institute groups in the coordinate system is oriented to the middle points of the circles. The coordinates of the middle points correspond to the respective horizontal and vertical scale values.
The basis for the funding data: Table 1 for R&D expenditure by the business enterprise sector according to the implementing sectors: Table 26 and 28 (see full version of the Federal Report on Innovation and Research 2012, in German only) for R&D funding of the remaining R&D institute groups; other sources for industrial funding percentages: FhG annual report 2010, Rest: estimates: source for patents and publications: European Patent Office: Patstat – Science Citation Index: SCISearch – Federal Statistical Office: series 11, number 4.3.2, series 14, number 6 – calculations and estimates by the Fraunhofer-ISI and ZEW.

projects of supraregional importance pursuant to Art. 91 b of the constitution. This reflects the joint responsibility of the federal government and the *Länder* for research, which in many cases calls for coordinated action in the interest of the nation as a whole.

The government's share of the state R&D expenditure alone was increased from approx. 9 billion euros in 2005 to 12.8 billion euros in 2010. In 2011, the federal expenditure for R&D rose again to 13.7 billion euros (budget); the budgeted R&D expenditure for 2012 totals around 13.8 billion euros. This, for instance, provides support for research in science sectors that have (as yet) no direct impact on technological and economic development but which serve the interests of society because basic research is an impetus for application-orientated research branches. Also, the science system trains qualified junior scientists which makes funding highly important in this area.

Business

The internal R&D expenditure by the business sector in Germany in 2010 totalled 46.9 billion euros (+ 3.7 % more than the previous year). An evaluation of the sector highlighted significant differences: around 37 % of the internal R&D expenditure by the business sector was invested in automotive engineering. Around 16 % of the expenditure was used for electrical engineering R&D. This was followed by mechanical engineering with approx. 10 %, the pharmaceutical industry with approx. 8 % and the chemical industry with approx. 7 %.

In Germany, around two thirds of all gross domestic expenditure for R&D is financed by the business sector (cf. Table 1 in chapter 5). In 2009, the share of the R&D activities financed by the business sector totalled 1.85 % of the gross domestic product. In 2005, this value was only 1.68 % of the gross domestic product.

Increasingly, the business sector carries out R&D with partners from business and science. In 2009, around a fifth of the R&D expenditure was spent on external research projects (at other companies, universities, state research institutes etc.). By comparison: in 1995 this totalled a tenth, in 2002 a sixth of the R&D expenditure.

Of the expenditure spent by companies on R&D carried out by external parties, around two thirds remained with domestic companies. Almost a fifth of the R&D orders were contracted to foreign organisations; in particular, companies in the chemical and pharmaceutical industry have more R&D capacity abroad than domestically. Around a tenth of the external R&D expenditure by the business sector went to universities and university professors.

1.2.2 European Union

The research framework programmes managed by the European Commission are playing an increasingly important role within the R&D funding structure. In addition to the significant financial importance of EU funding for the various specialist fields, the European research programmes also play an important role in networking science and research in Europe, thereby helping to develop a European research field and define the worldwide profile of the European research landscape. The main goal of the 7th EU research framework programme is the continuity of the content and instruments; the budget for this has been set at approx. 54 billion euros for the years 2007 to 2013, which is much higher than the previous programmes. The installation of the European Research Council (ERC) however represents a new, independent and knowledge-driven funding structure for research; it aims to fund a new type of basic research (pioneer research) in a European competition in which the sole criteria for selecting the projects is their excellence.

In addition, there are two further cooperation mechanisms, COST (European Cooperation in Science and Technology) and EUREKA (a pan-European network for market-oriented, industrial R&D) that provide a framework for cooperation between research institutes and companies in Europe without providing direct funding. These cooperation systems, which operate solely in the interest of science and business, are an excellent supplement to the European framework programmes in variable geometry. The cooperation between EUREKA and the European Commission was continued successfully and intensified further via the joint funding programme Eurostars. Eurostars is an R&D programme pursuant to Article 169 of the EC Treaty (Art. 185 AEUV) that targets small and medium-sized research enterprises. During the course of the programme between 2008 and 2013, participating nations will have access to around 300 million euros, a sum that will be topped up by a further 100 million euros from the European Commission.

The EU Lifelong Learning Programme, which has a total volume of around 7 billion euros for the years 2007 to 2013, not only focuses on extensive exchange activities, in particular transnational projects to improve the quality of the education systems; it also funds transnational networks in university and vocational training research fields.

1.3 How does government funding for research and innovation work?

Functional state research and innovation funding requires several pillars. The legal foundation is stipulated in the constitution. In compliance with the statutory framework, the federal government and the *Länder* work together on state research funding. The federal government and the *Länder* have several instruments that they use to facilitate targeted research funding: project funding, institutional funding and the financing of departmental research.

1.3.1 Legal principles

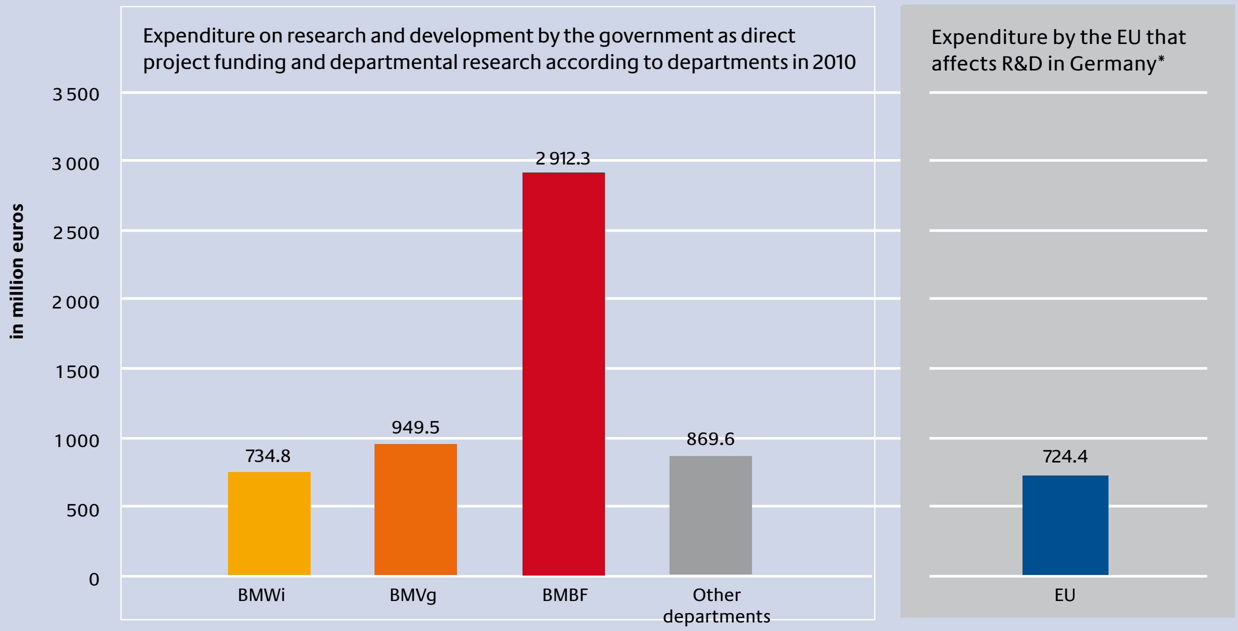
Funding research and development is the joint responsibility of both state and society. Internationally competitive research and the freedom of science anchored in Art. 5 Par. 3 of the constitution necessitate appropriate financial framework conditions. The financing competencies of the federal government and the *Länder* are defined in the constitution.

The main constitutional regulations governing the joint funding of science and research by the federal government and the *Länder* are laid down in Art. 91 b of the constitution. According to these regulations and based on agreements relating to projects of supraregional importance, the federal government and the *Länder* can work together to fund

- institItions and scientific research projects outside universities,
- science and research projects at universities,
- research buildings at universities including large equipment.

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

Fig. 9 Expenditure on research and development by the government as direct project funding and departmental research according to department and expenditure by the EU that affects R&D in Germany



Including expenses for orders as part of the departmental and military research and development and for further developing universities and science and realising equal opportunities for women in research and teaching.
*As the budget for the 7th research framework programme (programm term 2007–2013) increases exponentially over time and therefore the annual instalments of the expenditure by the EU that affects R&D in Germany also increase annually, it makes little sense to select a deadline year for the German allocation percentage of the EU project funding. Therefore a mean value of the previous period is stated.

Source: BMBF, EU data: ECORDA contract database for the 7th FRP

international research institutes. The federal government and the *Länder* also have financing competencies connected to the completion of sovereign tasks and providing advice for political and administrative decisions (departmental research).

1.3.2 Cooperation between the federal government and the *Länder*

In compliance with the constitution of the Federal Republic of Germany, the federal government and the *Länder* work together in the state research funding field. This not only involves the research and science ministries at the federal and state level, but also other departments (e.g. economy, agriculture and consumer protection, environment and health).

The Joint Science Conference (GWK) offers a forum for exchange and the coordination of the science and research policy. It also serves the joint cooperation for the funding of research organisations and projects of supraregional importance as a decision committee (e.g. in the Excellence Initiative and the Higher Education Pact).

The German Council of Science and Humanities (WR), comprising scientists, public figures and representatives of the federal government and the *Länder*, advises the federal government and the *Länder* with regard to the content and structural development of the universities, science and research.

1.3.3 Federal funding instruments

The research and development is funded by the federal government through target-oriented, short to medium-term research funding (project funding) and also medium and long-term institutional funding as well as within the framework of departmental research.

Project funding

The project funding – in particular by the Federal Ministry of Education and Research (BMBF), the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) and by the Federal Ministry of Health (BMG) – is distributed via funding and special programmes based on applications for fixed-term projects. In addition to individual projects, combined projects with several equal-ranking partners may also be financed.

Direct project funding is always specific to one research field. One of the objectives here is to reach and maintain a high international performance level in research and development for selected areas.

The goal of indirect project funding is to help research institutes and companies – in particular small and medium-sized enterprises – in their R&D endeavours. It targets, for instance, the development and strengthening of research infrastructure, research cooperation, innovative networks and the transfer of staff between research institutes and the business sector.

Departmental research projects are also financed. R&D projects are awarded by the department or institutions with research and development asignments. The projects are funded by the government within the legal and political framework conditions applicable at the European and national level.

At the European level, the European Commission's community guidelines for State aid for research, development and innovation plays a decisive role. In particular, the national framework conditions result from the Federal Budget Code (Bundeshaushaltsordnung) and the Federal Budget Act (Bundeshaushaltsgesetz). The scientific-technical aspects and administrative side of the funding projects are primarily supervised by project managers, who are appointed to advise the persons submitting the project request, to draw up the funding decision, to process the projects and check the success (including exploitation of the results).

Institutional funding

Institutional funding not only refers to individual research projects but also to the overall operation of and investments in research institutes that are funded for longer periods by the federal government or jointly by the federal government and the *Länder*. This secures the research infrastructure, competence and strategic direction of the German research landscape. Important examples of this are the payments made by the federal government and the *Länder* as part of the joint research funding pursuant to Art. 91 b of the constitution, e.g. to the research organisations Helmholtz Association, Leibniz Association, Max Planck Society and Fraunhofer-Gesellschaft.

Institutional funding is linked to stringent requirements and therefore also accountability.

Departmental research (including contract research)

As part of the federal administration, the institutional core of departmental research lies with those institutions with research and development asignments. These are assigned to a division of a specific federal ministry that also finances them. In 2010, there was approx. 830 million euros available for institutions with research and development asignments. This was used to carry out 6.5 % of the public R&D work by the government within the scope of departmental research. Part of these funds are used for placing, monitoring and analysing external R&D projects (extramural processing of R&D projects) undertaken by institutions of the science system. The institutions with research and development asignments that carry out departmental research are an important component of the national and international science system and have outstanding scientific infrastructures.

2 Federal goverment’s research and innovation policy

Public funding of research, development and innovation in Germany is primarily the task of the federal government, which coordinates its research and innovation policy with the *Länder* and also pursues the goal of stimulating research and development activity in the economy and offering targeted support.

Since 2006, the research and innovation policy of the government has been aligned to the principles of the High-Tech Strategy for Germany (HTS). This represents the first comprehensive national innovation strategy with which the existing scientific-technical competences are summarised and specifically expanded. In 2010, the success of this new approach logically led to the development of the follow-on High-Tech Strategy 2020 which focuses on current and future challenges in Germany and across the world and identifies five demand fields: climate/energy, health/nutrition, mobility, security and communication. The plan of action for the implementation of the HTS describes 10 foreward-looking projects for these fields stating clear objectives and milestones. The objective of the High-Tech Strategy is to ensure that Germany becomes a pioneer in these demand fields in terms of solving the global challenges and providing answers to urgent questions posed by the 21st century.

Supporting initiatives and programmes for funding key technologies and optimising framework conditions for research, development and innovation are just as important as the consistent consideration of cross-cutting issues (e.g. funding junior scientists). Via the HTS, new value creation potential for the economy is developed and qualified, future-proof jobs are created in Germany.

The federal government research funding also comprises activities for education research or research in the humanities and measures for small and medium-sized enterprises. Part II B of the full version of the Federal Report on Research and Innovation 2012 (in German only) provides an overview of the entire range of research and innovation funding by the federal government.

The health and nutrition demand field comprises the government’s research and innovation policy in the fields of health, medical technology, research and development for nutrition, agriculture and consumer protection:

Health research aims to establish basic new insights into how to retain good health and fight disease and to also develop solution concepts for existing and future social challenges.

Safe and tasty food, a healthy diet and dynamic regions that offer their inhabitants both work and relaxation and where the natural environment and the animals are protected are basic human needs. The agricultural, forestry, fishing and nutrition sectors, as well as research can make significant contributions here.

Measures in the climate and energy demand field concentrate on three main areas of funding: climate, environment, sustainability, and energy research and energy technology as well as regional planning and urban development:

What we know today about the way the climate is developing leaves no doubt about what we will face in the future: The climate has already changed and will continue to do so. The policy of the federal government therefore not only focuses on action aimed at reducing the quantity of climate-damaging substances to slow down the speed of climate change, but in particular on comprehensive protection and adaption measures. Taking precautions and improving resistance in all sectors is the goal of the German Strategy for Adaptation to Climate Change (DAS).

The structural change to a sustained power supply system needs forward-thinking innovations. Application-orientated and basic research funding aims to clear the way so that renewable energies and efficient technologies can penetrate the market. Research looks at a broad range of areas so that as many options as possible can be developed for energy policy decisions.

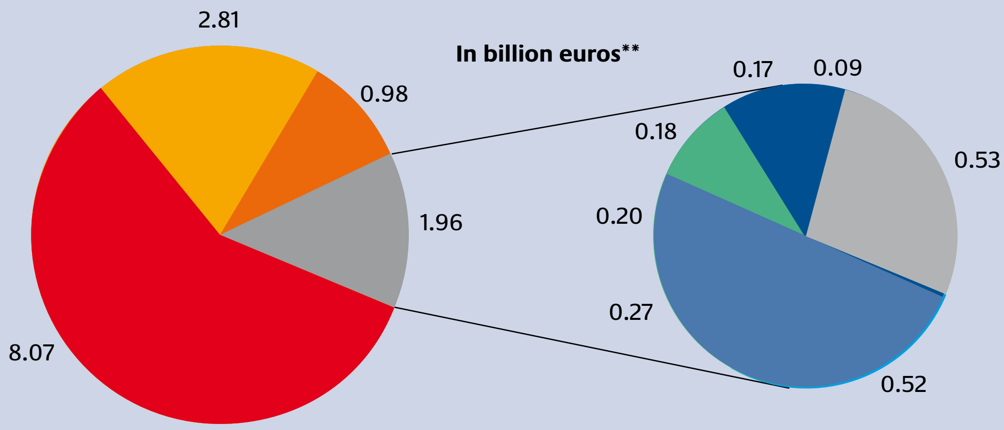
The major area of regional planning, urban development, living and building research comprises, amongst others, indicator-supported research of regional planning and urban development, forecasts for the housing and real estate markets, the evaluation of funding programmes, devising strategies and concepts and the further development of housing and urban development policy instruments that support sustained regional planning and urban development.

The mobility demand field comprises activities relating to vehicle and traffic technologies including maritime technologies and mobility and traffic research:

The federal government is aware of the fact that mobility is indispensable for economic growth, services for the public and quality of life and that special attention needs to be dedicated to innovation strategies in this field. Overcoming the challenges caused by growing mobility standards and requirements in a globalised world dominated by the division of labour, requires enormous effort both in research and development and also in implementing new and innovative solutions as well as funding emission-free modes of transport.

The focal points of research into information and commu-

Fig. 10 **Expenditure on science, research and development by the government according to department 2012 (target)**



- Federal Ministry of Education and Research
- Federal Ministry of Economics and Technology
- Federal Ministry of Defence
- Other departments
- Federal Ministry of Food, Agriculture and Consumer Protection
- Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
- Federal Ministry of Transport, Building and Urban Development
- Federal Foreign Office
- Federal Ministry of Health
- Federal Chancellery (including representative of the federal government for culture and media)
- Sum of the remaining unlisted departments

*Status: Bill of the federal government dated 12.8.2011
**Differences are possible when adding up due to the rounding of billion euro amounts

Basis of data: Table 4

nication technologies are represented by the funding granted in the communication demand field:

The role of information and communication technologies (ICT) for business and society in general is manifold, which is why only an equally comprehensive research and innovation policy can lead to success in the long term. Harmonised to the High-Tech Strategy 2020 and the ICT Strategy of the German Federal Government: Digital Germany 2015, the goals of a policy of this kind are to address major challenges, to improve competitive ability and enhance information technology security.

The security demand field encompasses research into civil security and all peace and conflict research: The objective of security research funded by the federal government is to improve the civil security of the citizens and to protect critical infrastructures, whilst simultaneously maintaining a balance between security and freedom.

The key technologies demand field consists of activities in the areas of biotechnology, nano-technology and materials technology, optical technologies, production systems and technologies as well as aerospace:

Research and development in key technologies is essential for solving social challenges, particularly within the key areas of health, climate protection/conservation of resources/energy, security and mobility. Without innovations driven by key technologies, it would not be possible to develop modern medicines or reduce CO_2 emissions from road traffic.

Other focal points of German research and innovation funding include research into the improvement of working conditions and in the service sector, research into innovations in education and in the fields of humanities, economic and social sciences.

One special focal point of the government's research and innovation policy is the innovative small and medium-sized enterprise sector in Germany for which special research funding measures have been set aside.

In 2012, the government intends to spend 13.8 billion euros on research and development.

3 Research and innovation policies of the *Länder* governments

The federal structure of the Federal Republic of Germany makes it possible for the regional capabilities, resources and infrastructure of the 16 *Länder* to be developed and utilised, whilst taking into account the individual circumstances. In addition to the activities of the Federal Republic, the 16 *Länder* implement a variety of state-specific research, technology and innovation policy funding measures.

In doing so, the specific strengths of the individual regions in terms of technology, industry and innovation are addressed and existing spatial structures and characteristics are taken into account. These state-specific funding activities complement the overall measures in place. As a result, the *Länder* can have funding measures in the same technology context but with different focal areas.

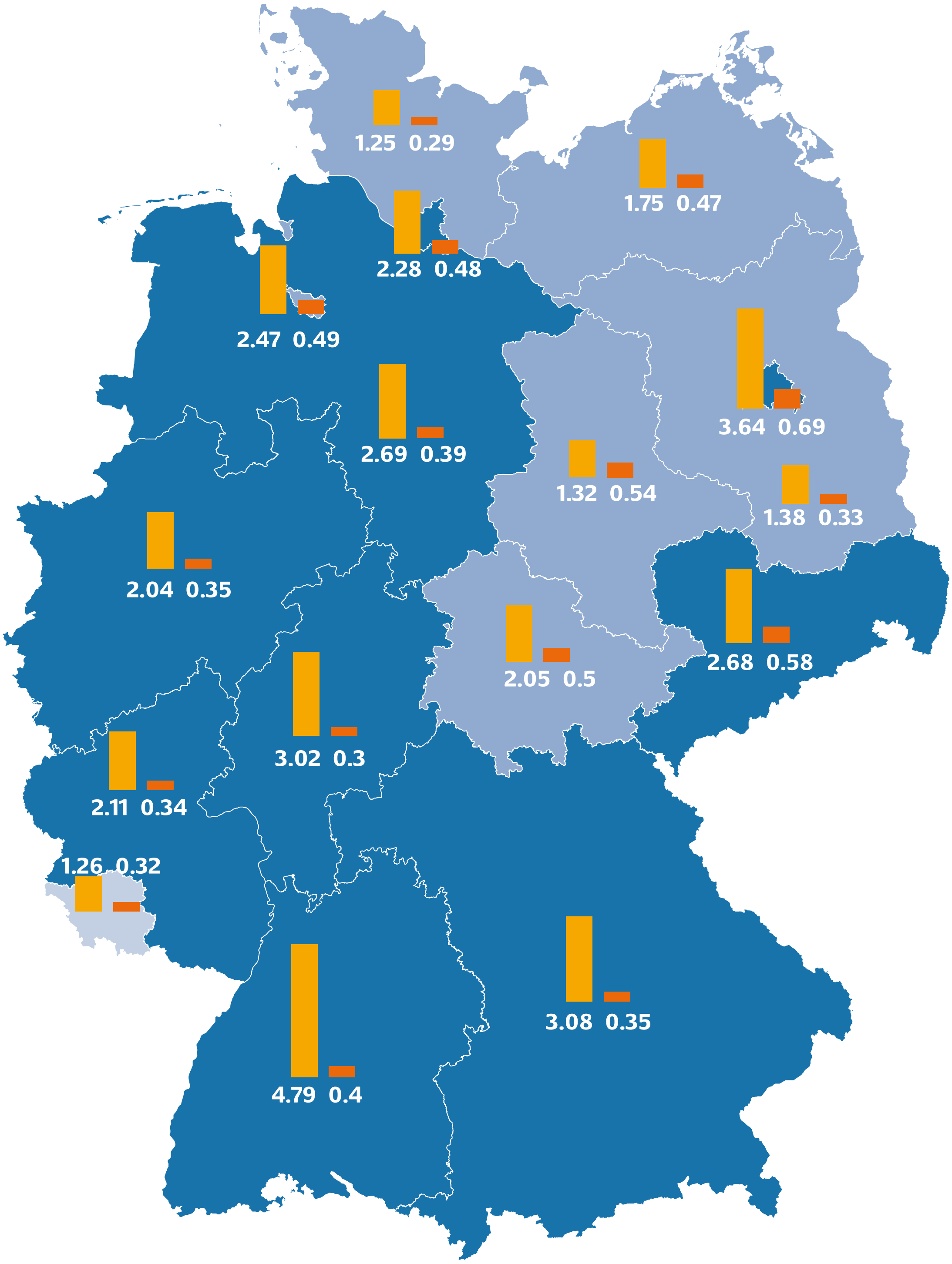
Whilst all the *Länder* have initiatives, e.g. for the information and communication technologies, medical technologies or environment technologies, they all have different priorities. Increasingly, the *Länder* are undertaking measures in the fields of security technologies and electro mobility. Many state-specific innovation programmes are of particular importance in supporting structural change, i.e. if traditional industrial locations develop into modern high-tech and service centres.

These different regional research and innovation funding measures as well as the addressed priorities are crucial to strengthening the German research and innovation system as a whole. Figure 11 provides an overview of the regional breakdown of expenditure on research and development (performance and financing of research and development) in 2009.

You can find a more detailed description of the research and innovation policy of the states in the long version of the Federal Report on Research and Innovation 2012.

Inside view of the KATRIN research centre in Karlsruhe

Fig. 11 **Regional distribution of the expenditure on research and development by the Federal Republic of Germany (performance and funding of research and development) (2009)**



R&D expenditure by the *Länder* (funding of R&D; 2009)

- Total expenses in % of the GDP by the federal state (implementation)
- Government expenses in % of the GDP by the federal state (funding)

Total expenditure on R&D by the *Länder* (implementation of R&D)

- < 500 million euros
- 500 – 1,000 million euros
- > 1,000 million euros

Explanations of the abbreviations R&D = research and development
GDP = Gross domestic product

Source: Stifterverband Wissenschaftsstatistik; Federal Statistical Office
Calculations of the Federal Ministry of Education and Research
Other data: www.datenportal.bmbf.de/portal/Tabelle-1.1.11

4 International cooperation on research and innovation

4.1 Strategy of the Federal Government for the Internationalization of Science and Research

In conjunction with the High-Tech Strategy, the Joint Initiative for Research and Innovation, the Higher Education Pact and the Excellence Initiative, the German Federal Government's strategy, which was adopted in 2008, for internationalising science and research is a key element of its research and development policy in this legislation period, too.

Enhancing research cooperation with the world's best

Worldwide networking is achieved by, amongst other things, better integration into European processes, such as the EU's research framework programme for the coordination of major projects (ESFRI process). Globalisation not only strengthens global competition, it also opens up new opportunities and options. Today there are a number of attractive partner locations across the world. Increasingly, this international research cooperation with the best will be used for an excellence-driven innovation policy in Germany at the interface between science and business. The improved framework conditions in recent years, e.g. the implementation of the EU Researcher Directive that grants residence permits for research and the easier access to the labour market for family members in Germany since 1st January 2009, have started to take effect. Academic exchange organisations, such as the German Academic Exchange Service (DAAD) and the Alexander von Humboldt Foundation have expanded their subsidy services with funds from the Federal Foreign Office (AA), the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Cooperation and Development (BMZ), thereby creating the prerequisites for better integration of the German research landscape in the global science circuits. The Alexander von Humboldt Professorship – at 5 million euros the best-endowed international research award in Germany – is a prime example of the successful integration of internationally recognised academics into the research and teaching work at German universities

Infobox

Strategy paper by the German Government: Shaping Globalization – Expanding Partnerships – Sharing Responsibility

For the term "new players", please see section "International networks for education, science and research".

The strategy was approved by the federal cabinet on 8th February 2012.

www.auswaertiges-amt.de/EN/Aussenpolitik/GlobaleFragen/G20/120208_Vorstellung_Gestaltungsmaechtekonzept_node.html

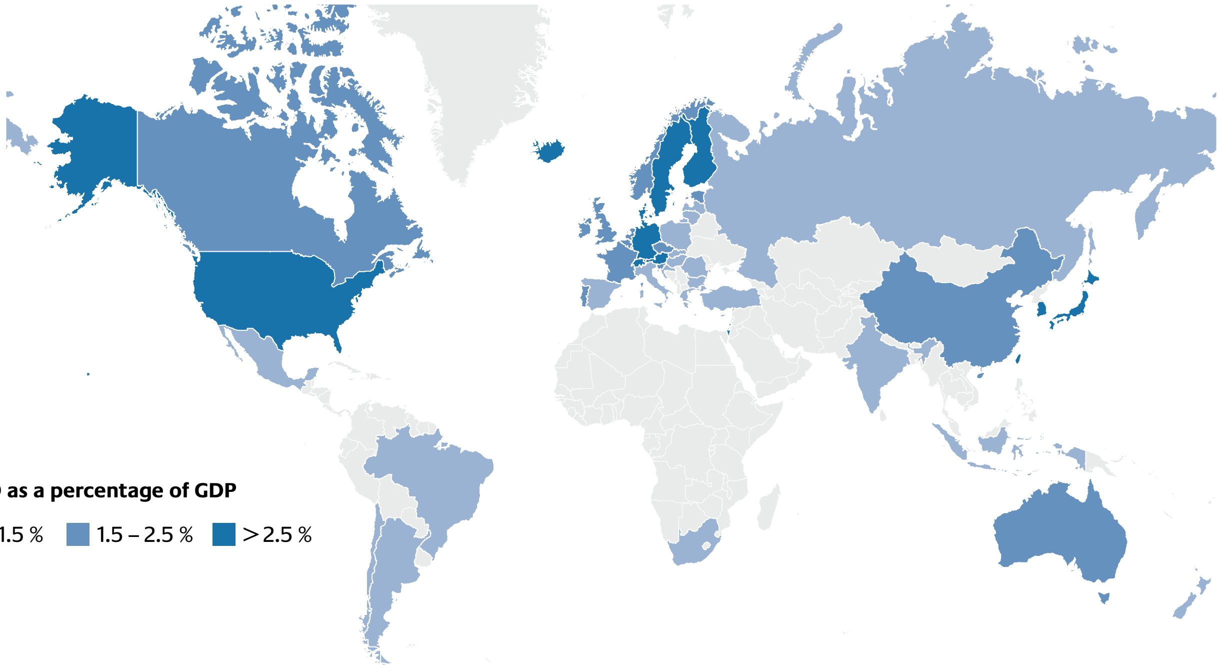
Opening up international innovation potential

Qualified experts play an important role when developing innovation potential. In addition to university, professional further training is a key factor for innovation and the competitive ability of German companies. The internationalization and the export of professional training to impart key competencies for innovation processes is therefore one special point of focus. In addition to accessing global markets, the central goal for German education providers is to provide innovative German companies with access to experts across the world. The successful export of education serves the success of German companies in other markets because the spread of technologies depends on the availability of qualified skilled workers who can install, operate or service this technology on site.

Strengthening long-term cooperation with developing countries in education, research and development

A primary goal of the Strategy of the Federal Government for the Internationalization of Science and Research is the strengthening of cooperation with countries in the Sub-Sahara region of Africa and in Arab countries. For example, the BMBF funds regional competence centres for climate change and adapted land management in Sub-Saharan Africa in cooperation with African partners. The aim of this is to expand infrastructures and accompanying research programmes in various African regions that are interconnected with each other and will be integrated into German and international research activities. In parallel, DAAD will erect and maintain specialist centres in Africa on behalf of the AA and BMZ, for example the Ghanaian-German Centre for Development Studies and Health

Fig. 12 Gross domestic expenditure on research and development (GERD) as a percentage of gross domestic product (GDP) of selected countries 2010



<1.5 %	
Indonesia[1]	0.05
Mexico[2]	0.37
Chile[3]	0.39
Romania	0.47
Cyprus[4]	0.50
Argentina[2]	0.51
Greece	0.60
Bulgaria[4]	0.60
Latvia	0.30
Slovakia	0.63
Malta	0.63
Croatia	0.73
Poland	0.74
Lithuania	0.79
India[2]	0.80
Turkey	0.84
South Africa[3]	0.93
Brazil[3]	1.10
Hungary	1.16
Russian Federation	1.16
Italy[5]	1.26
New Zealand[6]	1.30
Spain[4]	1.37

1.5–2.5 %	
The Czech Republic	1.56
Portugal[4]	1.59
Estonia[4]	1.62
Luxembourg	1.63
Norway[4,5]	1.69
China[6]	1.70
Great Britain[4]	1.77
Ireland[4,5]	1.79
Canada[4]	1.80
The Netherlands[4]	1.83
Belgium[4]	1.99
Slowenia[4]	2.11
Australia[3]	2.24
France[4]	2.26
Singapore[6]	2.27

>2.5 %	
Iceland[3,4]	2.64
Austria[4,5]	2.76
Germany[5]	2.82
USA[6,7]	2.90
Taiwan[2]	2.94
Switzerland[2]	2.99
Denmark[5]	3.06
Japan[6]	3.36
Sweden[5]	3.43
Korea	3.74
Finland	3.87
Israel[4,8]	4.40

[1] Information for Indonesia from 2005
[2] Information for Mexico, India, Norway, Argentina and Taiwan from 2007
[3] Information for South Africa, Brazil, Iceland, Switzerland and Australia from 2008
[4] Preliminary
[5] National estimate or forecast
[6] Information for New Zealand, Singapore, Japan and China from 2009
[7] USA: predominantly or completely without capital expenses
[8] Israel: without defence expenditure

Basis of data: OECD Main Science and Technology Indicators 2011/2, Federal Statistical Office – profiles of the states, Eurostat Yearbook 2011, World Bank Country Data on Science & Technology

Research in Accra, which was set up in June 2009 and is now part of a network of five centres in Ghana, Tanzania, the Democratic Republic of Congo, Namibia and South Africa.

Taking on international responsibility and overcoming global challenges

In the 21st century, humankind faces immense and globally-impacting challenges: climate change and a loss of biodiversity threaten our future.

International research cooperation can bring decisive insight into the global challenge of demographic change. A problem shared by most industrial countries and the new policy makers is that the percentage of people over 65 years of age in the population will grow significantly in the next few years in comparison to the working population (15-65 years of age). Until now, health aspects have always been the main point of focus but there will also be consequences for many other areas.

However, there is no fundamental knowledge about instruments and suitable models for research cooperation in the field of global challenges at the international level. In light of this, the BMBF is pursuing a dual strategy: firstly, it is committed to a series of European and international research initiatives that target global challenges. At the same time, the required research into instruments and suitable models for research cooperation will be undertaken under the heading "governance", for example within the scope of the OECD. A central element of the European research cooperation for coping with global challenges are the Joint Programming Initiatives, e.g. "More Years, Better Lives" relating to the demographic change. These initiatives were primarily initiated by the BMBF.

4.2 Bilateral cooperation

Interdisciplinary measures

Information and analyses relevant to worldwide research and education are provided via the international monitoring system, presenting opportunities for international cooperation to be used effectively to further develop Germany as a science and innovation location. The central instruments of the international monitoring system are the information portal www.kooperation-international.de and the ITB information service "Report on research, technology and innovation policy across the world".

Since 2006, the German innovation location has been presented abroad under the brand "Research in Germany – Land of Ideas". The most important instruments are theme and country campaigns that are operated for a period of two years (2010-2012: production technologies and medical technology as well as India and Russia). The Internet portal www.research-in-germany.de is the main source of information. In 2009, DAAD, AvH, DFG and FhG forged a research marketing association funded by the BMBF which undertakes a large number of individual measures to ensure the coordinated presentation of German science and intermediary organisations aboard. In doing so, the bilateral science years, which are funded by the BMBF, play an important role in raising Germany's profile abroad (in the years 2010/2011 the German-Brazilian Year of Science, Technology and Innovation; in the years 2011/2012 the German-Russian Year of Education, Science and Innovation).

The science advisors at the German embassies present the German research policy abroad. They play a special role in mediating between Germany and the respective partner state, for maintaining contacts and reporting. To enhance Germany's presence abroad and guarantee and improve the uniform presentation of all important institutes involved with science, research and innovation, the AA, BMBF, the research and intermediary organisations, and the Association of German Chambers of Industry and Commerce (DIHK) agreed to set up German Centre for Research and Innovation (DWIH). The first DWIH locations are Moscow, New Delhi, New York, Sao Paulo and Tokyo.

Cooperation with European states

Cooperation with other European countries is one of Germany's top priorities and, at the same time, Germany is a priority partner country for many other countries in Europe. Joint initiatives and the identification of joint interests serve to design the European research area. The activities specifically target the implementation of the Strategy of the Federal Government for the Internationalization of Science and Research in the European countries, above all in research cooperations with the world's best (target field 1), and tapping international innovation potential (target field 2). The Programme of International Cooperation in Education and Research, Region Central, Eastern and Southeast Europe is organised within this context; the BMBF and the BMWi use this programme to support the setting up of projects in national and European funding programmes.

Current examples of multilateral cooperation in Europe are the Baltic Sea Region Strategy and the EU Strategy for the Danube Region. These strategies, which also involve third countries, target the shared agenda of all participants, coordinated action and better utilisation of the potential of the region. With reference to the Baltic Sea Region Strategy, the BMBF established the "ideas competition for the establishment and development of innovative R&D networks with partners in the Baltic Sea region - Circum Mare Balticum" in 2010. This public tender aims to initiate interdisciplinary, innovative R&D networks, in which the countries along the shores of the Baltic Sea have an interest in the demand fields of the federal government's High-Tech Strategy and also tap innovation potential in and with the region.

Cooperation with the Community of Independent States

The cooperation with the countries in the Commonwealth of Independent States (GUS) – the former Soviet Union – plays an important role in the implementation of the Strategy of the Federal Government for the Internationalization of Science and Research. The cooperation is based on the close and longstanding relationships between science organisations, universities and innovative companies in Germany and the partner countries in the region, in particular Russia.

The key legal basis for the cooperation is the government agreement on science-technology cooperation with the former Soviet Union. This came into force in 1987 and its continued validity is largely accepted by the successor states. Independent bilateral agreements have now been signed with the individual countries (e.g. Ukraine in 1993, Belarus in 1996, Uzbekistan in 1998, Russia in 2009 and Armenia in 2011).

The cooperation comprises almost all areas of science, research and technology, although the traditional strengths of the GUS states lie in natural and engineering sciences. In addition to narrowly defined science cooperations, the cooperation also includes innovation such as the further development of the science structures and the vocational and academic education systems, also against the background of the on-going transformation and reform processes in the countries in the region. The main countries of the cooperation are Russia and the Ukraine. Increasingly, there is a shift in emphasis toward countries in central Asia and Southern Caucasus. For some partner countries, Germany is the most important international partner in many research fields.

Cooperation with the Asia-Pacific region

From a political, scientific and economic point of view, the Asia-Pacific region is currently the most dynamic region in the world, and is becoming increasingly important. For Germany and Europe, this region, in particular the individual countries such as Japan, China, Korea and India, have become simultaneously both important partners and competitors. The sustained high growth rates in university, scientific output or patent registrations have enhanced the region in its role as a global science location. Japan remains by far the country with which German researchers cooperate most intensively, followed by Australia and China. However, countries like South Korea, Singapore and New Zealand are also important partners. The BMBF can look back on many years of successful cooperation with countries such as China, India, Vietnam, Indonesia, New Zealand and Australia, but its concept also involves actively keeping up with the radical changes in the Asia-Pacific region in recent years, for example via cooperations with up-and-coming research locations such as Singapore or Thailand.

Cooperation with the USA and Canada

Scientific and technological cooperation with the North American industrial countries of the USA and Canada plays an important role for implementing the Strategy of the Federal Government for the Internationalization of Science and Research. Research institutes in these countries are still the leaders in global knowledge production. Cooperation with partners from the USA includes all areas of science and research and entails a variety of initiatives and funded exchanges of scientists and students to the respective partner country. Also, there is a traditionally intensive exchange of information in a wide range of joint or complementary research projects.

In recent years, Canada has made significant new investments in research and development. This has led to great improvements in equipment in research institutes, and funding organisations or strategic funding programmes have recorded notable growth. This makes Canada an interesting and important partner in the cooperation in education and research.

Cooperation with Central and South America

By publishing the document "Germany, Latin America and the Caribbean: a concept by the federal government" in August 2010, the federal government sent out a clear signal that one of its main priorities is to intensify cooperation with this region.

Intensive exchange of German-Latin American experts from science and education as well as bilateral innovation forums and other events contribute to better exploitation of the innovation potential and making Germany more attractive as a research location to the international community.

Cooperation with the Mediterranean region and Africa

Bilateral scientific and research cooperation with the Mediterranean region and Africa is becoming increasingly important in light of the local social and political developments and the upcoming global challenges. For example, African countries are particularly affected by the consequences of climate change, demographic developments and migration as well as the development of megacities. Since spring 2011, new opportunities but also challenges have arisen as a result of the democratic transformation processes in the North African countries. Cooperation in science, research and innovation aims to support these processes. Bilateral cooperation is embedded in scientific and research strategies within a multilateral framework, in particular those of the European Union. At a multilateral level, Germany is involved in the development and implementation of such strategies. In future, both the cooperations at a bilateral level as well as cooperations at a regional and multilateral level are to be strengthened and intensified.

Bilateral cooperation with countries in the Mediterranean region focuses on Turkey, Israel, Jordan and Egypt. South Africa is the most important cooperation partner in the countries in Sub-Saharan Africa.

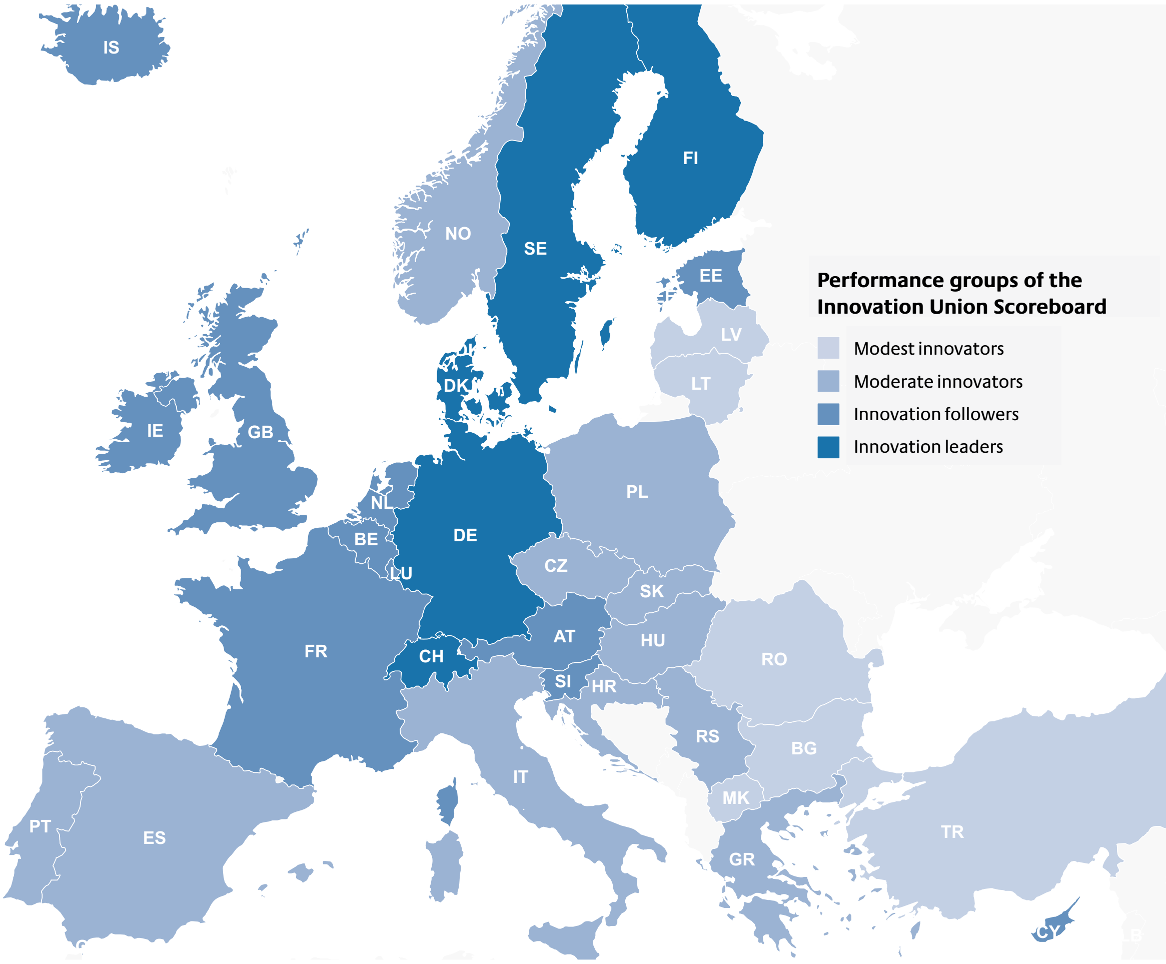
4.3 European cooperation

The Lisbon Treaty came into force on 1 December 2009. With this agreement, the European Union established the goal of enhancing its scientific and technological foundations by creating a European Research Area (ERA) where researchers are free to move from country to country and where scientific findings and technologies can be exchanged freely. Other goals include promoting the development of competitiveness of the European Union including that of its industry, and supporting all research measures considered necessary, based on other chapters of the agreements (Article 179 AEUV). In order to reach these goals, the European Union runs programmes for research, technological development and demonstration (Framework Research Programmes) (Article 180 AEUV).

The federal government has set itself the goal of actively establishing the European Research Area and it also supports an enhancement of the role of the Member States.

Basic decisions about the research areas that are to be funded and the sums that are to be spent are based on the ordinary legislative procedure in the shape of research framework programmes lasting several years as defined by the Council of the European Union and the European Parliament. Since the first research framework programme (1984-1987), the funds made available by the EU budget have risen continuously. The 7th FP provides for 54.4 billion euros for the period 2007 to 2013. At the end of 2011, the Commission will make a proposal for the upcoming research and innovation framework programme Horizon 2020 for the period 2014 to 2020 which will be submitted to the Council and Parliament, which will decide between 2012 and 2013.

Fig. 13 Innovation performance of European countries 2011



Country	Abbreviation	2011
Belgium	BE	0.62
Bulgaria	BG	0.24
Denmark	DK	0.72
Germany	DE	0.70
Estonia	EE	0.50
Finland	FI	0.69
France	FR	0.56
Greece	GR	0.34
Great Britain	GB	0.62
Ireland	IE	0.58
Iceland	IS	0.60
Italy	IT	0.44
Croatia	HR	0.31
Latvia	LV	0.23
Lithuania	LT	0.26
Luxembourg	LU	0.60
Malta	MT	0.34

Country	Abbreviation	2011
Former Yugoslav Republic of Macedonia	MK	0.25
The Netherlands	NL	0.60
Norway	NO	0.48
Austria	AT	0.60
Poland	PL	0.30
Portugal	PT	0.44
Romania	RO	0.26
Sweden	SE	0.76
Switzerland	CH	0.83
Serbia	RS	0.28
Slovakia	SK	0.31
Slowenia	SI	0.52
Spain	ES	0.41
The Czech Republic	CZ	0.44
Turkey	TR	0.21
Hungary	HU	0.35
Cyprus	CY	0.51

Comment: The 2011 indicator value for a country is calculated from 25 R&D-relevant individual indicators and refers to the years 2009/2010. The best possible value is 1 and the worst is 0. “Innovations leaders” are countries with a value of at least 20 % higher than the EU-27 average. “Innovation followers” attain a value that is up to 20 % higher or at the most, 10 % lower than the average. “Moderate innovators” are at least 10 % but not more than 50 % below the average. “Modest innovators” attain values that are lower than the EU-27 average by more than 50 %.

Basis of data: Innovation Union Scoreboard 2011, Annex E; Source: VDI/VDE-IT

5 Data and facts about the German research and innovation system

5.1 Selected data on the German research and innovation system

The selected data on the German research and innovation system refers to three subject areas: The resources for research and development (R&D) (funds, personnel), the output from the research and development process (publications, patents) and the actual innovation via economic utilisation of research and development results. In some areas, additional data was added to make interrelations clearer.

Resources[4] – such as funding or personnel for R&D institutions at universities, research institutes or private sector R&D centres – are required for research and development. An important source of this personnel are graduates of technical and scientific courses or doctoral students in these subjects.

Scientific findings or discoveries or technical inventions are output of the R&D processes. They may be used for exploitation, although usually the focus is on exploitation by the private sector for new products or production procedures. Also, the results may be utilised within a political, social or cultural context.

The R&D output[5] can be described more precisely in the case of scientific findings and discoveries via the number of scientific publications, and in the case of technical discoveries via the number of patents registered or granted.

Innovation is the end result of a successful R&D process, i.e. the utilisation of R&D output by the economy and society. The indicators for innovation[6] include the percentage of companies that have made product, process or other innovations in a specific period. The success of innovations is revealed in the case of product innovations in the percentage of turnover earned with new products. If successful, process innovations lead to reduced costs in the production process or improvements in quality.

4 In international literature, these resources are also referred to as input variables.

5 In international literature, this R&D output is also referred to as a throughput variable because it refers to neither the input nor the output but the intermediary results.

6 In international literature, these innovation indicators are also referred to as output variables.

5.1.1 Resources

Financial resources

Basic data about the expenditure on science, research and development

Particularly important indicators of R&D resources include the funds spent on R&D. Three main approaches must be distinguished here: scientific expenditure, R&D expenditure and gross domestic expenditure on research and development (GERD).

Scientific expenditure incorporates the expenditure for R&D, the expenditure for scientific education and teaching, and other related scientific activities, for example scientific and technical information services, data collection for general purposes or studies on the feasibility of technical projects.

The total scientific expenditure of the Federal Republic of Germany in 2009 amounted to 84.9 billion euros and has grown by 32 % since 2000.

In 2009, the private sector accounted for 55 % of scientific expenditure. Government funding, including non-profit scientific organisations, accounted for 45 %.

The state governments[7] have accounted for approximately 60 % of scientific expenditure of the public sector budgets since the mid-nineties. At almost 21.6 billion euros, it reached approx. 59 % in 2009. The federal government accounted for almost 40 % in the same year (14.5 billion euros).

90 % of scientific expenditure of the state governments was used for the universities, while 80 % of scientific expenditure of the federal government went to the non-university research institutes.

R&D expenditure is restricted to funding systematic, creative work to build on existing knowledge, including knowledge of humankind, culture and society, and using this knowledge with the objective of finding new applications.[8] In contrast to scientific expenditure, R&D expenditure does not include expenditure for academic teaching and training and other scientific activities, for example scientific and technical information services.

7 The data of the *Länder* is based on the basic funding concept in which the net expenditure for science is reduced by the direct income of the *Länder* from the science centres – in particular the care rate income of the university clinics – to cut out the impact of the expenditure on patient care at the university clinics.

8 Cf. Frascati Manual 2002, OECD, § 63, page 30.

Infobox

Availability of data

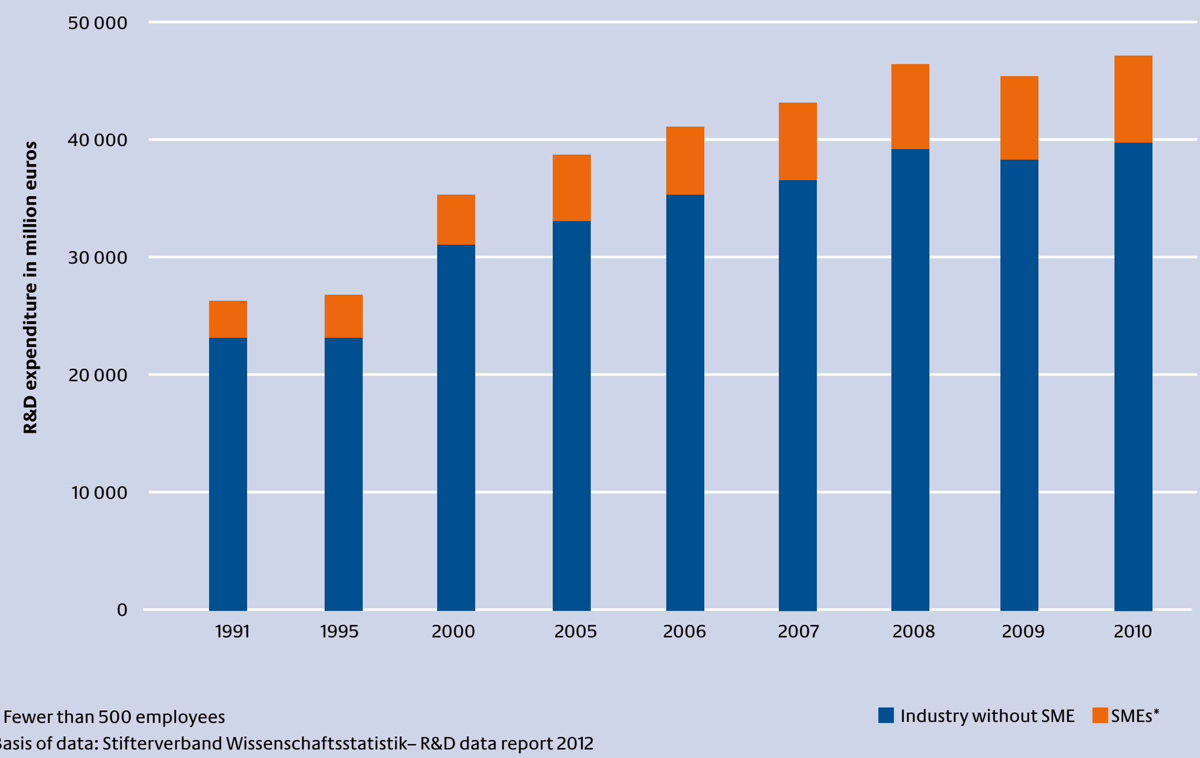
This chapter only uses data from the year 2009. Data or estimates are also provided in some cases for 2010. The main sources are the international statistics databases of the Organisation for Economic Cooperation and Development (OECD) and the Statistical Office of the European Community (Eurostat). These are supplemented by data from the Federal Statistical Office, the Bundesbank, the European Patent Office, the company Wissenschaftsstatistik gGmbH, an affiliate of Stifterverband für die Deutsche Wissenschaft (the business community's innovation agency for the German science system), and by the Centre for European Economic Research (ZEW). Also, data from studies by the Commission of Experts for Research and Innovation on the German innovation system is used.

In 2009, domestic bodies, that is, local authorities, private non-profit institutions and the private sector spent approximately 67.6 billion euros, or approximately 30 % more than in 2001. In 2009, the private sector provided 68 %, or approximately 46 billion euros. ● Table 2

The approaches to date refer to the R&D expenditure financed by state-internal bodies, which also includes the funds sent abroad for research purposes. In contrast to the financing and resident concept, the gross domestic expenditure for research and development (GERD) only contains the funds spent domestically on the implementation of research and development. According to the resident concept, this also includes R&D expenditure in Germany that was funded from foreign sources, for example by the EU or companies with headquarters abroad. The gross domestic expenditure for research and development is an important indicator, in particular for international comparison of R&D efforts, as double counting is avoided in this concept. For this reason, this indicator will be used for all of the following international comparisons (see chapter 5.2).

Especially important here is the share of the GERD as a ratio of the gross domestic product (GDP). The 3 % goal of the Lisbon strategy[9] also refers to the target GERD value of 3 % of the gross domestic product. In total, the preliminary calculations for

Fig. 14 R&D expenditure by the private sector 1991-2010



* Fewer than 500 employees
Basis of data: Stifterverband Wissenschaftsstatistik– R&D data report 2012

9 This objective is part of the Lisbon Treaty agreed by the European heads of state and government in Lisbon in a special summit meeting in March 2000. This strategy targets permanent economic growth with better qualified jobs and greater social cohesion.

the year 2010 show an increase of the share of the GERD in Germany to an estimated 2.82% of the GDP which is a significant increase over time – this is the highest value since the reunification. It was recorded as 2.47% in 2001, which shows a clear increase, particularly since 2008. ● Table 1

The 3% goal was also explicitly continued in the new European Growth Strategy "Europe 2020". A central element of the strategy passed by the European Council in June 2010 is further improvement of the conditions for R&D.

When considering funding of research and development, the increasing importance of the private sector is becoming clear. In 2009, the private sector in Germany funded over two thirds of the gross domestic expenditure on research and development amounting to 44.3 billion euros. This refers to all financial expenditure by the private sector, regardless of where the R&D work was performed: in the private sector itself or in government, in non-profit or public institutions such as universities. This figure is extremely high compared with the rest of the world and is considered a key feature of the German research and innovation system. ● Table 1

Over time, the R&D expenditure of the private sector once again underwent a very dynamic development from 2005 to 2010 – after a period of stagnation in the middle of the decade. by industry, vehicle construction, electrical engineering (including data processing devices and optics) and the chemical industry stand out in the level of their R&D expenditure.

Gross domestic expenditure on R&D is spread unevenly over the individual industries (sectors) that perform research and development. The private sector funded 67.6% of the overall gross domestic expenditure on R&D in 2009. This figure refers to the total of all expenditure for R&D performed in the private sector provided by the domestic economy itself, the national government, private non-profit institutions and from abroad.

With regard to the performing sectors, the majority of the R&D funding available was provided by the private sector in 2009, at 45.3 billion euros, while only a comparatively small amount was provided by the government and from abroad. The public sector (including private non-profit institutions) used approximately 9.9 billion euros and the universities 11.8 billion euros. Both sectors were primarily financed by the national government.

German Federal Government expenditure on research and development

The R&D expenditure of the German Federal Government increased from 9 billion euros in 2005 to 12.8 billion euros in 2010. In 2011, federal government expenditure on R&D increased further to 13.7 billion euros (target); for 2012, a rise to 13.8 billion euros is planned in a draft of the federal budget plan.[10]

86% of the federal government's total expenditure goes to the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry of Defence (BMVg) and the Federal Ministry of Education and Research (BMBF) collectively, the remaining 14% goes to the other departments. ● Table 4

The diagram showing R&D expenditure into funding areas and funding priorities is based on the federal government's R&D performance plan system. The expenditure is according to research subjects, regardless of the department that funded it.[11]

The German Federal Government has fundamentally updated the procedures for coordinating national research and development activities, and drawn up a new R&D performance plan system. The details of federal government research priorities in Part II B are structured according to this new system. The switchover to the new performance plan system is documented for the first time in this Federal Report on Research and Innovation. The R&D expenditure by the federal government or BMBF is in the Tables 5 and 6 of the full version of the Federal Report on Research and Innovation 2012 (in German only) according to funding areas and priorities of the new performance plan system and is shown from the year 2009.

Federal government R&D expenditure can be divided into civilian and military research. While civilian research is further according to funding areas and funding priorities, defence research and technology is a separate funding area regardless of its research topics. Civilian research reached 91% of overall federal government R&D expenditure in 2010; this amount has increased slowly in recent years. For 2012, the percentage of civilian research is expected to increase to 93%.

At 21%, the funding area of management organisation, university construction and primarily university-related special programmes account for the majority of federal government R&D expenditure in 2010 (actual value). The percentage planned for 2010 is similarly high at 24%. The majority of this consists of funds for basic financing for DFG at 7.0% (target 2012: 9.4%).

This is followed by the fields of aerospace research and aerospace technology (2010: 9.4%; target 2012: 10.2%), health and medicine (2010: 6.2%; target 2012: 8.6%), large-scale equipment for basic research (2010: 6.7%; target 2012: 8.5%), and innovation funding for small and medium-sized enterprises (2010: 8.2%; target 2012: 7.9%). ● Table 5

10 2010 and 2011 for the first time including investment and sinking funds (without allocation to the *Länder*). 2011 and 2012 including energy and climate funds to which, amongst other things, all the expenditure of all the departments for electro mobility have been assigned as of 2012. The R&D expenditure by the federal government also includes the R&D expenditure of the federal department research institutes.

11 For BMBF and in part for BMWi, BMU and BMELV, allocation is made at a project level, while the other departments focus on the budget unit level. The funds for institutional financial aid, including the expenditure of the federal government's scientific institutions, are allocated to one or more funding areas or key topics in accordance with their tasks, and are also by research subjects. The procedure differs for the basic funding of the MPG, DFG and FhG, as well as for the funds for university construction and university-related special programmes, which each form a separate major funding area and are grouped in one funding area.

Approximately 52 % of federal government R&D expenditure goes to the BMBF (2012: 58 %). This is dominated by the following funding areas: management organisations, university construction and primarily university-related special programmes (2010: 36.7 %; target 2012: 42.2 %), large-scale equipment for fundamental research (2010: 11.9 %; target 2012: 15 %), health and medicine (2010: 8.8 %; target 2012: 12.4 %), climate, environment and sustainability (2010: 7.9 %; target 2012: 9.4 %) and information and communication technology (2010: 6.9 %; target 2012: 7.0 %).

When breaking this data down into funding types, it is particularly important to distinguish between project funding, institutional research, university-related funding and international contributions. Project funding includes both project-specific funding and expenditure for commissions as part of the departmental and defence research. The overall percentage of the institutional funding in federal government R&D expenditure in 2010 (actual) was 41.6 % (target 2012: 42.5 %), and the project funding percentage including departmental research 2010 and target 2012 was 50 % respectively.

The R&D expenditure by the government on the business enterprise sector in 2010 amounted to 2,619 million euros. This was distributed as follows:

- 608 million euros (23 %) to the BMBF
- 607 million euros (23 %) to the BMVg
- 815 million euros (31 %) to the BMWi
- 589 million euros (23 %) to the remaining departments including the General Financial Administration that includes the expenditure on investment and sinking funds. Table 6

The breakdown of federal government expenditure on R&D by recipient groups gives an overview of the distribution of funding to the individual sectors – federal government and municipal authority institutions, non-profit organisations and private-sector companies.[12] In 2010 (actual), non-profit organisations (including DFG, the Max Planck Society [MPG], Fraunhofer-Gesellschaft [FhG], Helmholtz Association [HGF] and Gottfried Wilhelm Leibniz Scientific Association [WGL]) received the majority of federal government expenditure on R&D, amounting to 52 %. The second-placed recipient group comprised private sector groups and companies at 20 %. The percentage of federal government R&D expenditure received by local authorities was 18 %, of which 7 % was accounted for by federal government[13] and 11 % by local governments and municipalities. Table 6

The project funding by the government directly to and for the benefit of[14] small and medium-sized enterprises[15] (SME) in research and innovation amounted to almost 1.3 billion euros in 2011 (2008: more than 900 million euros) – excluding the economic stimulus package II.[16] Of this, 693 million euros (2008: 562 million euros) went to technology-open programmes of the BMWi for SMEs, of which approximately half went directly to SMEs. Within the specialised BMWi and BMBF programmes, 429 million euros was paid directly to SMEs (2008: 297 million euros); in the specialised programmes of the BMBF this is already more than half of the funds for companies.

In 2011, the other departments (excluding the BMVg) funded SMEs in this area with a further 114 million euros (2008: 71 million euros). Thus, the government project funds granted to SMEs increased significantly by over two thirds compared to 2007. Table E1, E2

The economic breakdown of the actual federal government expenditure on science, research and development to private sector groups and companies reveals that around 65 % of the expenditure went to the manufacturing industry in 2010. The most significant sub-groups are companies in the vehicle construction industry and manufacturers of office equipment, data-processing equipment and devices, electrical engineering and mechanical engineering. Table 6

Approximately a quarter (26 %; 3 billion euros) of the domestic R&D funded by the federal government went to the East German states, including Berlin, in 2010. This percentage has remained stable in recent years.

Of federal government expenditure on science, research and development in 2010, totalling around 15.4 billion euros, 92 % remained in Germany. The majority of the funds sent abroad amounted to around 1,235 million euros and approx. 971 million euros went to contributions for international scientific organisations and intergovernmental research institutions. Table 6

Länder governments' expenditure on science, research and development

The expenditure of the *Länder* governments on science, research and development benefits the universities in particular, both in the form of basic funding for research and teaching, and as external funding via the state's contribution to financing the German Research Foundation (DFG) and funding for

12 Funding includes both institutional funding and the other types of funding. Funds passed on to third parties for research by institutions are not incorporated, i.e. the initial recipient principle is always applied.

13 The percentage of the expenditure by the federal government to the federal institutions with research tasks is 6.5 %.

14 The formulation "for the benefit of SME" describes the actual results of the corresponding title of the BMWi from so-called technology-open programmes (e.g. Central Innovation Programme for SMEs [ZIM]). Of these funds, around 50 % go directly to SMEs. The remaining funds go to research institutes usually as part of cooperation projects with small and medium-sized enterprises from which SMEs profit directly.

15 Various definitions are used to define SME. The federal government has used a specific national definition for its statistics for many years. It draws on the criteria of the EU definition but sets broader limits with a turnover of 100 million euros (EU 50 million euros) and a value of a 50 % (EU 25 %) participation by larger companies. Table E1 uses the European definition, Table E2 the national definition.

16 Flow of funds from the economic stimulus package II as part of ZIM: 2010: 320 million euros, 2011: 397 million euros.

Table E1 Project funding by the government directly to SMEs as defined by the EU[16] (in million euros)

Year	Technology-specific programmes of BMWi and BMBF	Programmes by other departments*	Government total
2007	216	33	249
2008	246	46	293
2009	305	61	366
2010	352	66	419
2011	369	87	456

*Without BMVg
Source: Project funding database "profi" (differences compared to earlier figures result from the adjustments of the recipient assignment and the inclusion of other measures in "profi")

Table E2 Project funding by the government directly to SMEs as defined nationally[16] (in million euros), seperate display of funding for the benefit of SME (in million euros)

Year	Technology-specific programmes of BMWi and BMBF	Programmes by other departments*	Technology-open pro grammes of the BMWI (without additional funds from the econo mic stimulus package II)	Government total	Additional: Funds as part of the Central Innovation Programme for SMEs (ZIM) from the economic stimulus package II
	to SMEs (national definition)		for the benefit of SMEs	for or to the benefit of SMEs	for the benefit of SMEs
2007	258	48	477	783	
2008	297	71	562	930	
2009	370	85	646	1 101	53
2010	408	92	654	1 154	320
2011	429	114	693	1 236	397

* Without BMVg
** Actual results of the corresponding title of the BMWi. Of these funds, almost 50 % go directly to SMEs. The remaining funds go to research institutes, usually as part of cooperation projects with small and medium-sized enterprises, from which SMEs profit directly. Classification as an SME according to the EU definition is usually a prerequisite for funding.

Source: The values "to SMEs" were taken from the "profi" project funding database (differences compared to earlier figures result from the adjustments of the recipient assignment and the inclusion of other measures in "profi").

graduate students. In addition to this, joint federal and local government research funding also plays a major role, i.e. the funding of the Max Planck Society, Fraunhofer-Gesellschaft, Helmholtz Association, Leibniz Association and academy programme institutes. Also, federal state expenditure on science and research is paid to the *Länder* and municipal institutions with responsibilities in science and research as well as in the private sector, which receives public funding as part of funding measures for research, technology and innovation. *Länder* governments and municipalities spent 21.9 billion euros on science, research and development in 2009. This figure has increased slightly compared with previous years. East German states (including Berlin) received 22.7 % of the total scientific expenditure of the *Länder* in 2009.

The majority of the scientific expenditure, or, to be more precise, of the basic funding for science, from the *Länder* and municipalities in 2009 was paid to universities including university hospitals (85 %), with 15 % going to science and research outside the universities. The percentage of expenditure on the universities thus remained virtually constant compared with previous years.

Federal state expenditure on research and development (excluding municipalities) amounted to approximately 9.8 billion euros in 2010 (estimated), compared to around 9.4 billion euros in the previous year.

In 2009, the *Länder* contributed 13.8 % of the total public and private R&D expenditure in Germany (67.6 billion euros), compared with 13.7 % in 2005. The *Länder* accounted for 43.8 % of total federal and state government expenditure. This shows a slight downwards trend – at the turn of the last decade, the corresponding figure was approximately 48 %. Table 2

In 2009, the *Länder* of North Rhine-Westphalia (19.5 % of the federal state expenditure), Bavaria (16.0 %) and Baden-Wuerttemberg (14.6 %) were the largest contributors to federal state expenditure. The highest growth compared to 2008 was recorded in Hamburg (24.8 %), Bremen (13.9 %) and Saxony-Anhalt (15.3 %). The greatest decreases were in Schleswig-Holstein (-8.9 %) and Brandenburg (-5.8 %).

Joint research funding by the federal government and states

Together, the federal government and states spent approximately 21.4 billion euros on research and development in 2009. Thus, the country funded 31.6 % of all R&D expenditure in Germany. Approximately one third (32 %) of this national R&D expenditure was on institutional funding, which is paid as part of the joint research funding by the federal government and states. Table 2

The funds provided by the federal government and states were primarily used for basic financing (institutional funding) of the scientific and research organisations Max Planck Society (MPG), Helmholtz Association of German Research Centres (HGF), Gottfried Wilhelm Leibniz Scientific Association (WGL), Fraunhofer-Gesellschaft (FhG) and German Research Foundation (DFG). In total, joint research funding for these institutions in 2010 amounted to 7.1 billion euros. Of this total expenditure, approximately two thirds are provided by the federal government, whereby the funding shares of federal government and states differ, depending on the institution.

Resources of universities

In addition to the private sector and non-university institutions, universities are the third main area where research and development is carried out. The close link between research and teaching is a special feature of universities, which makes precise examination of these two responsibilities difficult. [17]

In 2009, expenditure by the universities for teaching and research amounted to 25.5 billion euros. This shows an increase of 34.4 % between 2000 and 2009. The percentage of universities which carry out R&D in Germany was 17.6 % in 2009. Table 1

University expenditure on R&D in 2009 amounted to approximately 11.8 billion euros. This corresponds to 46.4 % of the overall expenditure of the universities on education and research. The increase in R&D expenditure by universities between 2000 and 2009 amounted to 45 %, which means that the rate of increase in the R&D expenditure is significantly higher than the rate of increase in overall expenditure of the universities on education and research.

The R&D expenditure of universities is largely provided by the state (federal government and the *Länder*) (81 % in 2009). The percentage of all R&D expenditure of universities accounted for by external funding has increased significantly. In 2009, this was 46.6 % (equal to 5.5 billion euros) compared to 36 % (3.1 billion euros) in 2001. Thus, external funding increased by almost 77.4 % in this period.

17 The R&D expenditure by universities is calculated using so-called R&D coefficients based on the overall expenditure of the universities. Further factors include, amongst others, the number of students, the examinations taken and the working hour budget of the personnel. According to the criteria for R&D statistics passed as part of the OECD, the university sector does not include the affiliated institutes, which have close and multifaceted connections to the respective universities, but are legally autonomous institutions.

Human resources

R&D Personnel

In addition to R&D expenditure, R&D personnel is the most important indicator of resources in the area of research and development in a country or in a sector of the research landscape.[18]

In 2009, a total of 534,500 full-time equivalents were employed in research and development in Germany. This represents an increase of 9.3 % compared to 2000. Table 9

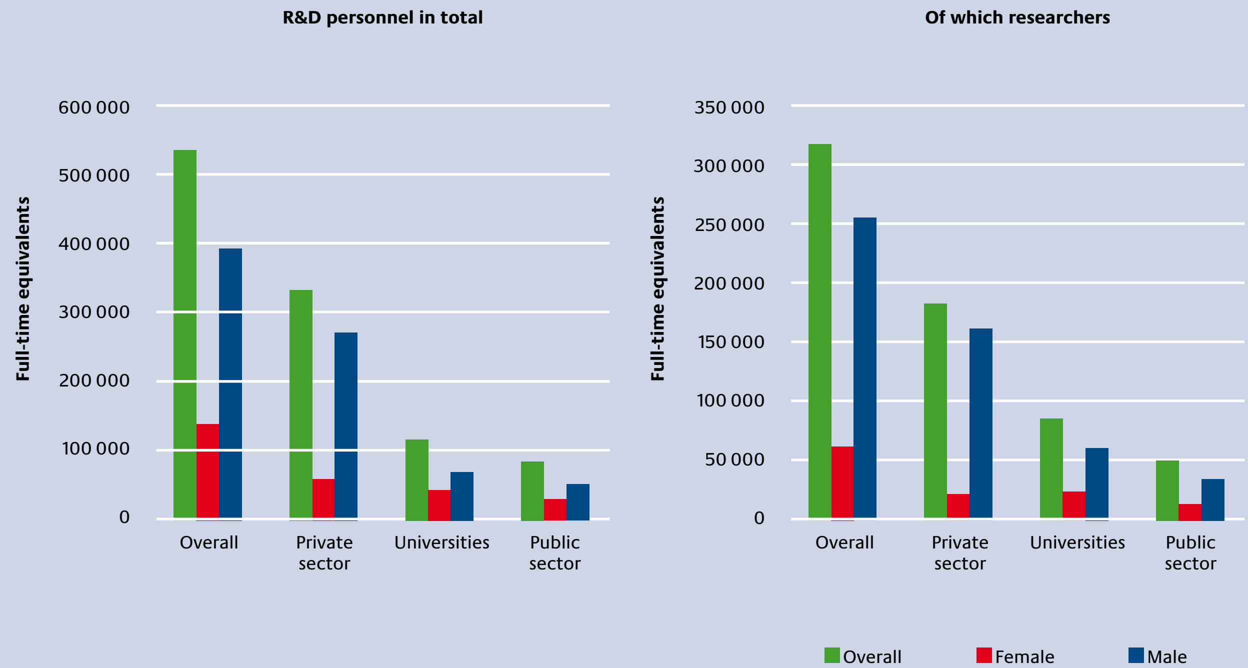
Not all staff members employed in the R&D area perform direct research work. The abovementioned figures also contain groups of persons who perform technical (e.g. machine operation) or other supporting tasks (e.g. secretarial services) for these actual research activities. The percentage of scientific R&D personnel – researchers – of the overall R&D personnel in 2009 was 59 %. After a slight increase at the beginning of the decade, this percentage has remained virtually constant since 2004. Table 9

Women are underrepresented among R&D personnel. Of 534,565 employees in R&D in 2009, 143,300 or almost 27 % were female. The participation rate of women among R&D personnel has thus increased slightly since 1995 (24 %). There are significant differences between the sectors. While the percentage of women at universities in 2009 was around 42 %, and accounted for around 38 % of the overall R&D personnel at non-university research institutes or, to use OECD nomenclature, the public sector, they only made up 19 % of the private sector.

Among highly-qualified employees, the difference between the sectors is also clear. In this category, female researchers are also rarest in the private sector, where they make up just 13 % of personnel. At universities (28 %) and in the public sector (30 %), the percentage of women among the highly-qualified research personnel was over twice as high in 2009. Of the approximately 317,000 researchers in Germany, around 62,000 are female, which is equivalent to 19 %. Overall, the percentage of women has increased significantly from 16 % to 19 % since 2003. This increase was clearest, from 24 % to 28 % at the universities, and from 25 % to 30 % in the public sector, while the percentage of women in the private sector hardly changed (increase from 11 % to 13 %). This increase proves the success of the policy of the German Federal Government to improve equal opportunities at universities and research institutions.

18 One advantage of using R&D personnel over R&D expenditure as an indicator is that inflationary effects do not have an effect when comparing different periods or purchasing power differences to those of other countries. In order to rule out the effects of part-time employment contracts, R&D personnel is specified in full-time equivalents. This form of counting also takes into account that, in particular, research and education are regularly performed by one and the same person at universities. The research percentage is calculated using R&D coefficients based on a process agreed by the Federal Ministry of Education and Research, the Conference of Cultural Ministers, the Federal Statistical Office and the German Council of Science and Humanities.

Fig. 15 **R&D personnel by gender, by sector and personnel groups 2009**



Source: Table 32 (cf. long version, in German only)

Within the university sector, significant differences can be observed in the percentage of female researchers in individual scientific fields. Medicine at 49 % and agricultural science at 46 % were the fields with the highest female percentage of highly-qualified research personnel in 2009. In the humanities and social sciences, they accounted for 41 % and for 26 % in the natural sciences. In the engineering sciences, men clearly continue to dominate, as 17 % of researchers in this field are female. However, it is notable that at universities in all areas of science, the percentage of female highly-qualified research personnel has increased continuously since 1995.

The non-university research institutions stated that, on average during 2009, 38 % of their R&D personnel were women. This figure has increased slightly since 2000 (35 %). The percentage of females among the highly-qualified researchers increased particularly significantly from 22 % (2000) to 30 % (2009).

Up-and-coming researchers: university qualifications and doctorates

University graduates are a key future resource for R&D. This area has developed positively in recent years. The number of graduates increased from 198,000 in 2005 to a record level of 294,000 in 2010. Almost 20 % of a year group completed their education with a university qualification in 2005; in 2010 this was almost 30 %.

For technological development and utilisation of future markets, it is particularly important to ensure sufficient new personnel for mathematics, information technology, science and technology (commonly abbreviated to MINT in German).

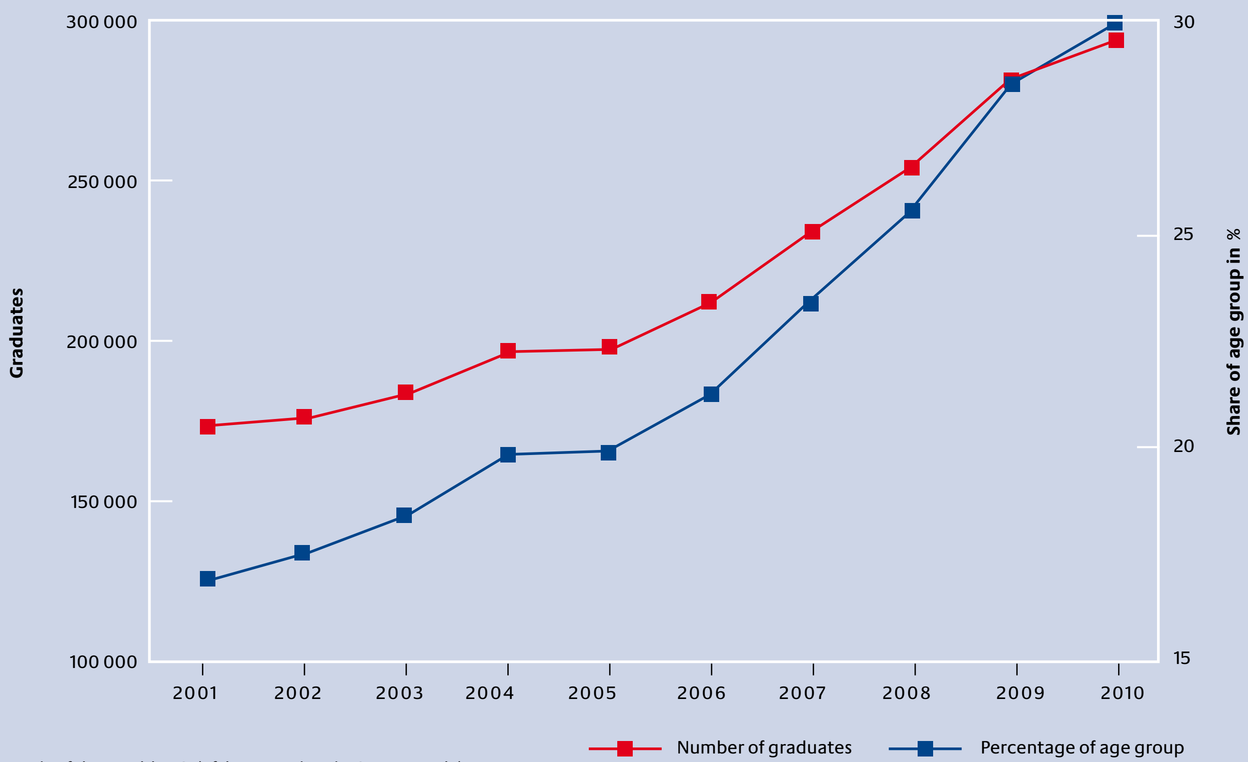
From 2005 to 2010, the number of graduates in engineering increased significantly by almost half or approximately 16,800 students after a phase of stagnation. The percentage of the age group also increased around one quarter.

For graduates in mathematics and science, the increase in absolute figures was even more impressive, with over 18,700 persons or around 60 %, which even tops the positive trend of previous years. It is also remarkable here that the graduates in mathematics and natural sciences, which formerly lay well below the engineering sciences – for example by more than 10,000 persons in 2003 – reached the level of engineering science in 2009 and lay just below it in 2010.

These positive developments of the MINT graduates are extremely pleasing, not only with regard to the demand of the German research and innovation system for qualified personnel. In addition to this, it must also be taken into account that, in particular, engineering courses are considered typical "advancement routes" for students whose parents are not academics. The number of foreign students in science and engineering courses is also extremely high.[19]

19 Cf. Leszczensky/Frietsch/Gehrke/Helmrich, Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 1-2010.

Fig. 16 Number of graduates, as a percentage of their age group 2001-2010



Basis of data: Table 52 (cf. long version, in German only)

Doctoral studies are relevant for particularly highly-qualified staff for R&D activities. Moreover, the number of doctorates can also serve as a general indicator for R&D activities.

The development since 2000 has been inconsistent. After a constant decline from 2000 to 2003 by a total of approximately 10 % or around 2,600 students, the numbers of doctorate qualifications increased markedly to a decade high of almost 26,000 doctorates in 2005, before decreasing once more to around 25,000 doctorates in 2009. The most recent figures from 2010 again show an upward tendency to figures of over 25,600 doctorates; however, they did not quite reach the peak values of 2005 and 2000.

Like the numbers of graduates, the doctorates in the MINT area will also be considered separately. After a decrease from 2000 to 2004, the number of doctorates in mathematics and science has increased constantly since 2006. The ratio – the percentage of doctorates in mathematics and sciences of all doctorates of the respective years – is relatively constant at a very high level: in 2010, almost 32 % of all doctorates were in these subjects.

In engineering science, the development is also marked by a greater degree of consistency, both with regard to the absolute figures and the percentage of all doctorates. The most recent figures reveal a certain positive tendency (increase by around 10 % in absolute figures from 2009 to 2010).

Overall, it is noteworthy that the MINT subjects account for almost 42 % of all doctorates. This highlights the particular relevance of this group of subjects for research.[20]

5.1.2 R&D output

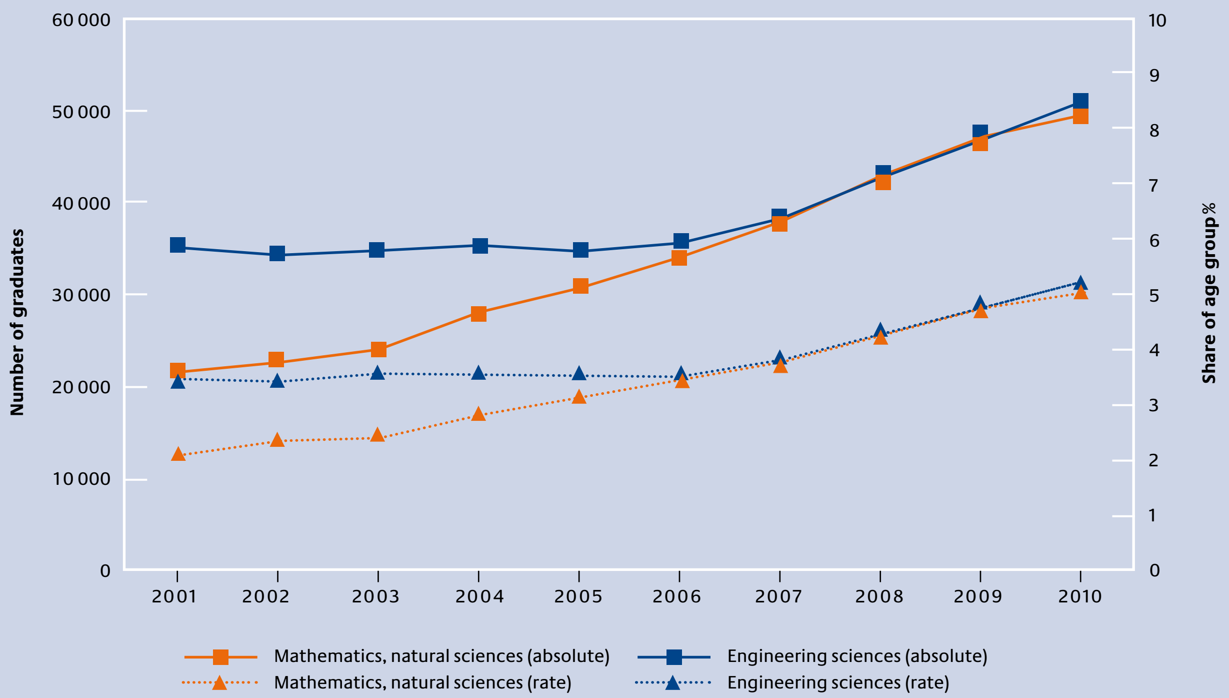
Successful research and development work leads to scientific findings or technological inventions. Scientific findings are reflected in scientific publications, and technological inventions are reflected in patents.[21]

Patents are an indicator of the technological performance of a country in a narrower sense; by contrast, publications measure the scientific performance. With regard to the increasing importance of knowledge as a production factor, publications are recognised as an indicator of scientific performance in innovation policy contexts. It must be taken into account that there are significant differences in the publication activities between the academic disciplines. Moreover, the absolute publication data does not provide information on the

20 It must also be taken into account that in certain scientific disciplines, doctorates are required for many jobs.

21 Publications and patents can be referred to as the output of the R&D process. With regard to the overall innovation process, these publications and patents can be viewed more as intermediate results, which in turn are a prerequisite (input) for the utilisation of the findings and inventions in business and society. This is why they are also referred to as throughput indicators.

Fig. 17 **Number of graduates in MINT subjects, as a percentage of their age group 2001–2010**



Basis of data: Table 52 (cf. long version, in German only)

recognition of the publication in the research community. Additional citation data must be considered.

Scientific performance: publications

The number of scientific publications (per million citizens) has increased continuously in recent years in Germany. Between 2000 and 2010, this increase was approximately 28 %.

One of the leading positions in the triad comparison (Europe, North America, East Asia) in terms of scientific publications is held by the USA.[22] Germany has caught up to the USA in the report period: in 2000, the number of German publications was around 92 % of the publications by American researchers, and reached approximately 102 % in 2010. The lead over Japan also increased significantly in this interval (from around 143 % to around 186 % of the respective Japanese figures). Compared with the European average, Germany's leadership position – in particular due to the greater average growth in publication figures in the EU-27 region – decreased somewhat (from around 130 % to around 129 % of the respective European figures).

The percentages of countries of all international publications revealed a decrease in the values of the classical industrial nations – including Germany – due to a greater participation in publication by eastern Asian countries, such as South Korea and China.[23] For example, the German percentage of publications recorded in the Science Citation Index (SCI)[24] fell by 10 % between 2000 and 2009. The figures for the USA (–13 %), France (–10 %), Great Britain (–16 %) and Japan (–27 %) are similar. By contrast, China (+91.1 %) and Korea (+196 %) have grown rapidly.

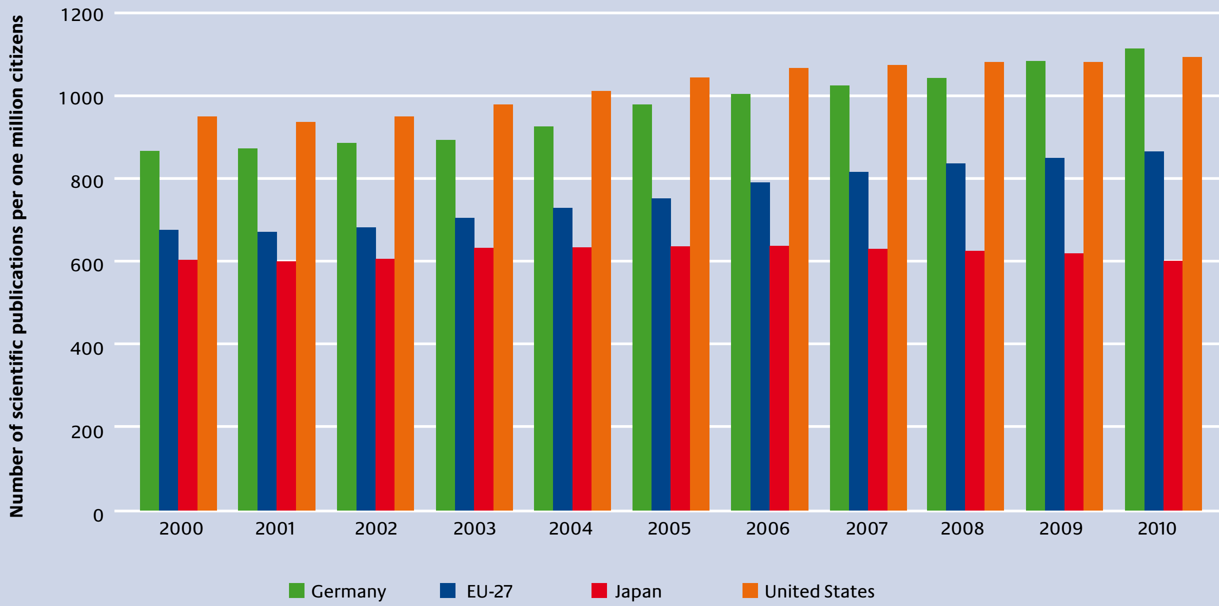
This data provides a rough overview of the scientific performance of individual countries based on the absolute numbers of publications. Citation indices are used for more in-depth analyses, which consider the citations in the year of publication of the corresponding publication and the two subsequent years. Further indicators also take the citations of articles from a specific country into account compared with other articles published in the same journal (journal-specific consideration) or the positive or negative disproportional representation of articles from a specific country in internationally renowned journals (international focus).

22 In terms of the USA, it should be remembered that researchers who are native English speakers have a significant advantage regarding international publications.

23 Cf. Schmoch/Mallig/Neuhäusler/Schulze: Performance and Structures of the German Science System in an International Comparison 2010 with a special analysis of public non-university research organizations. Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 8-2011 (www.e-fi.de/fileadmin/Studien/StuDIS_2011/StuDIS_8_2011.pdf).

24 For a list of the journals recorded in SCI, see http://scientific.thomson.com/cgi-bin/jrnlst/jloptions.cgi?PC=K.

Fig. 18 **Publications: Germany, EU-27, Japan and the United States 2000–2010**



Basis of data: Table 44 (cf. long version, in German only)

Technological performance: Patents

Patents are often used as indicators of technological performance. Even if data on this is readily available, interpreting it with regard to R&D output in the national economy is not without its problems. For example, there are certain industries in which inventions are, in principle, never or rarely patented for reasons of confidentiality.

Inventions that are registered in Europe or with the World Intellectual Property Organization (WIPO)[25] are referred to as global market-relevant or transnational patents. Such patents are particularly important for the export-oriented German economy because they protect the invention, even beyond the borders of the domestic market. This indicator has grown strongly at a high absolute level in Germany. The growth in the number of patents per million citizens was around 13 % between 2001 and 2009. In the same period, Germany increased its lead over the EU-27 average slightly (from approximately 244 % to approximately 250 % of the respective European values). Compared with the USA, Germany records approximately twice as many transnational patents per million citizens, with a slightly increasing tendency from 2001 to 2009. Compared with Japan, the patent intensity is approximately 50 % higher, with a slightly declining tendency.

However, it must be taken into account that the situation is different if other standard patent indicators are used. This applies in particular to triad patents: patents which are also registered in the other two regions of the Europe/North America/eastern Asia triad in addition to the domestic country. In this indicator, for example, the Japanese figures are significantly higher than the German figures, compared with the figures for global-market relevant patents specified here. This will become clear in Chapter 5.2 on international indicator systems.

If we break this down by patents in different technology areas, a typical constellation for Germany is revealed in international comparison: in the medium-high-technology industries[26] (e.g. automobile, mechanical engineering), Germany is very strongly represented with patents. However, in the high-technology industries[27] (e.g. computers/electronics or pharmaceuticals/biotechnology), it is below the global average.[28]

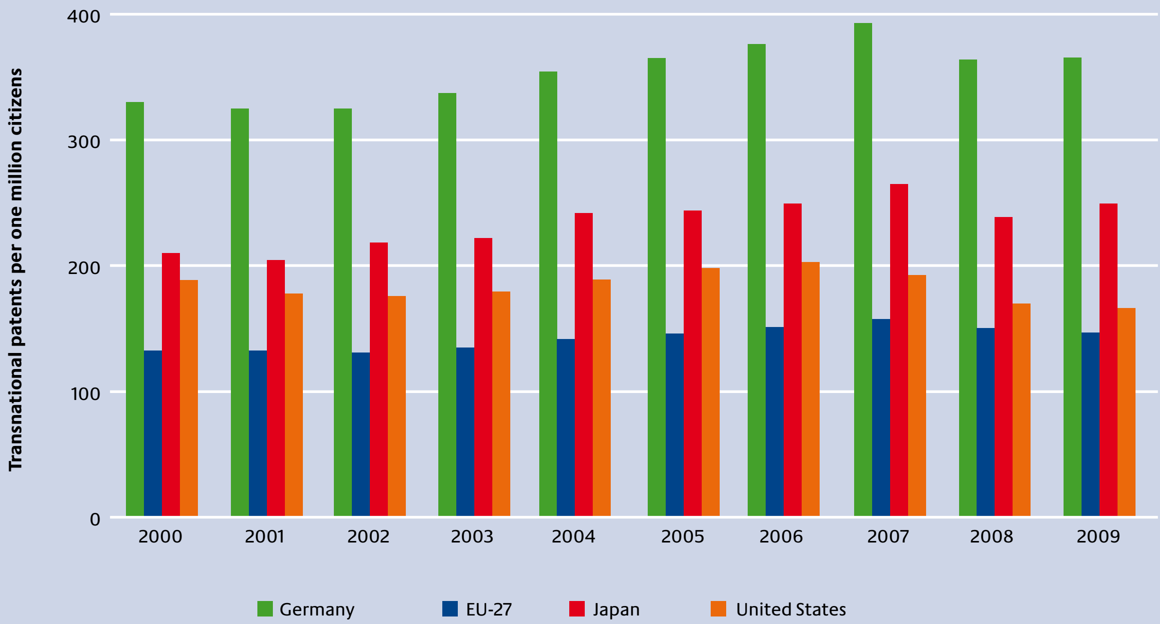
25 Global organisation for intellectual property, a specialised agency of the United Nations.

26 Medium-high-technology industries are those industries with an R&D intensity of 2.5 to 7 percent.

27 High-technology industries are those industries with an R&D intensity of more than 7 percent.

28 Cf. Frietsch/Schmoch/Neuhäusler/Rothengatter: Patent Applications – Structures, Trends and Recent Developments. Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 9-2011.

Fig. 19 **Transnational patents: Germany, EU-27, Japan and the United States 2000 – 2009**



Basis of data: Table 45 (cf. long version, in German only)

Performance capability of universities and non-university research institutes

Publication activity and the number of patent registrations are variables with which the German sciences institutions can be measured. As already shown, publications are primarily the result of scientific research, whilst patent registrations reflect the technological development activity in science. Both dimensions are equally important for the role of science in the innovation system.

In the disciplines of natural, engineering, medicine and agricultural science, which are particularly important for measuring innovation capability, the universities have increased their publication intensity (publications per researcher per year) from around 0.8 in the middle of the 1990s to around 1.3 by the end of the 2000s. In contrast, the patent intensity (patent registrations per 1,000 researchers) dropped severely from 48 to 39. The institutes of the WGL and the HGF centres were able to achieve clear increases for both indicators. By the end of the 2000s, the WGL institutes increasingly approached the level of the universities with a publication intensity of 0.95 and a patent intensity of 23, although they were far behind in the middle of the 1990s. This reflects the increased efforts in raising efficiency, for instance by carrying out regular evaluations and programme budgeting.

The FhG institutes were able to maintain their specific position in the German science system with a very high patent intensity combined with a low publication output per researcher, although in the period in question a number of new institutes were founded or brought under the auspices of the FhG from other organisations. The MPG positioned itself with a very high publication intensity (around 1.6) and a relatively low patent intensity (2006/2008: 17) inversely to the FhG, which reflects its role as an institute for excellent basic research.

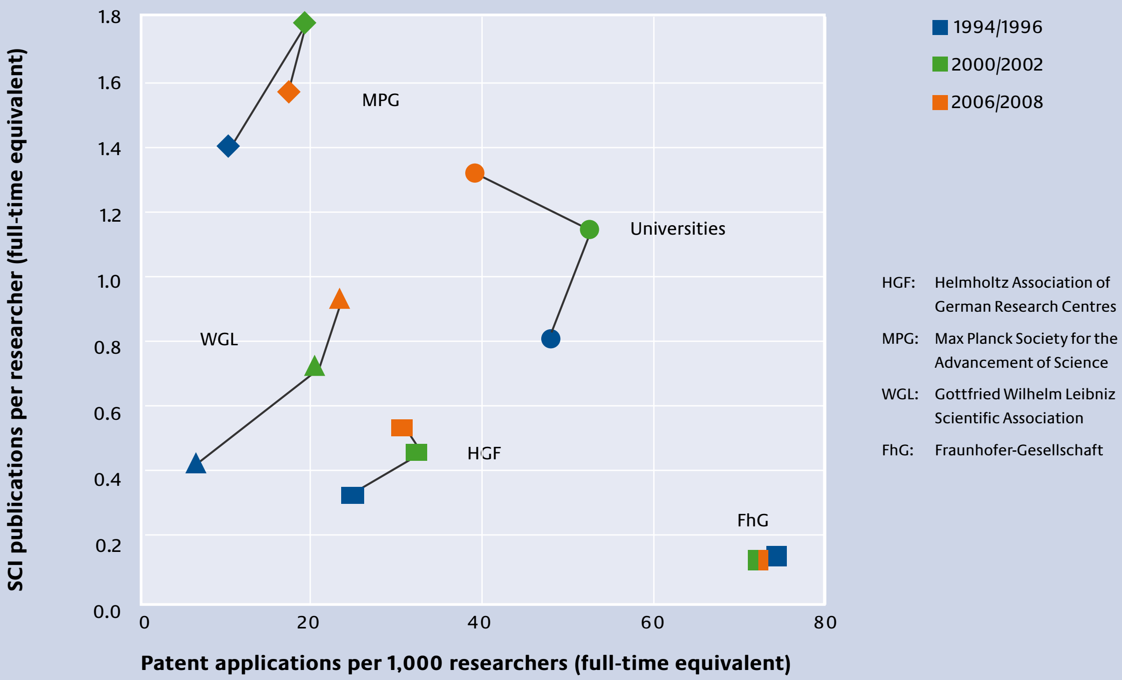
5.1.3 Innovation

Innovation participation

Investments by science and business in R&D are reflected in commercial revenue if the R&D results are utilised by commercial organisations (companies) to improve product range or productivity rates. Two indicator groups have been established in the empirical innovation research field that are used to assess the scope and success with which company inventions (i.e. technical-scientific inventions) are turned into company innovations:[29] The innovator rate measures the percentage of companies that introduce new products or processes within a certain period. The direct success of innovation work is partly measured on the basis of the turnover percentage achieved

29 For more information about the individual indicators and their definitions cf. Rammer/Aschhoff/Doherr/Hud/Köhler/Peters/Schubert/Schwiebacher: Indikatorenbericht zur Innovationserhebung 2011 (Indicator report on the 2011 innovation survey). Mannheim: Centre for European Economic Research, January 2012

Fig. 20 **Publication and patent intensity of the universities and non-university research organisations 1994-2008 in the natural, engineering, medical and agricultural sciences**



Publications and researchers refer respectively to the natural, engineering, medical and agricultural sciences; patent registrations at universities including registrations by university staff and sole inventors (estimated).
It should be noted that the scientific publication activity from engineering science fields in the SCI is not shown in full, so that the publication intensity is underestimated especially for the FhG.
1994/1996: funds from the years 1994-1996: 2000/2002: funds from the years 2000-2002; 2006/2008: funds from the years 2006-2008

Source: European Patent Office: Patstat – SCI: SCISearch – Federal Statistical Office series 11, number 4.3.2, series 14, number 6 – calculations and estimates by the Fraunhofer-ISI and ZEW. See also: Commission of Experts for Research and Innovation EFI (2012): survey on research, innovation and technological performance capability in Germany; Berlin: page 45 (available in the Internet: www.e-fi.de/fileadmin/Gutachten/EFI_Gutachten_2012_deutsch.pdf)

with the new products and secondly via the amount of cost reductions that can be achieved via the new processes.

In the manufacturing industry, including mining, 58 % of the companies were innovators in 2010; these are companies which introduced at least one product or process innovation within the preceding three-year period. This innovation need only be new from the point of view of the company itself – and can therefore already have been introduced by another company. The corresponding innovator ratios for knowledge-intensive company-related services were around 47 % and for the other company-related services[30] around 28 %.

Product innovators

Figure 21 shows the percentage of companies which have introduced at least one product innovation in the period in question; the innovations can be either market innovations or product copies (copycat innovations). In this and the following figures, please note the following: between 2005 and 2006, there is a disruption in the time sequence as a result of changes in the survey methods or the definition of the population.[31]

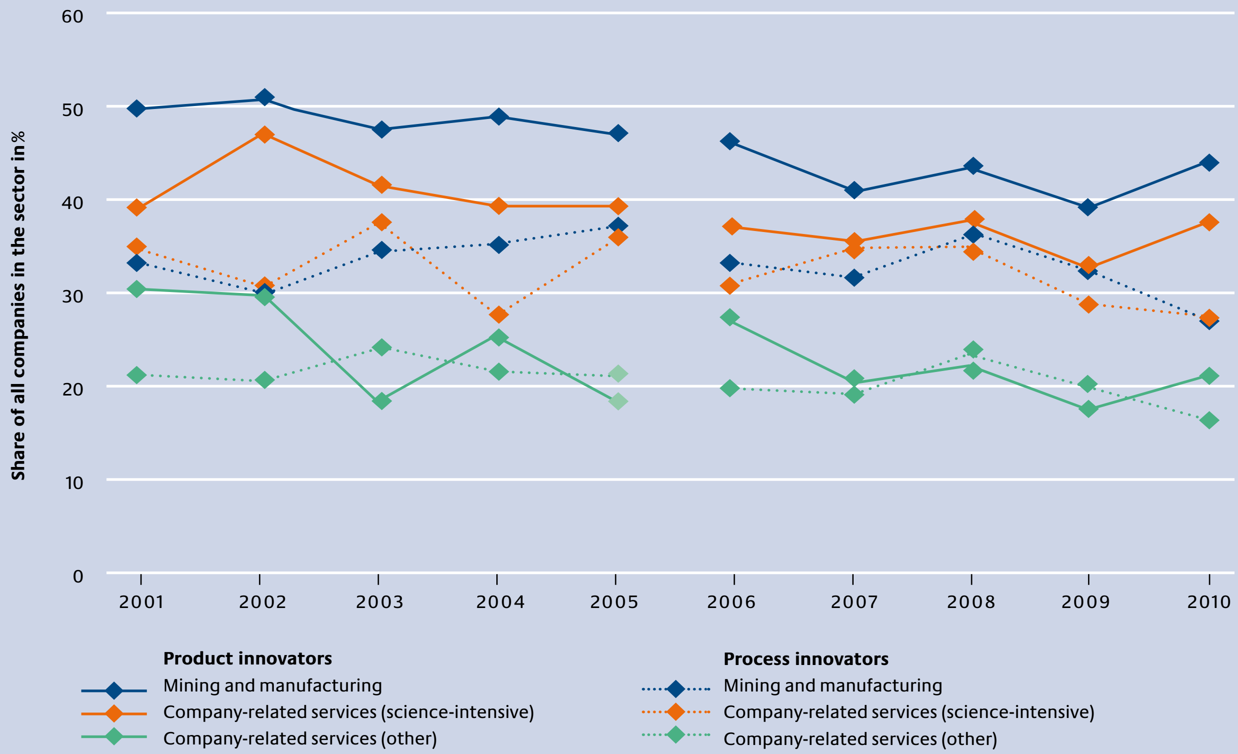
The most intensive innovation activity takes place in the manufacturing industry (incl. mining) with product innovator ratios of 40 % to 50 %, followed by knowledge-intensive company-related services (around 40 %) and other company-related services (20 % to 30 %). After inconsistent and declining development in early years, the most recent figures show an clear increase in 2008 followed by a decrease in 2009. 2010 reveals a positive trend for all sectors. This underscores the dependency of the product innovation work on the economy.

The percentage of companies with market innovations

30 Information and communication, financial and insurance services, freelance, scientific and technical services.

31 Cf. Rammer/Peters: Innovationsverhalten der Unternehmen in Deutschland 2008 (Innovation activity of companies in Germany in 2008). Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 7-2010.

Fig. 21 **Product and process innovators 2001-2010**



Basis of data: Table 1.8.1 and 1.8.2 at www.datenportal.bmbf.de
Disruption between 2005 and 2006 due to changed methods

shows the scope with which the companies launched new products onto the market that have not yet been offered by other companies in this or a similar form.

The percentage of companies with such original product innovations in Germany was 13 % in 2010 maintaining the level of the previous year. At 19 %, this percentage for the manufacturing industry is somewhat higher than in the knowledge-intensive company-related services (15 %) and much higher than the other company-related services (6 %).

Process innovators

Like the product innovator ratios, Figure 21 also shows the percentage of companies that introduced at least one process innovation in the period in question.

In terms of intensity of the innovation activity in process innovations, the manufacturing industry (incl. mining) sectors and the knowledge-intensive company-related services with process innovation ratios of currently 27 % distinguish themselves positively from the other company-related services (21 %). After relatively high values in 2008, there is a slight downward trend in the number of companies with process innovations in 2009 and 2010. Process innovations can lead to cost reductions or also improved quality. In the manufacturing industry (incl. mining), 15 % of the companies achieve cost reductions which is lower than the percentage of companies whose process innovations lead to improved quality (18 %). In contrast, quality goals are the main focus of the process innovation work in both sectors of the company-related services.

Innovation success

Percentage turnover with market innovations

The percentage turnover made with products new to the company and with market innovations is an ideal indicator for product innovation success. The latter indicator is the more discriminating, as only “real“ innovations, not copycat innovations, are taken into account. These innovations are in a much closer relationship to R&D than mere imitative innovations.

The percentage turnover with products new to the companies was around 25 % in mining and the manufacturing industry in 2010. In the knowledge-intensive company-related services sector (around 12 %) and other company-related services sector (around 7 %), the figures were far lower; the figures are typical for the individual industry sectors and largely stable conditions over time. For the overall economy, the percentage turnover with new products was approximately 15 %: Thus, in 2010, one seventh of the overall turnover of the German economy was based on new products.

The percentage turnover with market innovations is far lower as this is the more discriminating of the two indicators. In 2010, the corresponding figure for the mining sector and manufacturing industry was 6.1 %, 2.7 % for knowledge-intensive company-related services and 1.4 % for other company-related services.

Figure 22 shows the development of the percentage turnover with market innovations indicator over time. For the manufacturing industry (incl. mining) and the other company-related services, the trend is a moderate decline. In 2010 the industrial companies were once again able to increase the percentage turnover with market innovations thereby achieving the high values of 2001 and 2002 – taking into account the level change as a result of the methodical changeovers in 2006. In the other company-related services sector the percentage turnover with market innovations fell to a very low level of below 1% by 2005, after which it remains stable until increasing noticeably in 2010. In the science-intensive company-related services sector, which includes the banking and insurance sector, in particular data processing and telecommunication services, technical and consulting services, the percentage turnover with market innovations collapsed by around three quarters of the indicator value between 2004 and 2006.[32] There has been an upward trend since 2006, however at a much lower level than the level before 2004. It should be noted that the period from approximately 1997 to 2002 was a historically atypical situation. During this period, the dissemination of new information and communication technologies (Internet boom, dotcom hype) made many new types of product innovation possible, both for hardware providers and in particular for the providers of software and telecommunication services at issue here. The clear subsequent decrease could be interpreted as a return to normality. The moderately increasing values of the last three years attest to this.

Also, the increasing internationalization of this industry may have lead to product innovations that were considered new in regional markets but were revealed to be imitations in international market environments, as they had already been introduced by others on non-domestic markets.[33]

Reduction in costs due to process innovations

The percentage reduction in costs due to process innovations is an indicator for the cost effects of these innovations. This reduction refers to the unit or process costs in the year in question, saved as a result of the process innovation introduced in the preceding three-year period.[34]

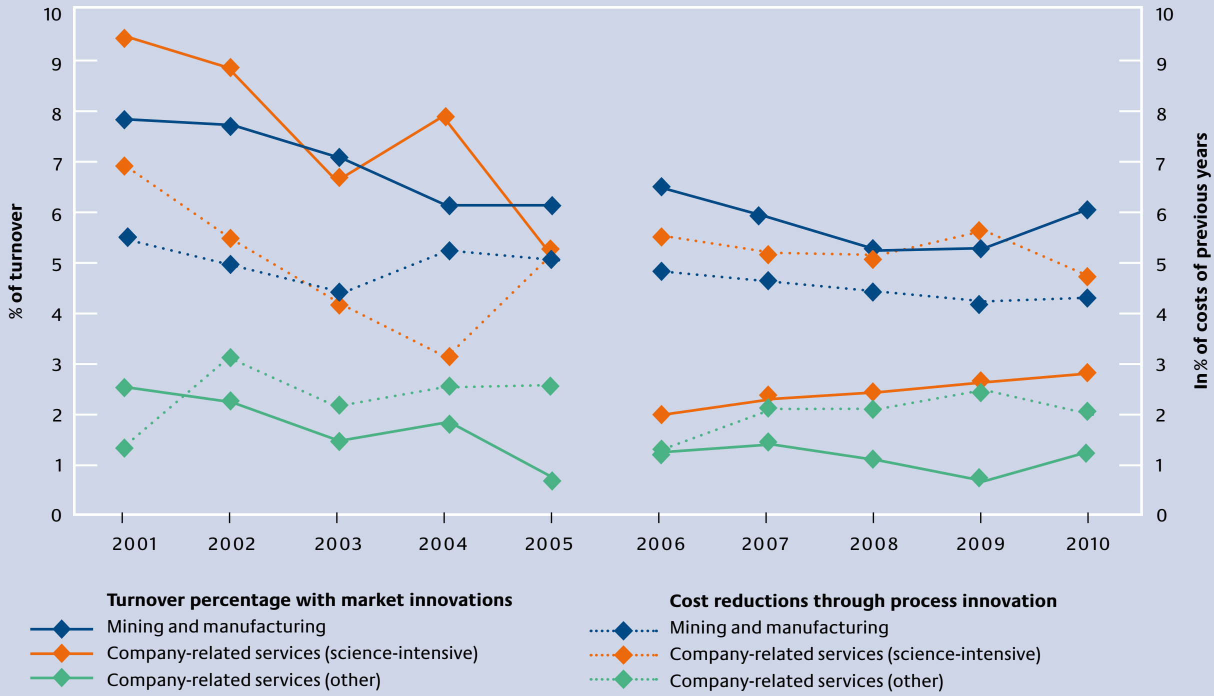
Figure 22 shows the percentage turnover with market innovations and also the percentage of cost reductions achieved by process innovation. There is an apparent downward trend for the manufacturing industry (including mining) since 2006, even if the indicator value rises again slightly in 2010. In the knowledge-intensive company-related services, a significant decline from 2001 to 2004 was partially compensated in 2005. The development from 2006 to 2008 revealed a moderate decrease. In the crisis year of 2009, cost reduction measures based on process innovation improved significantly and achieved an average cost saving of 5.7%. This was primarily due to the financial service providers and the telecommunications field. In 2010 the indicator value dropped to 4.7%.

32 This statement does not change qualitatively if the values are corrected for the change in the survey method; see Rammer/Peters, Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 7-2010.

33 Cf. Rammer/Peters: Innovationsverhalten der Unternehmen in Deutschland 2008 (Innovation activity of companies in Germany in 2008). Studien zum deutschen Innovationssystem (Studies on the German innovation system) No. 7-2010.

34 Another success indicator for process innovations is an increase in turnover due to process innovation achieved by quality improvements. This is not discussed here, as there are no time sequences comparable to the other indicators for this indicator. This indicator is mentioned for the first time in the ZEW indicator report on the 2005 innovation survey. See Aschhoff/Doherr/Ebersberger/Peters/Rammer/Schmidt: Indikatorenbericht zur Innovationserhebung 2005 (Indicator report on the 2005 innovation survey). ZEW publication, March 2006.

Fig. 22 Innovation success: percentage of turnover earned with market innovations and cost reduction share via process innovation 2001–2010



Basis of data: Table 1.8.1 and 1.8.2 under www.datenportal.bmbf.de
Disruption between 2005 and 2006 due to changed methods

5.2 The German research and innovation system in an international comparison

The special features and performance capability of the German research and innovation system can be highlighted in European or international comparisons. The main focus of comparable international indicators is the GERD ratio of the GDP. The fact that the "three-percent target" of the Lisbon Treaty refers to European research and innovation policy makes a comparison of Germany with the other EU countries and general European values highly interesting. Germany holds 4th position among the EU-27 countries in terms of the GERD ratio of the GDP. Only Sweden and Finland exceed the three percent criterion, albeit significantly by more than half a percent. Denmark and Austria achieve similar values to Germany. All other countries lie far below this level – at least half a percent.

In a global comparison of the OECD states, Germany, with 2.82 % in 2010, is among the top group of countries with a GERD ratio of more than 2.5 % of the GDP. Higher values were achieved by Israel (4.40 %, 2010), Sweden (3.43 %, 2010), Finland (3.87 %, 2010), Japan (3.36 %, 2009), South Korea (3.74 %, 2010), Switzerland (2.99 %, 2008) and the USA (2.90 %, 2009). The weakest group with GERD ratios below 1.5 % comprises Eastern and Southern European countries (e.g. Romania, Greece) and Latin American countries (Mexico, Argentina). Israel's leading position corresponds to almost twice the average of the OECD Member States of 2.4 % (2009). (Figure 23, 24) ● Table 7

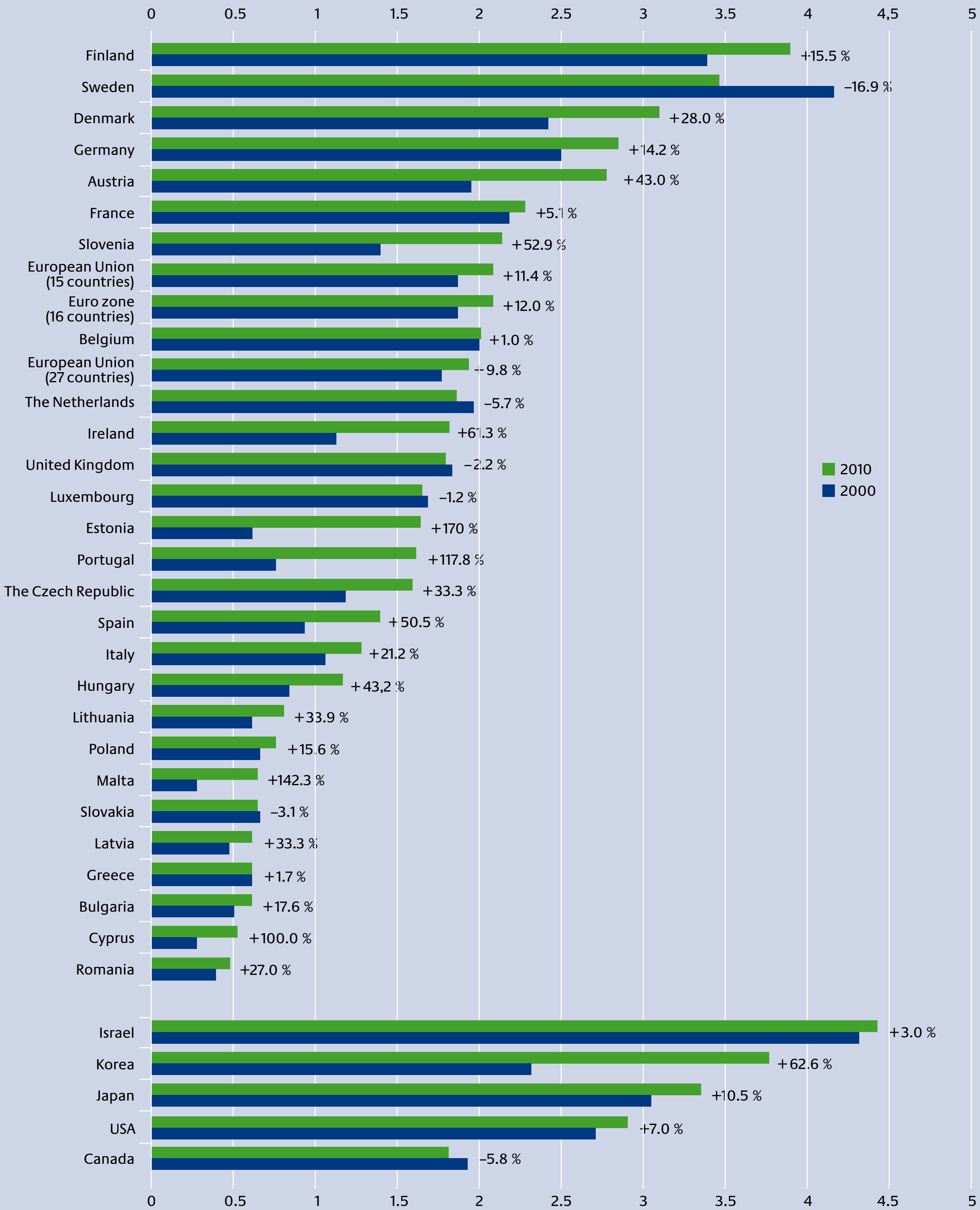
The development of this indicator for selected OECD countries over time shows different dynamics. The top European countries Sweden and Finland are also at a high level similar to Japan. Korea in particular stands out thanks to the significant growth rates. It has lain above Germany and the USA since the middle of the decade; however there has been an upward trend in Germany since 2008.

The presentation and interpretation of individual research and innovation indictors is supplemented below by international indicator systems that facilitate general comparisons of countries and regions. This allows the characteristics of national research and innovation systems to be identified. Indicator systems have been developed on different transnational levels. At the European level, the Innovation Union Scoreboard (IUS)[35] and at the global level the indicator sets of the OECD, such as the Main Science and Technology Indicators (MSTI) play an important role.[36]

35 Cf. Innovation Union Scoreboard (IUS) 2011.

36 Cf. OECD, Main Science and Technology Indicators 2011/2.

Fig. 23 Gross domestic expenditure on research and development as a percentage of the gross domestic product of selected countries 2000 and 2010*



*Differences due to data availability: instead of 2000 for Sweden, Denmark and Greece 2001, for Malta 2002; instead of 2010 for Greece 2007 and for Japan and the USA 2009
Basis of data: OECD Main Science and Technology Indicators 2011/12 and Eurostat Yearbook 2011

5.2.1 Europe

The "Innovation Union Scoreboard" is an indicator system that comprises all individual indicators from all areas mentioned in chapter 5: R&D resources, R&D revenue and innovation. The innovation index (Summary Innovation Index – SII) is a weighted value formed from all 25 indicators of the IUS. This value provides a summarised evaluation of the national research and innovation systems that are based on indicators from all three areas "resources", "R&D revenue" and "innovation".

As shown in Figure 13 this indicator puts Germany into the top group of highly innovative European states. To further highlight Germany's position in an international comparison, the indicators that can be best compared to those used to characterise the German research and innovation system in chapter 5.1 were selected from the IUS indicators and supplementary Eurostat data. At the same time, the indicators will also cover the areas of R&D resources and R&D revenue.

Figure 25 shows the German indicator values compared to the corresponding European mean values (EU-27).[37] It is apparent that the German values all lie above the respective European mean values.

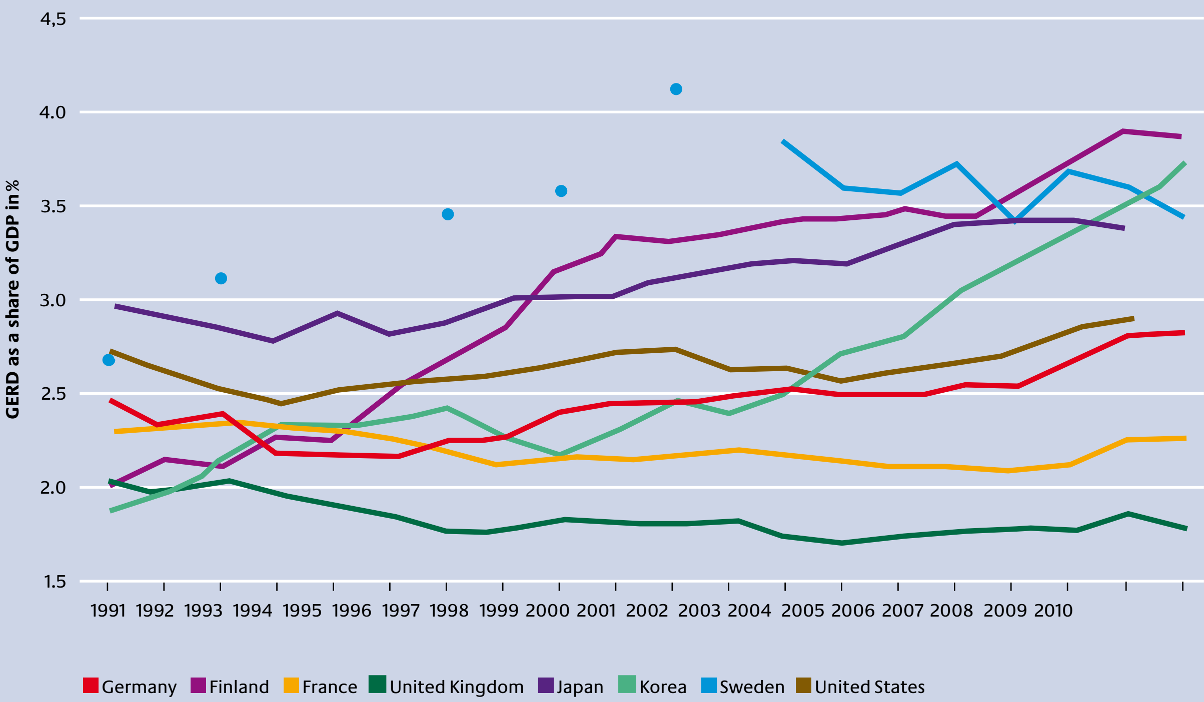
Germany achieves particularly high values (maximum values or almost maximum values in the European comparison) for patent registrations submitted to the European Patent Office (EPO).

The latter indicators deviate somewhat from those in chapter 5.1. For instance, the innovator percentages only refer to the subset of the SME and not all companies. Product and process innovators are presented together. The marketing and organisational innovations to not refer to technological innovations which are becoming the focus of interest recently.

5.2.2 OECD

The OECD provides a series of indicator sets that can be used to describe research and innovation systems. The following selection refers to indicators that were used in the OECD Science, Technology and Industry Outlook 2010. Similar to the European data, those indicators that can be best compared to those used to characterise the German research and innovation system in chapter 5.1 and those that cover the areas of R&D resources and R&D revenue were selected. Compared to other OECD indicator sets, the OECD Science, Technology and Industry Outlook is the best foundation for comparison purposes.

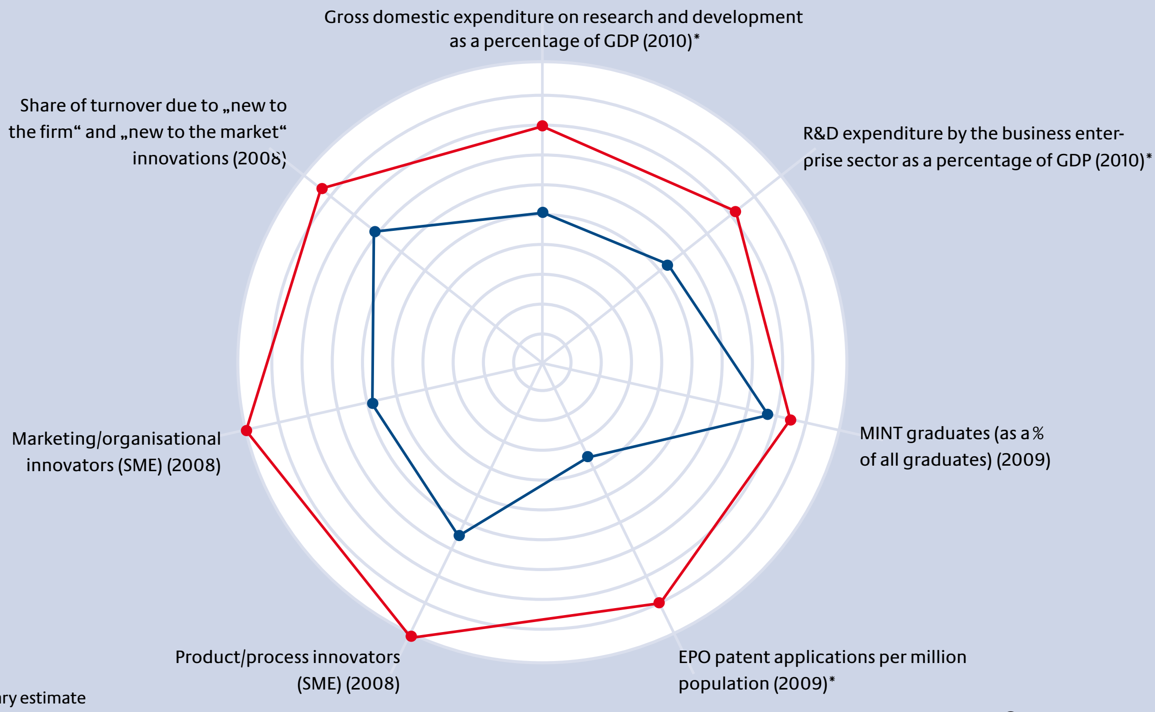
Fig. 24 Gross domestic expenditure on research and development as a percentage of the gross domestic product of selected countries 1991–2010



Basis of Data: OECD Main Science and Technology Indicators 2011/2

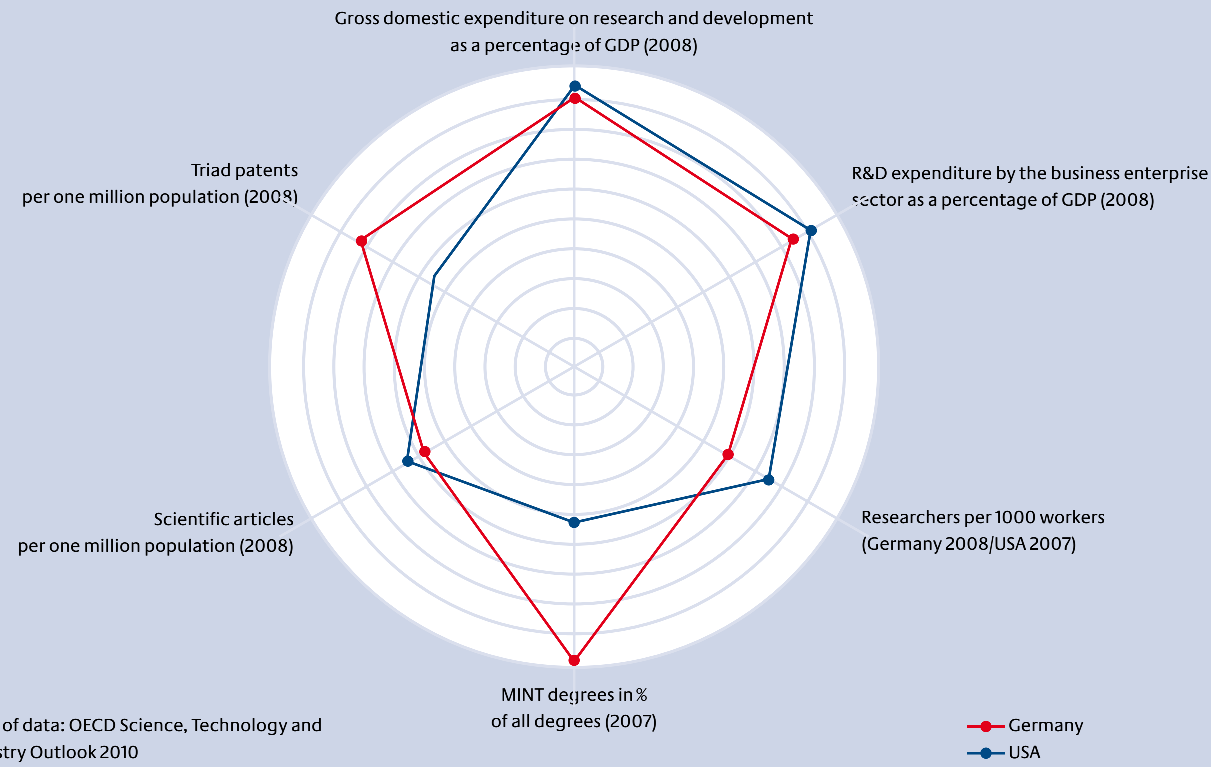
37 For the diagrams in Figure 25 the respective maximum indicator values – i.e. the value of the countries with the highest value in this dimension – were set to the scale value 100. All the values in this figure can be interpreted as percentages or percentage ratios of the respective maximum value of the scales.

Fig. 25 Selected R&D-relevant indicators: comparison of Germany and EU-27



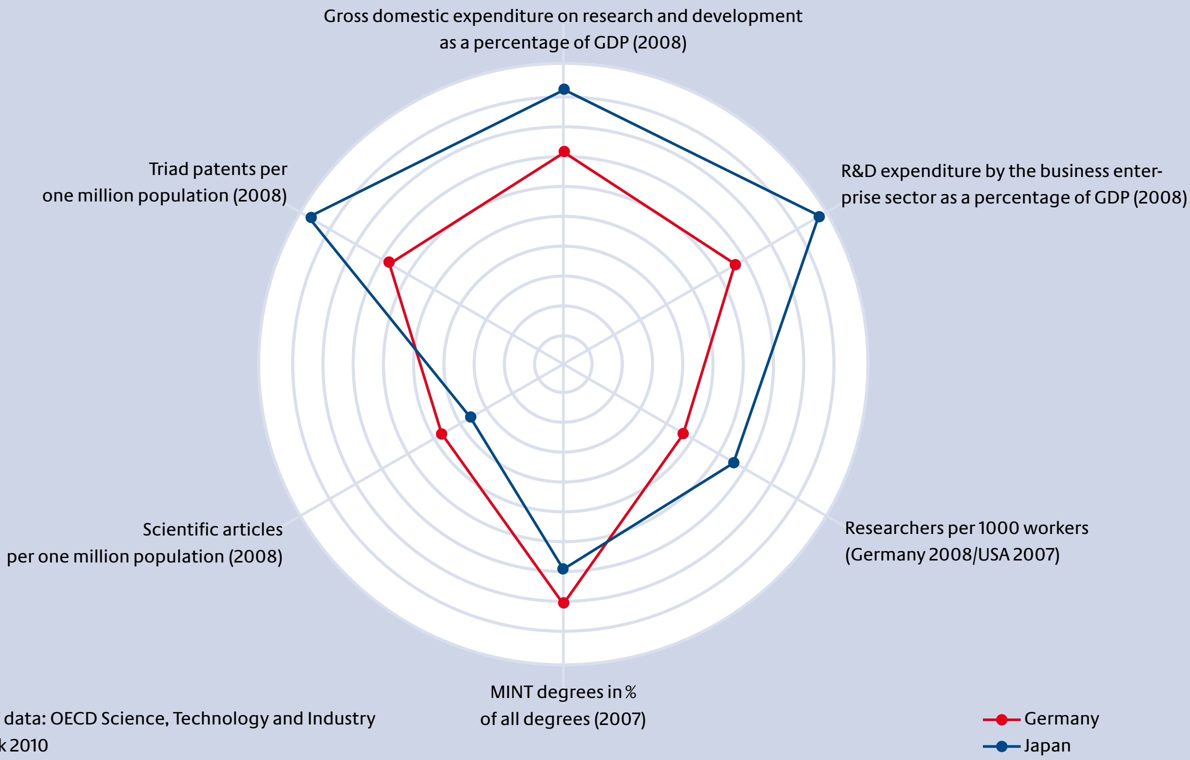
*Preliminary estimate
Basis of data: Innovation Union Scoreboard 2011; Eurostat database
Source: own calculations by VDI/VDE-IT

Fig. 26 Selected R&D-relevant indicators: comparison of Germany and the United States



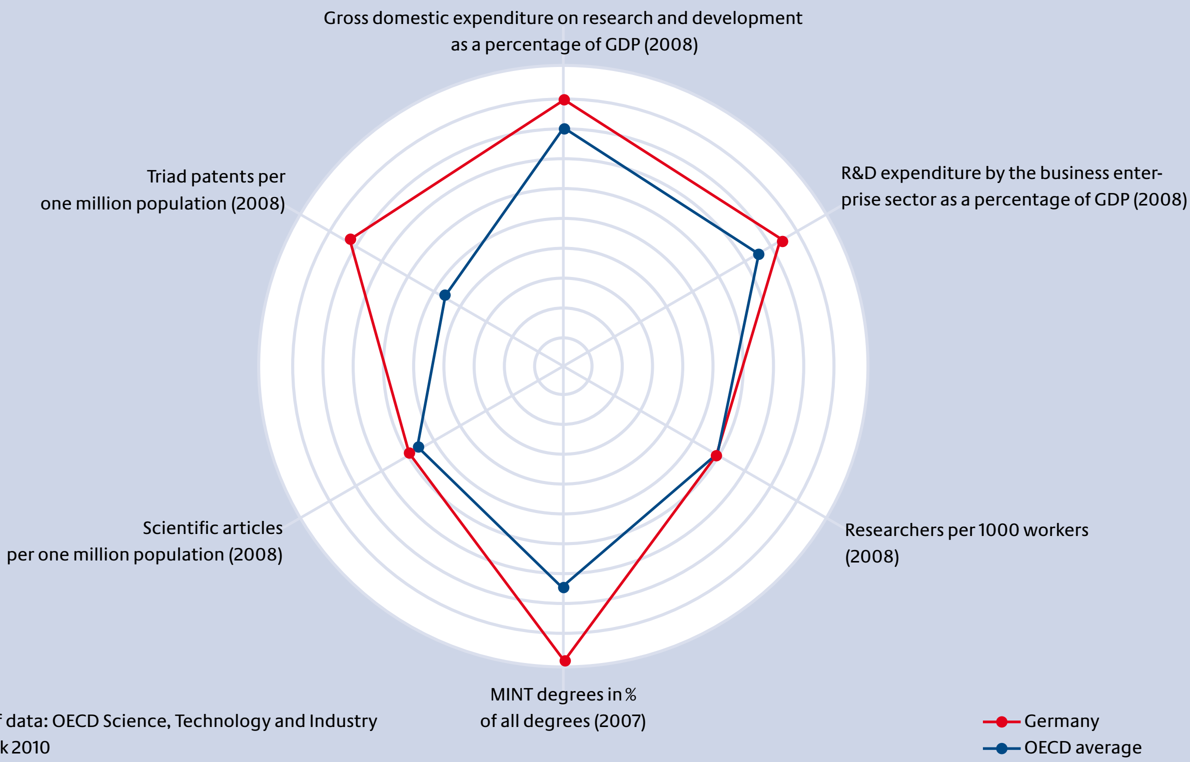
Basis of data: OECD Science, Technology and Industry Outlook 2010

Fig. 27 **Selected R&D-relevant indicators: comparison of Germany and Japan**



Basis of data: OECD Science, Technology and Industry Outlook 2010

Fig. 28 **Selected R&D-relevant indicators: Germany compared to the OECD average**



Basis of data: OECD Science, Technology and Industry Outlook 2010

In a “triad comparison” the German data is compared to that of the USA and Japan. Figure 26 shows the comparison of the German and the USA data.

Relative strengths of Germany are clearly the percentage of MINT graduates as a ratio of all graduates and the triad patents per one million citizens. Triad patents are patents that are not only registered nationally but also in the two other regions of the triad Europe-North America-East Asia.

Relative strengths of the USA are the scientific publications per one million citizens and the researchers per 1,000 workers. The GERD as a ratio of the GDP is slightly higher than in Germany. The research activities in the USA are even more driven by the business enterprise sector than in Germany.

Figure 27 shows the corresponding comparison with Japan. Relative German strengths are only apparent in two indicators: in the percentage of MINT graduates as a ratio of all graduates and (less clearly) of the scientific publications per one million citizens.

The Japanese superiority in the triad patents is remarkable. In contrast to data that refers to patents relevant for the global market – which are defined as patents that are registered in Europe or the WIPO[38] – the Japanese have a clear head start here. Also in the other indicators selected here, the Japanese values lie above those of Germany. In addition to the much higher GERD as a ratio of the GDP it is also apparent that the research activities are primarily concentrated in the business enterprise sector.

Finally, Figure 28 shows Germany in comparison to OECD mean values. Germany’s clear strengths are apparent in the ratio of MINT degrees of all graduate degrees and the triad patents.

38 World Intellectual Property Organization, a specialised agency within the United Nations.

5.3 Selected tables

The preceding sections contained diagrams and text that gave a quick overview of the status and development of the German research and innovation system. The following section contains a comprehensive collection of tables that gives readers with special interests access to detailed data on the German research and innovation system.

Explanation of terms

The sources of the data tables are the German Federal Ministry for Education and Research, the Federal Statistical Office, Stifterverband, and the Organisation for Economic Cooperation and Development (OECD). Information from the German Federal Bank, the Centre for European Economic Research (ZEW), the Lower Saxony Institute for Economic Research (Niedersächsisches Institut für Wirtschaftsforschung, NIW) and the Statistical Office of the European Commission (Eurostat) is also used.

The following definitions of the main terms used are based on national agreements or, where indicated accordingly, on the R&D manual (Frascati Manual) passed by the OECD, which defines the terms and methods for statistical evaluation of research and development. The corresponding OECD innovation manual (Oslo Manual) is also relevant for innovations. Further definitions are given in the text itself.

Expenditure

Scientific expenditure

Expenditure on research and development (R&D), expenditure on academic teaching and education and other related scientific and technological activities. The latter includes for example scientific or technological information services, data collection for general purposes, feasibility studies for technological projects (however, feasibility studies for research projects are part of R&D), developing bases for decision-making aids for politics and the private sector.

R&D expenditure

Research and experimental development (R&D) is the systematic creative work that builds on existing knowledge, including knowledge of mankind, culture and society, and that uses this knowledge with the objective of finding new applications.[39] Expenditure in relation to this work is expenditure on research and development.

39 Cf. Frascati Manual 2002, § 63

Net expenditure

Expenditure adjusted for payments within the same level of the public sector, less payments from other public sectors. It indicates the expenditure financed from internal revenue sources of the respective entity or group of entities (cost unit principle).

Direct expenditure

Expenditure for personnel, current material expenses, investments in equipment and current and capital-forming payments to other areas, unless these are payments to public organisations.

Deviations from net expenditure basically correspond to the balance of payment transactions within the government sector.

Basic funds

Net expenses from which the direct income, i.e. the income generated in the respective task area, has been deducted. This shows which funds were provided to the task area by the entity from the general budget funds.

Gross domestic expenditure on R&D

All funds used to implement research and development within a country, regardless of the source of funding; this therefore also includes overseas funding and funding from international organisations for research work performed domestically. Conversely, this does not include funding for R&D performed by international organisations with domestic locations abroad, or funding sent abroad.[40]

Internal R&D expenditure or R&D spending

All funds used for research and development nationally or within a specific sector of a national economy or within another sub-area (reporting unit), regardless of the source of funding. This does not include R&D funding paid to international organisations or abroad.[41]

External R&D expenditure or R&D spending

Expenditure on research and development made abroad, in international organisations or outside a specific sector or another sub-area of a national economy (report unit).[42]

Overall R&D expenditure or spending

Overall expenditure or spending includes internal and external expenditure or spending on R&D by a country, a sector or another sub-area of a national economy (report unit).

40 Cf. Frascati Manual 2002, § 423

41 Cf. Frascati Manual 2002, § 358 f.

42 Cf. Frascati Manual 2002, § 408

Publicly funded R&D expenditure

All R&D expenditure funded by federal government and *Länder* governments, regardless of the sector in which the research and development is performed.

Private sector expenditure on R&D

Expenditure of companies and institutions on joint industrial research and joint experimental research.

Self-financed private sector expenditure

Internal R&D expenditure financed by the private sector.

Breakdown by sector

Business enterprise sector (private sector)

Private and government companies, institutions for joint industrial research and joint experimental research, and private non-profit institutions largely funded by the private sector or which primarily provide services for companies.[43]

Universities (higher education sector)

All universities, technical colleges, universities of applied science and other tertiary institutions, regardless of their sources of funding or legal status. This also includes research institutes, experimental facilities and hospitals.[44]

Government (government sector without universities)

For national reporting, a close distinction is assumed, that is on the funding side, only the funds in the budgets of the local authorities (central and local governments) and on the implementation side, only the institutions of central and local government and communities are considered. For international reporting, the government sector also includes the private non-profit organisations that are largely funded by the government (e.g. HGF, MPG, FhG). On the funding side, the independent revenues of these organisations are also attributed to the government sector.[45]

Private non-profit sector (PNP sector)

For national reporting, this sector includes non-profit organisations funded primarily by the national government (e.g. HGF, MPG, FhG), and private non-profit organisations that are neither funded primarily by the national government nor funded primarily by the private sector, or that do not principally provide services to private sector companies.

Conversely, for international reporting, this sector only includes private non-profit organisations that are neither funded primarily by the national government nor primarily by the private sector.[46]

Abroad

On the funding side, funding from abroad, the European Union (EU) and international research and development organisations within the Federal Republic of Germany are documented, while on the implementation side, the funds paid abroad, to the EU or international organisations – even if they are located in Germany – by the Federal Republic of Germany are documented.[47]

Personnel employed in research and development (R&D personnel)

All personnel working directly in R&D regardless of their position. This includes researchers, technical and similar personnel, other personnel.[48]

Researchers

Scientists or engineers who design or create new findings, products, processes, methods and systems – generally university graduates.[49]

Technicians and equivalent staff

Personnel with technical training or corresponding training for non-technical areas who work directly in R&D, generally under the supervision of a researcher – generally graduates of technical secondary schools.[50]

Other personnel

Personnel whose work is directly linked to the performance of R&D, that is clerical, secretarial and administrative staff, technical staff, unskilled and semi-skilled assistants.[51]

Full-time equivalent

Calculation unit for full-time employment of an employee in a given period. This unit serves to convert the working hours of employees only partially involved in R&D (including part-time

43 Cf. Frascati Manual 2002, §§ 163-183

44 Cf. Frascati Manual 2002, §§ 206-228

45 Cf. Frascati Manual 2002, §§ 184-193

46 Cf. Frascati Manual 2002, §§ 194-205

47 Cf. Frascati Manual 2002, §§ 229-235

48 Cf. Frascati Manual 2002, §§ 294 ff.

49 Cf. Frascati Manual 2002, § 301

50 Cf. Frascati Manual 2002, § 306

51 Cf. Frascati Manual 2002, § 309

employees) to the working hours of a person employed full time in R&D.[52]

Innovations

Innovations

Innovations are new or markedly improved products or services introduced on the market (product innovations) or new or improved processes that are introduced (process innovations). The percentage cost reduction is the percentage of costs saved by implementing the process innovations.[53]

Innovation expenditure

More than expenditure for R&D; also incorporates licence fees, investments and advanced training for the implementation of R&D results, and so on.

Regional terms

Results for Germany as a whole

Documentation of results for the Federal Republic of Germany based on its territorial status since 3rd October 1990: Germany.

Documentation of results for regions

Documentation of results for the Federal Republic of Germany, including West Berlin, based on the territorial status until 3rd October 1990: Former territory of Federal Republic of Germany.

Documentation of results by Eastern and Western German states from 3rd October 1990: Eastern German states and Berlin (Eastern German states include Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia), Western German states excluding Berlin.

Legend

0 = less than one half in the last decimal place used, but more than zero
– = not available
. = survey not performed, not yet completed or no longer possible
X = not reported for reasons of confidentiality, but contained in the overall total

Note

Rounding differences may occur both in the tables and in the figures and cannot be ruled out.

52 Cf. Frascati Manual 2002, § 331 ff.

53 Cf. Oslo Manual 1997, § 129

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(in brackets: The figure number in the long version of the Federal Report on Research and Innovation 2012)

Tables

Tab. 1 Gross domestic expenditure on R&D (GERD) of the Federal Republic of Germany by performing sectors

Performing sector[1]		Millions of €		
		2005	2007	2009
Business enterprise sector[2]				
	financed by			
	Business enterprise sector	35 585	39 427	41 662
	Government sector	1 723	1 936	2 022
	Private non-profit sector	66	74	39
	Abroad	1 278	1 597	1 553
Total		**38 651**	**43 034**	**45 275**
Government and private non-profit sector[3]				
	financed by			
	Business enterprise sector	777	923	976
	Government sector	6 524	6 986	8 302
	Private non-profit sector	98	143	137
	Abroad	469	488	517
Total		**7 867**	**8 540**	**9 932**
University sector				
	financed by			
	Business enterprise sector	1 304	1 532	1 690
	Government sector	7 575	7 994	9 610
	Private non-profit sector	–	–	–
	Abroad	342	382	508
Total		**9 221**	**9 908**	**11 808**
Gross domestic expenditure on R&D				
	financed by			
	Business enterprise sector	37 666	41 882	44 328
	Government sector	15 821	16 915	19 933
	Private non-profit sector	164	217	176
	Abroad	2 089	2 468	2 578
Total		**55 739**	**61 482**	**67 014**
GERD in % of GDP[5]		2.51	2.53	2.82

1) Data from surveys of the relevant performing sectors. Until 1990 the former Federal Republic of Germany; as of 1991 all of Germany. Due to revision of the calculation method figures as of 1991 are only partially comparable to data from earlier publications.
2) Figures for even years are estimates. The estimated figures are based on values converted from deutschmarks (DM) into euros (€) and rounded off.
3) Companies and institutions for cooperative industrial research; intramural R&D expenditures (OECD concept) of business enterprises; until 1990 including non-apportionable government funding; as of 1992 government R&D funding for business enterprises pursuant to figures of funding institutions – Federal Government and *Länder*. The funding-source data of the Stifterverband Wissenschaftsstatistik (subsidiary of the Association of German Academic Foundations) which have been obtained from R&D-performing reporting units differ from these since the performing reporting units are not always able to identify the original funding source clearly.
4) Non-university institutions. Government: (Research) institutions of the federal government, *Länder* and municipalities; Federal government institutions as of 1981; *Länder* institutions as of 1985 only with their R&D shares. As of 1992 modified survey procedure; in 1995 the reporting scope was expanded; in 2004 partially revised; in 2005 modified calculation method.
5) From 1991 gross domestic product revised (Revision 2011).

Source: Stifterverband Wissenschaftsstatistik Federal Statistical Office and Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.1

Tab. 2 R&D expenditure of the Federal Republic of Germany and funding thereof[1]

Year	Financed by				Total R&D expenditure
	Territorial authorities[2]		Business enterprises[4]	Private non-profit institutions[5]	
	Millions of €	In % of the overall government budget[3]	Millions of €		Millions of €
1981	8 981	3.2	1 154	78	**20 214**
1983	9 475	3.2	13 011	86	**22 571**
1985	10 587	3.4	15 896	68	**26 551**
1987	11 114	3.3	18 831	122	**30 067**
1989	11 864	3.3	21 064	166	**33 094**
1991	14 821	3.2	23 935	196	**38 952**
1993	15 491	2 7	23 973	122	**39 586**
1995	15 735	2.6	24 733	104	**40 572**
1997	15 608	2.6	27 036	141	**42 785**
1999	15 965	2.7	32 411	205	**48 581**
2001	16 814	2.8	35 095	222	**52 131**
2002	17 210	2.8	35 904	242	**53 356**
2003	17 136	2.8	38 060	176	**55 372**
2004	16 791	2.7	38 394	208	**55 393**
2005	16 761	2.7	39 569	164	**56 494**
2006	17 310	2.7	42 281	211	**59 802**
2007	18 183	2.8	43 768	217	**62 168**
2008	19 874	2.9	46 890	207	**66 971**
2009	21 388	2.9	46 019	176	**67 583**

1) Data from surveys for the relevant domestic funding sectors. Until 1990, the former Federal Republic of Germany; as of 1991, all of Germany. Discrepancies from the figures in Table 1 result from use of different surveys (Table 2: survey of financing sectors; Table 1: survey of performing sectors).
2) Federal government and *Länder* governments. Funding for Federal research institutions as of 1981; funding for *Länder* research institutions as of 1983, but only R&D shares. Figures revised in comparison to figures from earlier publications as of 1991.
3) Net expenditure without social insurance. As of 1998, does not include hospitals and university clinics with commercial accounting procedures.
4) Data from surveys of the Stifterverband Wissenschaftsstatistik; from 1981 to 1989, figures include data for the R&D staff cost subsidy programme (German Federation of Industrial Cooperative Research Associations (AiF)), with an estimate for 1989, and adjusted to eliminate double counting. Figures for industry-funded R&D expenditures refer to intramural R&D expenditures and to funds that other sectors (e.g. universities, other countries) received from business enterprises. Due to revision of the calculation method, figures as of 1991 are not comparable to data from earlier publications.
5) Financed from own funds. Some figures are estimates.

Source: Federal Statistical Office, Stifterverband Wissenschaftsstatistik and Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.2

Tab. 3 Regional distribution of the total expenditure on research and development by the Federal Republic of Germany[1]

Federal *Land*	Performing of R&D							
	Total R&D expenditure							
	2003		2005		2007		2009	
	€ m	in %	€ m	in %	€ m	in %	€ m	in %
Baden-Wuerttemberg	12 322	22.6	13 702	24.6	15 676	25.5	16 351	24.4
Bavaria	11 348	20.8	11 458	20.6	12 212	19.9	13 037	19.5
Berlin	3 107	5.7	3 028	5.4	2 865	4.7	3 345	5.0
Brandenburg	550	1.0	572	1.0	651	1.1	748	1.1
Bremen	641	1.2	538	1.0	586	1.0	660	1.0
Hamburg	1 435	2.6	1 552	2.8	1 665	2.7	1 929	2.9
Hesse	5 107	9.4	5 204	9.4	5 682	9.3	6 510	9.7
Mecklenburg-Western Pomerania	395	0.7	450	0.8	456	0.7	617	0.9
Lower Saxony	5 240	9.6	4 298	7.7	5 152	8.4	5 534	8.3
North Rhine-Westphalia	8 460	15.5	8 742	15.7	9 471	15.4	10 642	15.9
Rhineland-Palatinate	1 678	3.1	1 675	3.0	1 952	3.2	2 153	3.2
Saarland	277	0.5	289	0.5	328	0.5	359	0.5
Saxony	1 841	3.4	1 992	3.6	2 406	3.9	2 482	3.7
Saxony-Anhalt	531	1.0	550	1.0	588	1.0	666	1.0
Schleswig-Holstein	732	1.3	777	1.4	851	1.4	922	1.4
Thuringia	798	1.5	805	1.4	880	1.4	985	1.5
Total for all *Länder*	**54 462**	**.**	**55 631**	**100.0**	**61 420**	**100.0**	**66 940**	**100.0**
Of which: Eastern German *Länder* and Berlin	7 222	13.3	7 397	13.3	7 844	12.8	8 844	13.2
German institutions based abroad	56	.	57	.	62	.	75	.
Total[2]	**54 539**	**.**	**55 739**	**.**	**61 482**	**.**	**67 015**	**.**

1) Estimated in some cases.
2) Including non-apportionable government funding.

Source: Federal Statistical Office, Stifterverband Wissenschaftsstatistik and Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.3

Tab. 4 1/2 Expenditure by the government for science, research and development by department

Government departments[2]	Millions of €	
	ACTUAL	
	2010	
	Total	Of which, R&D
Federal Chancellor and Federal Chancellery[3]	306.4	84.8
Federal Foreign Office	255.0	183.4
Federal Ministry of the Interior	79.5	59.0
Federal Ministry of Justice	2 5	2.5
Federal Ministry of Finance	0 8	0.8
Federal Ministry of Economics and Technology	2 618.2	2 420.2
Federal Ministry of Labour and Social Affairs	71.1	33.1
Federal Ministry of Food, Agriculture and Consumer Protection	590.6	509.0
Federal Ministry of Defence	1 320.1	1 154.0
Federal Ministry for Family Affairs, Senior Citizens, Women and Youth	23.2	23.2
Federal Ministry of Health	272 0	124.4
Federal Ministry of Transport, Building and Urban Affairs	331 7	200.6
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	397.9	227.5
Federal Ministry of Education and Research[4]	8 608.3	7 243.8
Federal Ministry for Economic Cooperation and Development	34.8	33.3
General Fiscal Administration[5]	509.6	492.9
Total expenditure	**15 421.8**	**12 792.5**

1) Status: Federal government's bill from 12.08.2011.
2) To facilitate comparison, expenditure for the new distribution of tasks has been applied retrospectively.
3) Including the expenditure by the federal government's representative for culture and media.
4) Planned expenditure, taking into account the proportional reduced global expenditure for science, R&D (2011: €155.9 million, 2012: €183.6 million).
5) Including payments for universities and projects in application-oriented research facilities in connection with the German reunification (1991 and 1995); from 2008 discontinuation of payments to the Volkswagen Foundation. In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.4

Tab. 4 2/2 Expenditure by the government for science, research and development by department

Government departments[2]	Millions of €			
	ACTUAL		Government bill	
	2011		2012[1]	
	Total	Of which, R&D	Total	Of which, R&D
Federal Chancellor and Federal Chancellery[3]	297.0	85.6	297.1	86.9
Federal Foreign Office	251.8	179.0	276.1	183.0
Federal Ministry of the Interior	69.2	47.8	74.6	52.0
Federal Ministry of Justice	2.9	2.9	2.8	2.8
Federal Ministry of Finance	1.9	1.9	2.0	2.0
Federal Ministry of Economics and Technology	2 817.8	2 620.6	3 022.1	2 805.6
Federal Ministry of Labour and Social Affairs	76.3	38.5	79.9	41.1
Federal Ministry of Food, Agriculture and Consumer Protection	609.2	516.0	614.6	520.1
Federal Ministry of Defence	1 131.7	972.4	1 144.6	976.1
Federal Ministry for Family Affairs, Senior Citizens, Women and Youth	25.0	25.0	24.7	24.7
Federal Ministry of Health	311.4	156.4	344.3	170.4
Federal Ministry of Transport, Building and Urban Affairs	348.7	224.9	321.4	197.5
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	433.9	247.6	477.3	274.3
Federal Ministry of Education and Research[4]	9 567.3	7 649.8	10 574.1	8 074.0
Federal Ministry for Economic Cooperation and Development	36.5	34.7	41.5	39.7
General Fiscal Administration[5]	903.4	877.0	368.1	368.0
Total expenditure	**16 883.9**	**13 680.1**	**17 665.0**	**13 818.2**

1) Status: Federal government's bill from 12.08.2011.
2) To facilitate comparison, expenditure for the new distribution of tasks has been applied retrospectively.
3) Including the expenditure by the federal government's representative for culture and media.
4) Planned expenditure, taking into account the proportional reduced global expenditure for science, R&D (2011: €155.9 million, 2012: €183.6 million).
5) Including payments for universities and projects in application-oriented research facilities in connection with the German reunification (1991 and 1995); from 2008 discontinuation of payments to the Volkswagen Foundation. In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.4

Tab. 5 1/6 Expenditure by the government for science. research and development for project funding. departmental research and institutional funding by funding area and funding priorities[1]

Funding area Funding priority		Millions of €			
		ACTUAL			
		2009[2]		2010[2]	
		Total	Of which. R&D	Total	Of which. R&D
A	**Health research and medical technology**	**900.4**	**749.1**	**958.9**	**798.7**
AA	Research in the health sector	857.9	716.7	923.9	774.9
AB	Patient-relevant research	4.3	3.3	3.6	2.3
AC	Health services research	7.1	6.9	2.2	1.7
AD	Research in medical technology	12.7	8.3	12.2	7.5
AE	Radiation protection	18.5	13.8	17.1	12.3
B	**Biotechnology**	**386.3**	**386.2**	**390.3**	**390.2**
C	**Civilian safety research**	**73.6**	**68.9**	**85.8**	**80.6**
D	**Nutrition. agriculture and consumer protection**	**585.5**	**501.3**	**629.0**	**540.8**
DA	Nutrition	25.8	17.4	17.7	9.6
DB	Sustainable agriculture and rural areas	308.4	284.2	327.7	308.9
DC	Health-related and commercial consumer protection	251.3	199.8	283.7	222.3
E	**Energy research and energy technologies**	**963.5**	**658.4**	**935.2**	**653.7**
EA	Rational energy conversion	46.7	45.2	38.2	36.7
EB	Renewable energies	322.5	320.3	339.0	336.8
EC	Nuclear safety and disposal	240.0	116.2	234.3	118.1
ED	Disposal of nuclear plants	210.2	33.1	191.3	30.1
EF	Fusion research	144.2	143.6	132.4	131.9
F	**Climate. environment. sustainability**	**905.2**	**738.8**	**896.1**	**724.5**
FA	Climate. climate protection; global change	126.2	124.6	126.9	125.2
FB	Coast. marine and polar research. geosciences	301.2	252.7	328.4	284.1
FC	Environment and sustainability research	237.5	160.7	216.5	144.6
FD	Ecology. nature conservation and sustainable use	240.4	200.8	224.3	170.6
G	**Information and communication technologies**	**582.0**	**551.5**	**630.3**	**599.4**
GA	Software systems; science technologies	167.0	162.3	191.2	185.6
GB	Communication technologies and services	3.4	2.0	4.5	3.2

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications. first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II). from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG. DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 5 2/6 Expenditure by the government for science, research and development for project funding, departmental research and institutional funding by funding area and funding priorities[1]

Funding area Funding priority		Millions of €			
		ACTUAL			
		2009[2]		2010[2]	
		Total	Of which, R&D	Total	Of which, R&D
GC	Electronics and electronic systems	206.1	204.1	199.8	197.9
GD	Micro-systems engineering	113.2	112.5	132.3	131.6
GE	Multimedia – development of convergent ICT	92.3	70.5	102.5	81.0
H	**Vehicle and traffic technologies including maritime technologies**	**274.2**	**199.2**	**461.9**	**377.9**
HA	Vehicle and traffic technologies	238.0	173.6	417.3	344.5
HB	Maritime technologies	36.2	25.7	44.6	33.4
I	**Aerospace**	**1 179.1**	**1 176.8**	**1 202.6**	**1 200.5**
IA	Aviation	185.1	184.6	207.7	207.3
IB	National space research and space engineering	382.8	382.1	361.9	361.3
IC	European Space Organisation ESA	611.2	610.1	633.0	631.9
J	**Research and development to improve the work conditions and in the service sector**	**118.1**	**112.5**	**126.2**	**82.5**
JA	Research to improve work conditions	108.2	106.6	113.1	73.5
JB	Research in the service sector	9.9	5.9	13.1	9.0
K	**Nanotechnologies and materials technologies**	**240.1**	**210.0**	**250.2**	**222.1**
KA	Nanotechnologies	14.2	9.5	14.7	9.8
KB	Materials technologies	225.9	200.5	235.4	212.2
L	**Optical technologies**	**110.3**	**106.4**	**116.1**	**111.9**
M	**Production technologies**	**76.9**	**75.0**	**79.6**	**77.7**
N	**Spatial planning and urban development; construction research**	**65.7**	**62.4**	**61.0**	**57.6**
NA	Spatial planning, urban development and living	26.2	26.0	18.1	17.9
NB	Construction research	39.4	36.4	42.9	39.8
O	**Innovations in education**	**621.1**	**388.7**	**755.2**	**469.2**
OA	Institutional funding	15.5	15.5	17.1	17.1
OB	Educational reporting, international assessments	415.5	247.4	500.2	310.3

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including Universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG, DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 5 3/6 Expenditure by the government for science, research and development for project funding, departmental research and institutional funding by funding area and funding priorities[1]

Funding area Funding priority		Millions of €			
		ACTUAL			
		2009[2]		2010[2]	
		Total	Of which, R&D	Total	Of which, R&D
OC	Research in the education sector	172.6	108.3	221.4	125.4
OD	New media in education	17.5	17.5	16.5	16.5
P	**Humanities; economic and social sciences**	**813.7**	**558.9**	**867.0**	**607.2**
PA	Humanities research	487.6	264.7	514.4	291.7
PB	Social science research	120.6	101.7	114.2	96.6
PC	Economic and financial science research	40.2	40.2	39.8	39.8
PD	Infrastructures	165.3	152.3	198.7	179.2
Q	**Innovation funding for small and medium-sized enterprises**	**781.8**	**772.8**	**1 053.5**	**1 042.5**
QA	Start-up funding	75.5	75.5	75.6	75.6
QB	Technology funding for small and medium-sized enterprises	413.0	409.5	661.2	656.2
QC	Technology transfer and innovation consulting	98.6	93.5	123.7	118.1
QD	Research infrastructure for small and medium-sized enterprises	194.6	194.2	193.0	192.7
R	**Innovation-relevant underlying conditions and other cross-cutting activities**	**105.3**	**72.6**	**117.1**	**82.2**
RB	Structural cross-cutting activities	1.6	1.1	1.6	1.2
RC	Other	103.8	71.5	115.5	81.0
T	**Funding organisations, restructuring of the research field in acceding areas; construction of universities and primarily university-specific special programmes[5]**	**3 716.8**	**2 721.5**	**3 749.9**	**2 682.1**
TA	TA Basic funding for research institutes[6]	1.954.5	1.954.3	1.927.1	1.926.9
TB	Other	1.762.4	767.2	1.822.8	755.2
U	**Large appliances in the basic research field**	**814.1**	**813.8**	**861.1**	**860.9**
Z	**Global reduced expenditure; budget reserve[7]**	–	–	–	–
Civilian funding areas combined		**13 313.9**	**10 924.9**	**14 227.2**	**11 662.2**
S	**Military science research**	**1 159.8**	**1 097.1**	**1 194.6**	**1 130.3**
SA	Military medicine and military psychology research	40.1	13.8	41.3	12.8
SB	Defence research	1 096.8	1 078.0	1 130.4	1 111.9
SC	Social science research	1.8	1.2	1.6	1.0
SD	Military history research	7.1	2.8	7.9	3.3
SE	Geoscientific research	14.0	1.3	13.4	1.2
Total expenses[8]		**14 473.7**	**12 022.0**	**15 421.8**	**12 792.5**

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including Universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG, DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 5 4/6 Expenditure by the government for science, research and development for project funding, departmental research and institutional funding by funding area and funding priorities[11]

Funding area Funding priority		Millions of €			
		ACTUAL		Government bill	
		2011[2, 3]		2012[2,3, 4]	
		Total	Of which, R&D	Total	Of which, R&D
A	**Health research and medical technology**	**1 038.7**	**872.3**	**1 287.0**	**1 100.3**
AA	Research in the health sector	1 002.3	846.7	1 244.8	1 071.3
AB	Patient-relevant research	4.2	2.8	6.0	4.1
AC	Health services research	2.8	2.2	4.8	3.7
AD	Research in medical technology	12.1	7.6	13.2	7.8
AE	Radiation protection	17.3	13.0	18.3	13.4
B	**Biotechnology**	**390.9**	**390.8**	**253.9**	**253.8**
C	**Civilian safety research**	**88.2**	**83.3**	**91.4**	**86.3**
D	**Nutrition, agriculture and consumer protection**	**645.2**	**545.9**	**652.2**	**550.9**
DA	Nutrition	27.0	18.1	24.2	15.2
DB	Sustainable agriculture and rural areas	368.9	349.7	371.3	350.9
DC	Health-related and commercial consumer protection	249.3	178.1	256.8	184.8
E	**Energy research and energy technologies**	**1 138.7**	**772.6**	**1 181.0**	**824.2**
EA	Rational energy conversion	82.6	81.3	77.2	75.7
EB	Renewable energies	393.7	391.7	429.6	427.4
EC	Nuclear safety and disposal	250.1	120.9	268.7	125.7
ED	Disposal of nuclear plants	266.9	33.9	245.3	35.7
EF	Fusion research	145.3	144.8	160.3	159.7
F	**Climate, environment, sustainability**	**980.3**	**802.0**	**1 042.8**	**858.4**
FA	Climate, climate protection; global change	158.7	156.6	196.1	194.5
FB	Coast, marine and polar research, geosciences	369.7	320.8	354.1	303.5
FC	Environment and sustainability research	265.4	190.1	285.9	207.0
FD	Ecology, nature conservation and sustainable use	186.6	134.5	206.7	153.4
G	**Information and communication technologies**	**632.1**	**600.3**	**604.1**	**574.3**
GA	Software systems; science technologies	186.9	182.0	192.0	191.4
GB	Communication technologies and services	3.8	2.6	5.4	4.0

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including Universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG, DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 5 5/6 Expenditure by the government for science, research and development for project funding, departmental research and institutional funding by funding area and funding priorities[1]

Funding area / Funding priority		Millions of €			
		ACTUAL		Government bill	
		2011[2,3]		2012[2,3,4]	
		Total	Of which, R&D	Total	Of which, R&D
GC	Electronics and electronic systems	213.7	211.9	182.9	181.0
GD	Micro-systems engineering	133.8	133.1	138.6	137.9
GE	Multimedia – development of convergent ICT	94.0	70.7	85.1	59.9
H	**Vehicle and traffic technologies including maritime technologies**	**642.9**	**555.4**	**603.1**	**528.6**
HA	Vehicle and traffic technologies	599.2	523.3	557.1	494.4
HB	Maritime technologies	43.8	32.1	46.0	34.3
I	**Aerospace**	**1 273.5**	**1 271.6**	**1 308.5**	**1 306.3**
IA	Aviation	250.3	249.9	260.2	259.8
IB	National space research and space engineering	388.1	387.5	425.6	425.0
IC	European Space Organisation ESA	635.2	634.2	622.7	621.6
J	**Research and development to improve the work conditions and in the service sector**	**118.0**	**75.1**	**84.1**	**39.5**
JA	Research to improve work conditions	106.2	66.9	70.8	30.4
JB	Research in the service sector	11.8	8.1	13.3	9.2
K	**Nanotechnologies and materials technologies**	**240.9**	**213.3**	**216.2**	**187.3**
KA	Nanotechnologies	13.7	9.2	14.9	9.9
KB	Materials technologies	227.3	204.2	201.4	177.4
L	**Optical technologies**	**112.4**	**108.7**	**121.7**	**117.5**
M	**Production technologies**	**76.3**	**74.6**	**92.9**	**91.0**
N	**Spatial planning and urban development; construction research**	**58.1**	**54.5**	**73.7**	**69.9**
NA	Spatial planning, urban development and living	17.5	17.1	21.6	21.2
NB	Construction research	40.7	37.4	52.1	48.7
O	**Innovations in education**	**859.8**	**448.3**	**954.0**	**474.1**
OA	Institutional funding	18.5	18.5	20.2	20.2
OB	Educational reporting, international assessments	461.9	292.3	494.9	306.2

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including Universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG, DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 5 6/6 Expenditure by the government for science, research and development for project funding, departmental research and institutional funding by funding area and funding priorities[1]

Funding area Funding priority		Millions of €			
		ACTUAL		Government bill	
		2011[2,3]		2012[2,3,4]	
		Total	Of which, R&D	Total	Of which, R&D
OC	Education research	369.4	127.5	428.9	137.7
OD	New media in education	10.0	10.0	10.0	10.0
P	**Humanities; economic and social sciences**	**910.4**	**660.8**	**980.2**	**708.5**
PA	Humanities research	543.9	332.1	579.0	368.3
PB	Social science research	122.7	103.9	156.9	115.6
PC	Economic and financial science research	41.9	41.9	43.6	43.6
PD	Infrastructures	201.9	182.9	200.8	181.1
Q	**Innovation funding for small and medium-sized enterprises**	**1 367.2**	**1 356.1**	**1 016.9**	**1 007.5**
QA	Start-up funding	78.5	78.5	76.9	76.9
QB	Technology funding for small and medium-sized enterprises	936.7	931.2	567.1	563.7
QC	Technology transfer and innovation counselling	157.2	151.9	173.0	167.3
QD	Research infrastructure for small and medium-sized enterprises	194.8	194.5	200.0	199.6
R	**Innovation-relevant underlying conditions and other cross-cutting activities**	**123.6**	**90.4**	**129.6**	**94.4**
RB	Structural cross-cutting activities	1.5	1.1	1.6	1.1
RC	Other	122.2	89.3	128.0	93.2
T	**Funding organisations, restructuring of the research field in acceding areas; construction of universities and primarily university-specific special programmes[5]**	**4 390.8**	**2 974.1**	**5 044.0**	**3 084.9**
TA	Basic funding for research institutes[6]	2 023.6	2 023.5	2 442.9	2 442.7
TB	Other	2 367.2	950.6	2 601.2	642.2
U	**Large appliances in the basic research field**	**935.2**	**935.0**	**1 091.9**	**1 091.6**
Z	**Global reduced expenditure; budget reserve[7]**	**–155.9**	**–155.9**	**–183.6**	**–183.6**
Civilian funding areas combined		**15 867.7**	**12 729.4**	**16 645.6**	**12 865.7**
S	**Military science research**	**1 016.2**	**950.7**	**1 019.4**	**952.5**
SA	Military medicine and Military psychology research	43.4	15.1	43.2	14.9
SB	Defence research	948.7	929.8	952.1	931.8
SC	Social science research	1.8	1.2	1.6	1.0
SD	Military history research	7.9	3.4	8.1	3.5
SE	Geoscientific research	14.4	1.3	14.4	1.3
Total expenditure[8]		**16 883.9**	**13 680.1**	**17 665.0**	**13 818.2**

1) According to the federal government's planning system 2009. Expenditure was implemented in accordance with the federal government's planning system 2009.
2) In comparison to earlier publications, first presentation 2009–2011 including investment and redemption fund without state allocations (economic stimulus package II), from 2011 including energy and climate funds (from 2012 including electro mobility).
3) Distribution of funding areas and funding priorities estimated in some cases.
4) Status: federal government's bill from 12.08.2011.
5) Including Universities of the Federal Armed Forces and the Federal University of Applied Administrative Sciences.
6) Basic funding of the research institutes MPG, DFG and FhG.
7) The distribution of the global reduced expenditure of the BMBF to funding areas or funding priorities can only be carried out in the ACTUAL.
8) Slight differences compared to earlier publications due to subsequent amendments to the allocation to the funding areas/funding priorities and the budget bill 2011.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.5

Tab. 6 Expenditure by the government for science, research and development by recipient group

Recipient group		Millions of €			
		ACTUAL			
		2009[1]		2010[1]	
		Total	Of which, R&D	Total	Of which, R&D
1.	**Territorial authorities**	**4 084.0**	**2 240.6**	**4 322.9**	**2 323.1**
1.1	Federal Government	1 871.5	926.2	1 929.6	925.3
1.1.1	Federal Government-owned research institutions	1 631.2	869.1	1 680.3	866.2
1.1.2	Other institutions of Federal administration[2]	240.3	57.2	249.4	59.1
1.2	*Länder* and communities	2 212.5	1 314.4	2 393.2	1 397.8
1.2.1	Research institutions of the *Länder*	103.0	98.6	109.6	104.3
1.2.2	Universities and university hospitals[3]	2 043.5	1 156.5	2 195.6	1 224.2
1.2.3	Other institutions of the *Länder*	36.3	32.8	49.8	40.2
1.2.4	Communities, local authority and special-purpose associations	29.6	26.5	38.3	29.2
2.	**Private non-profit organisations[4]**	**6 858.8**	**6 344.2**	**7 192.6**	**6 665.8**
2.1	Research funding organisations	3 315.1	3 147.8	3 591.1	3 395.4
2.2	Helmholtz Association of German Research Centres (HGF)	2 504.1	2 333.0	2 503.4	2 343.0
2.3	Other non-profit science organisations	946.1	788.0	985.4	840.2
2.4	Other non-profit organisations	93.5	75.4	112.7	87.2
3.	**Business enterprise[6]**	**2 338.6**	**2 296.3**	**2 667.3**	**2 618.7**
3.1	Business enterprises	1 617.4	1 595.7	1 862.3	1 840.7
3.2	Services if rendered by companies and the professions	721.2	700.7	804.9	777.9
4.	**Abroad**	**1 188.8**	**1 138.3**	**1 235.1**	**1 182.7**
4.1	Payments to business enterprises abroad	150.6	146.9	154.5	149.1
4.2	Contributions to international organisations and other payments to recipients abroad	1 038.2	991.4	1 080.6	1 033.6
5.	**Cross-group positions**	**3.5**	**2.5**	**4.0**	**2.2**
Total expenditure[7]		**14 473.7**	**12 022.0**	**15 421.8**	**12 792.5**
	For information:				
	Business enterprises[6]	2 338.6	2 296.3	2 667.3	2 618.7
	Of which:				
	Federal Ministry of Economics	863.8	857.5	822.3	814.8
	Federal Ministry of Defence	645.2	645.2	606.6	606.6
	Federal Ministry of Education and Research	585.8	550.7	643.5	607.9

1) In comparison to earlier publications, first presentation including investment and redemption fund without state allocations (economic stimulus package II).
2) Including Universities of the Federal Armed Forces. Discrepancies in R&D expenditures with regard to earlier publications are due to retroactive revision of the R&D coefficient for the BMBF's expenditure on university expansion and construction.
3)Not including basic funding for DFG and funding for collaborative research centres.
4) Without funds to international organisations situated overseas.
5) Including basic funding for DFG and funding for collaborative research centres.
6)Including funding to promote contract research; differentiation in keeping with the classification of economic activities; not including funding for business enterprises abroad.
7)Minor discrepancies with regard to earlier publications are due to subsequent data collection and/or retroactive revision of the allocation to recipient groups.

Source: Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.1.8

Tab. 7 1/2 Gross domestic expenditure for research and development by funding and performing sectors in selected OECD states

Country	Year[1]	R&D expenditure		Financed by			Performed by			
		Millions of US $[2]	Share of GDP in %	Business enterprise sector	Govern-ment sector	Other domestic sources and abroad	Business enterprise sector	Govern-ment sector	University sector[3]	PNP-sector[4]
				Share in %						
Germany	**2005**	64 298.8	2.49	67.6	28.4	4.0	69.3	14.1	16.5	.
	2006	70 156.4	2.53	68.3	27.5	4.2	70.0	13.9	16.1	.
	2007	7 071.8	2.53	68.1	27.5	4.4	70.0	13.9	16.1	.
	2008	81 849.4	2.68	67.3	28.4	4.3	69.2	14.0	16.7	.
	2009	82 730.7	2.78	.	.	.	67.5	14.9	17.6	.
Finland	**2005**	5 601.2	3.48	66.9	25.7	7.5	70.8	9.6	19.0	0.6
	2006	6 061.9	3.48	66.6	25.1	8.3	71.3	9.3	18.7	0.6
	2007	6 641.5	3.47	68.2	24.1	7.7	72.3	8.5	18.7	0.6
	2008	7 472.9	3.72	70.3	21.8	7.9	74.3	8.0	17.2	0.5
	2009	7 457.8	3.96	68.1	24.0	7.9	71.4	9.1	18.9	0.6
France	**2005**	39 235.7	2.10	51.9	38.6	9.4	62.1	17.8	18.8	1.3
	2006	41 969.6	2.10	52.3	38.5	9.2	63.1	16.5	19.2	1.2
	2007	44.044.8	2.07	52.3	38.1	9.6	63.0	16.4	19.5	1.2
	2008	46 262.3	2.11	50.7	38.9	10.3	62.8	15.9	20.0	1.2
	2009	47 953.5	2.21	.	.	.	61.9	16.3	20.6	1.2
United Kingdom	**2005**	34 080.7	1.73	42.1	32.7	25.2	61.4	10.6	25.7	2.3
	2006	37 007.5	1.75	45.2	31.9	22.9	61.7	10.0	26.1	2.2
	2007	38 760.4	1.78	46.0	30.9	23.1	62.5	9.2	26.1	2.2
	2008	40 096.4	1.77	45.4	30.7	23.9	62.0	9.2	26.5	2.4
	2009	40 279.5	1.85	44.5	32.6	22.9	60.4	9.2	27.9	2.5
Italy	**2005**	17 999.0	1.09	39.7	50.7	9.7	50.4	17.3	30.2	2.1
	2006	20 186.3	1.13	40.4	47.0	12.6	48.8	17.2	30.3	3.7
	2007	22 331.9	1.18	42.0	44.3	13.7	51.9	14.5	30.1	3.5
	2008	24 510.2	1.23	45.2	42.9	11.9	52.7	12.5	31.6	3.2
	2009	24 752.6	1.27	.	.	.	51.5	13.9	31.4	3.2

1) Values have been revised in some cases and are preliminary or estimated or cannot be fully compared to previous years (see original publication "Main Scienceand Technology Indicators").
2) Nominal expenditures, converted into US$ purchasing-power parities.
3) Including general funding for university research.
4) PNP: Private non-profit sector.
5) 2008: National estimate or forecast.
6) Funding contributions by the state sector have been modified by the secretary's office to meet the standards of the Frascati Manual. 2008 break in series.
7) Predominantly without expenditure for investments; implementation proportions by the state sector only taken into account with federal expenditure. 2008 preliminary.

Source: OECD (Main Science and Technology Indicators 2011/1, Tables 01-G_PPP, 02-G_XGDP, 13-G_XFB, 14-G_XFG, 15-G_XFON, 16-G_XFA, 17-G_XEB, 19-G_XEG, 18-G_XEH, 20-G_XEI) and calculations by the Federal Ministry of Education and Research

Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.3.1

Tab. 7 2/2 Gross domestic expenditure for research and development by funding and performing sectors in selected OECD states

Country	Year[1]	R&D expenditure		Financed by			Performed by			
		Millions of US $[2]	Share of GDP in %	Business enterprise sector	Govern-ment sector	Other domestic sources and abroad	Business enterprise sector	Govern-ment sector	University sector[3]	PNP-sector[4]
				Share in %						
Sweden[5]	2005	10 509.9	3.56	63.9	24.5	11.7	72.7	5.0	22.0	0.3
	2006	11 936.9	3.68	.	.	.	74.7	4.5	20.6	0.2
	2007	11 960.5	3.40	62.3	24.9	12.7	72.7	5.0	22.2	0.2
	2008	13 448.9	3.70	.	.	.	74.1	4.4	21.3	0.2
	2009	12 494.9	3.62	58.8	27.4	13.7	70.4	4.4	25.1	0.1
Japan[6]	2005	128 694.6	3.32	76.1	16.8	7.1	76.4	8.3	13.4	1.9
	2006	138 612.9	3.40	77.1	16.2	6.7	77.2	8.3	12.7	1.9
	2007	147 768.2	3.44	77.7	15.6	6.7	77.9	7.8	12.6	1.7
	2008	148 719.2	3.44	78.2	15.6	6.2	78.5	8.3	11.6	1.6
	2009	137 908.6	3.33	75.3	17.7	7.1	75.8	9.2	13.4	1.6
Canada	2005	23 090.0	2.04	49.3	31.8	18.9	55.8	9.7	34.0	0.5
	2006	24 070.4	2.00	51.1	31.1	17.8	56.7	9.7	33.1	0.5
	2007	24 705.3	1.96	49.9	32.1	18.1	55.6	9.8	34.0	0.5
	2008	24 217.6	1.87	48.4	34.1	17.5	52.8	10.0	36.6	0.6
	2009	24 551.3	1.92	47.6	33.4	19.0	51.7	10.1	37.6	0.6
United States[7]	2005	323 047.0	2.57	64.3	30.2	5.4	70.0	11.9	14.0	4.1
	2006	347 809.0	2.61	65.3	29.3	5.4	71.2	11.4	13.5	3.9
	2007	373 185.0	2.67	66.2	28.3	5.5	72.2	10.8	13.1	3.9
	2008	398 194.0	2.79	67.3	27.1	5.7	72.6	10.6	12.8	3.9
	2009	.	.	.	.	.	.	.	.	.

1) Values have been revised in some cases and are preliminary or estimated or cannot be fully compared to previous years (see original publication "Main Scienceand Technology Indicators").
2) Nominal expenditures, converted into US$ purchasing-power parities.
3) Including general funding for university research.
4) PNP: Private non-profit sector.
5) 2008: National estimate or forecast.
6) Funding contributions by the state sector have been modified by the secretary's office to meet the standards of the Frascati Manual. 2008 break in series.
7) Predominantly without expenditure for investments; implementation proportions by the state sector only taken into account with federal expenditure. 2008 preliminary.

Source: OECD (Main Science and Technology Indicators 2011/1, Tables 01-G_PPP, 02-G_XGDP, 13-G_XFB, 14-G_XFG, 15-G_XFON, 16-G_XFA, 17-G_XEB, 19-G_XEG, 18-G_XEH, 20-G_XEI) and calculations by the Federal Ministry of Education and Research

Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.3.1

Tab. 8 1/2 Employees, turnover and internal R&D expenditure of the private sector by business sector and workforce classes[1]

Industry sector[2]			2009					
			Employees[3]	Turnover[3]	Internal R&D expenditure			
					Total	Per employee	Share of turn-over	For information: Total in the Eastern German *Länder* and Berlin
			Thousand	**€ m**	**€ m**	**€ 1,000**	**in %**	**€ m**
A	**01–03**	**Agriculture, hunting and forestry; fishing**	**5**	**1 030**	**131**	**26.2**	**12.7**	**31**
B	**05–09**	**Mining and quarrying**	**31**	**15 284**	**13**	**0.4**	**0.1**	**1**
C	**10–33**	**Manufacturing**	**3 147**	**903 031**	**38 711**	**12.3**	**4.3**	**2 158**
	10–12	Manufacture of food products and beverages; manufacture of tobacco products	120	48 784	318	2.7	0.7	19
	13–15	Manufacture of textiles and apparel	29	5 914	126	4.3	2.1	22
	16–18	Manufacture of wood and wood products excluding furniture	56	15 074	176	3.1	1.2	29
	19	Manufacture of coke, refined petroleum products and nuclear fuel	9	38 975	93	10.3	0.2	1
	20	Manufacture of chemicals and chemical products	246	84 595	3 198	13.0	3.8	114
	21	Pharmaceutical industry	114	42 812	3 896	34.2	9.1	312
	22	Manufacture of rubber and plastic products	144	29 690	847	5.9	2.9	26
	23	Manufacture of glass, ceramics and non-metallic mineral products	68	13 021	288	4.2	2.2	29
	24	Manufacture of basic metals; manufacture of fabricated metal products	152	52 279	495	3.3	0.9	26
	25	Metal products	187	34 266	712	3.8	2.1	66
	26	DP equipment, electronic and optical goods	382	75 357	5.815	15.2	7.7	743
	27	Electrical equipment	161	33 294	1.333	8.3	4.0	63
	28	Mechanical engineering	551	116 632	4.499	8.2	3.9	340
	29	Motor vehicles and parts	718	263 035	13.821	19.2	5.3	147
	30	Other vehicle construction	104	26 741	2.056	19.8	7.7	51
	31–33	Other goods manufacturing	105	22 562	1.039	9.9	4.6	169
D,E	**35–39**	**Energy and water supply, disposal**	**148**	**139 235**	**216**	**1.5**	**0.2**	**35**
F	**41–43**	**Real estate, renting and business activities**	**71**	**13 124**	**69**	**1.0**	**0.5**	**28**

1) Not including institutions for cooperative industrial research and experimental development.
2) Classification of the economic sectors, issue 2008.
3) Employees and revenue of the companies with (internal and/or external) R&D expenditure.

Source: Stifterverband Wissenschaftsstatistik
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.5.2

Tab. 8 2/2 Employees, turnover and internal R&D expenditure of the private sector by business sector and workforce classes[1]

Industry sector[2]			2009					
			Employees[3]	Turnover[3]	Internal R&D expenditure			
					Total	Per employee	Share of turn-over	For information: Total in the Eastern German *Länder* and Berlin
			Thousand	€ m	€ m	€ 1,000	in %	€ m
J	**58–63**	**Information and communication**	**229**	**50 241**	**2 564**	**11.2**	**5.1**	**2 564**
K	**64–66**	**Financial and insurance services**	**72**	**57 671**	**335**	**4.7**	**0.6**	**335**
M	**69–75**	**Other community, social and personal service activities**	**196**	**27 224**	**2 629**	**13.4**	**9.7**	**2 629**
G–I	**L, N–U**	**Remaining categories**	**160**	**72.022**	**313**	**2.0**	**0.4**	**313**
Total			**4 058**	**1 278 862**	**44 983**	**11.1**	**3.5**	**44 983**
Employee size category								
Companies with employees								
		less than 100	232	38 316	2 372	10.2	6.2	816
		100 to 249	315	64 063	2 335	7.4	3.6	458
		250 to 499	337	81 129	2 330	6.9	2.9	180
		sub-total	**884**	**183 508**	**2 688**	**3.0**	**1.5**	**1 454**
		500 to 999	348	99 355	9 725	27.9	9.8	262
		1 000 to 1 999	430	119 763	4 101	9.5	3.4	131
		2 000 to 4 999	505	168 463	5 766	11.4	3.4	479
		5 000 to 9 999	387	180 942	5 640	14.6	3.1	123
		10 000 and over	1 505	526 831	19 751	13.1	3.7	959
		sub-total	**3 175**	**1 095 354**	**35 258**	**11.1**	**3.2**	**1 954**
Total			**4 058**	**1 278,862**	**44 983**	**11.1**	**3.5**	**3 408**

1) Not including institutions for cooperative industrial research and experimental development.
2) Classification of the economic sectors, issue 2008.
3) Employees and revenue of the companies with (internal and/or external) R&D expenditure.

Source: Stifterverband Wissenschaftsstatistik
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.5.2

Tab. 9 1/2 R&D personnel by personnel groups and sectors

Sector (OECD differentiation)	Year (ACTUAL)	Full-time equivalents			
		Total	Of which:		
			Researchers	Technicians	Others
1. Business enterprise sector[1,2]	1995	283 316	129 370	78 155	75 791
	2000	312 490	153 026	81 654	77 810
	2005	304 502	166 874	76 256	61 372
	2006	312 145	171 063	78 170	62 912
	2007	321 853	174 307	83 563	63 983
	2008	332 909	180 295	86 433	66 181
	2009	332 491	183 214	88 002	61 275
2. Government sector[3 4]	1995	75 148	37 324	20 380	17 444
	2000	71 454	37 667	17 599	16 188
	2005	76 254	39 911	8 420	27 923
	2006	78 357	41 486	10 383	26 487
	2007	80 644	43 561	11 751	25 332
	2008	83 066	45 342	11 815	25 910
	2009	86 633	49 241	12 274	25 118
3. University sector[5]	1995	100 674	64 434	13 636	22 604
	2000	100 790	67 087	12 151	21 551
	2005	94 522	65 363	9 902	19 258
	2006	97 433	67 273	10 369	19 791
	2007	103 953	72 985	11 836	19 132
	2008	106 712	76 831	11 384	18 497
	2009	115 441	84 771	11 365	19 305
4. Total	1995	459 138	**231 128**	**112 171**	**115 839**
	2000	484 734	**257 780**	**111 404**	115 549
	2005	475 278	**272 148**	**94 578**	**108 553**
	2006	487 935	**279 822**	**98 922**	**109 190**
	2007	506 450	**290 853**	**107 150**	**108 447**
	2008	522 688	**302 467**	**109 632**	**110 588**
	2009	534 565	**317 226**	**111 641**	**105 698**

1) Even years have been estimated.
2) 2006 and 2008: in even years, distribution to personnel groups is the same as the respective previous year. Rounding differences.
3) State institutes and private non-profit scientific organisations primarily funded by the state.
4) From 2003 onwards, the difference between technical and other personnel was modified for methodical reasons.
Therefore, expenditure from 2003 onwards cannot be fully compared to the previous years.
5) Information on the university sector based on the full-time personnel of the private and state universities (IST) and calculated in accordance with the procedure agreed by the Conference of Education Ministers, the German Council of Science and Humanities, the Federal Ministry of Education and Research and the Federal Statistical Office.

Source: Stifterverband Wissenschaftsstatistik and Federal Statistical Office
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.7.1

Tab. 9 2/2 R&D personnel by personnel groups and sectors

Sector (OECD differentiation)	Year (ACTUAL)	Full-time equivalents			
		Total	Of which:		
			Researchers	Technicians	Others
of which: Eastern German *Länder* and Berlin					
1. Business enterprise sector[1,2]	**1995**	**32 611**	19 768	5 402	7 443
	2000	**36 220**	21 370	7 790	7 060
	2005	**29 525**	17 393	6 696	5 436
	2006	**30 260**	17 826	6 863	5 571
	2007	**31 509**	18 194	7 825	5 490
	2008	**32 591**	18 819	8 094	5 679
	2009	**33 189**	19 386	8 642	5 164
2. Government sector[3 4]	**1995**	**20 782**	11 481	4 894	4 407
	2000	**19 951**	11 641	4 372	3 938
	2005	**21 970**	12 012	2 018	7 940
	2006	**23 019**	13 083	2 556	7 379
	2007	**23 955**	13 950	2 823	7 182
	2008	**24 916**	14 477	2 989	7 451
	2009	**25 741**	15 421	3 096	7 224
3. University sector[5]	**1995**	**24 601**	15 484	3 214	5 901
	2000	**23 032**	15 415	2 494	5 122
	2005	**22 441**	15 579	1 896	4 966
	2006	**22 454**	15 650	1 940	4 863
	2007	**23 184**	16 636	2 203	4 345
	2008	**24 075**	17 695	2 212	4 168
	2009	**26 018**	19 533	2 360	4 126
4. Total	**1995**	**77 994**	**46 733**	**13 510**	**17 751**
	2000	**79 203**	**48 426**	**14 657**	**16 120**
	2005	**73 936**	**44 984**	**10 610**	**18 342**
	2006	**75 733**	**46 559**	**11 359**	**17 813**
	2007	**78 648**	**48 780**	**12 851**	**17 017**
	2008	**81 582**	**50 991**	**13 295**	**17 297**
	2009	**84 948**	**54 340**	**14 098**	**16 513**

1) Even years have been estimated.
2) 2006 and 2008: in even years, distribution to personnel groups is the same as the respective previous year. Rounding differences.
3) State institutes and private non-profit scientific organisations primarily funded by the state.
4) From 2003 onwards, the difference between technical and other personnel was modified for methodical reasons. Therefore, expenditure from 2003 onwards cannot be fully compared to the previous years.
5) Information on the university sector based on the full-time personnel of the private and state universities (IST) and calculated in accordance with the procedure agreed by the Conference of Education Ministers, the German Council of Science and Humanities, the Federal Ministry of Education and Research and the Federal Statistical Office.

Source: Stifterverband Wissenschaftsstatistik and Federal Statistical Office
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.7.1

Tab. 10 1/2 R&D personnel in EU Member States and selected OECD Member States by personnel groups and sectors[1]

Country	Year	Full-time equivalents						
		Resear chers	Technicians and other staff	Total R&D personnel		Of which, active in the		
						Business enterprise sector	University sector	Government and PNP[4] sector
		Number			per 1,000 labour force	Share in %		
Germany	**2005**	272 148	203 130	**475 278**	11 6	64 1	19 9	16 0
	2008	302 467	220 221	**522 688**	12 5	63 7	20 4	15 9
	2009	311 519	218 007	**529 526**	12 7	62 2	21 4	16 4
Finland	**2005**	39 582	18 675	**58 257**	21 8	56 6	30 0	13 4
	2008	40 879	15 819	**56 698**	20 8	58 4	28 2	13 4
	2009	40 849	15 220	**56 069**	20 8	57 5	.	.
France	**2005**	202 507	147 174	**349 681**	12 8	55 8	28 2	16 0
	2008	229 130	155 383	**384 513**	13 7	57 7	27 3	15 0
	2009				.	.	.	.
United Kingdom[2]	**2005**	248 599	76 318	**324 917**	10 8	44 8	47 0	8 2
	2008	251 932	90 154	**342 086**	11 0	44 5	47 8	7 7
	2009	256 124	91 362	**347 486**	11 1	43 6	48 6	7 8
Italy	**2005**	82 489	92 759	**175 248**	7 2	40 4	38 2	21 4
	2008	96 677	142 339	**239 016**	9 5	44 6	36 4	19 0
	2009	101 821	137 425	**239 246**	9 6	43 6	37 8	18 6

1) Some values are only preliminary or estimated or cannot be fully compared to previous years (see original publication "Main Science and Technology Indicators 2011/1").
2) 2005 to 2009: R&D personnel and personnel in the university sector underestimated, personnel in economic sector overestimated.
3) 2009: R&D personnel in total and number of researchers underestimated, personnel in economic sector overestimated.
4) Private non-profit organisations.

Source: OECD (Main Science and Technology Indicators 2011/1, Tables 07-TP_RS, 09-TP_TT, 10A-TP_TTXLF, 31-BP_TTXTT, 51-HP_TT) and calculations by the Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.7.11

Tab. 10 2/2 R&D personnel in EU Member States and selected OECD Member States by personnel groups and sectors[1]

Country	Year	Full-time equivalents						
		Resear chers	Technicians and other staff	Total R&D personnel		Of which, active in the		
						Business enterprise sector	University sector	Government and PNP[4] sector
		Number			per 1,000 labour force	Share in %		
Sweden[3]	**2005**	55 090	22 614	**77 704**	16 5	72 2	22 8	5 0
	2008	48 220	29 329	**77 549**	15 8	75 8	20 1	4 1
	2009	46 892	28 955	**75 847**	15 5	71 6	24 9	3 5
Japan[4]	**2005**	680 631	216 224	**896 855**	13 5	68 0	23 4	8 6
	2008	656 676	226 063	**882 739**	13 3	70 8	20 6	8 6
	2009	655 530	222 888	**878 418**	13 3	70 7	21 1	8 2
Canada	**2005**	136 768	81 837	**218 605**	12 6	65 0	26 1	8 9
	2008	148 983	93 703	**242 686**	13 3	65 5	25 7	8 8
	2009				.	.	.	.
United States	**2005**	1 375.304	.	.	.	.	.	.
	2008	.	.	.	.	.	.	.
	2009	.	.	.	.	.	.	.

1) Some values are only preliminary or estimated or cannot be fully compared to previous years (see original publication "Main Science and Technology Indicators 2011/1").
2) 2005 to 2009: R&D personnel and personnel in the university sector underestimated, personnel in economic sector overestimated.
3) 2009: R&D personnel in total and number of researchers underestimated, personnel in economic sector overestimated.
4) Private non-profit organisations.

Source: OECD (Main Science and Technology Indicators 2011/1, Tables 07-TP_RS, 09-TP_TT, 10A-TP_TTXLF, 31-BP_TTXTT, 51-HP_TT) and calculations by the Federal Ministry of Education and Research
Data portal of the BMBF: www.datenportal.bmbf.de/portal/1.7.11

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(in brackets: The table numbers of the long version of the Federal Report on Research and Innovation 2012)

Infobox

Information about government funding options

The funding advisory service "Research and Innovation" provides general information about the funding options and procedures, targeted forwarding to the correct contact partners and help in submitting applications. In addition to the website www.foerderinfo.bund.de, there are also two free hotlines:

- For information regarding research and innovation funding: **0800 262-3008**
- Support service for SME funding (Lotsendienst): **0800 262-3009**
- The government funding advisory service "Research and Innovation" can be contacted by e-mail at beratung@foerderinfo.bund.de. The electronic information service AS-Info provides information about all new elements of the government research and innovation funding system.

All interested parties may visit the BMBF website www.bmbf.de to view the available information and services; this information is continuously supplemented and updated on a target-group basis. The BMBF website comprises information about BMBF and its work fields, as well as current topics from the field of education and research policy. It also contains information about interesting publications and dates and allows research in an extensive archive. Through numerous links to other information sources, structured access to various specialised information is simplified (e.g. information about over 100,000 research and development projects is available via the funding catalogue of the BMWi, BMBF, BMU and BMELV).

Information about the content and goals of the department research conducted by BMG and information about current public tenders is available at www.bmg.bund.de (keywords: departmental research or public tenders). Information about the content and goals of the department research conducted by BMELV and other information is available at www.bmelv.de (Ministry, Research and Innovation).

The BMWi (www.bmwi.bund.de) and the BMU (www.bmu.de) are connected via the Internet to the government funding database that provides a complete and up-to-date overview of the funding programmes.

The information office of the BMWi funding department also provides information on tel. no. **030 18615-8000** and per e-mail: foerderberatungs@bmwi.bund.de.

Infobox

Data portal of the BMBF

The new BMBF data portal at www.datenportal.bmbf.de contains a wide range of facts and figures about science, research, development, innovation and education. In addition to the tables in Part II E of the Federal Report on Research and Innovation, there is also extensive data on education and science. The tables of the Federal Report on Research and Innovation are available in the data portal in detail and for a longer period than the report itself.

The BMBF data portal contains the latest data and also historical figures that in part go back to the 1960s; these figures are also supplemented by international comparisons. The Basis of data of the portal is updated every six months.

The BMBF data portal not only contains specific information about the various education and research areas, but also information on federal government and state expenditure. The research and development field also comprises statistics on public and private research expenditure, R&D personnel and patents. Key indicators on innovation conduct are also shown here. In the education field, there are also statistics on the elementary area, playschools, day-care centres and schools, as well as universities (including students, teaching staff), further training and vocational training funding (BAföG, Master craftsman BAföG).

The system allows the user to research data by means of keywords or by navigating through subject menus. The glossary contains an alphabetical list of explanations of the terms and abbreviations used. The results of the search can be downloaded in a number of formats (HTML, PDF, Excel) for prompt further use.

All tables in the Federal Report on Research and Innovation are updated and available in a various formats in the data portal at www.datenportal.bmbf.de.

Federal Ministry
of Education
and Research