

OECD SCIENCE, TECHNOLOGY AND INDUSTRY OUTLOOK 2004 COUNTRY RESPONSE TO POLICY QUESTIONNAIRE

GERMANY

1. General framework and trends in science, technology and innovation policy

The education and research system in Germany is in the process of being reformed. This reform is part of the planned reorganisation of the overall federal structure, the aim being to improve the Federal and state governments' ability to act, assign political responsibilities more clearly and increase appropriateness and efficiency in the discharge of responsibilities. For this purpose, the German Bundestag and Bundesrat set up a joint commission in October 2003 which will present its proposals for modernising the federal structure in the second half of 2004. The proposals for reform will also affect the joint tasks of the Federal Government and the states concerning research promotion and university construction.

The Federal Ministry of Education and Research (BMBF) is focusing research funding under its programmes on those fields which have great leverage for growth and employment. This means strengthening **information and communications technology** as the basic technology and driver of growth in many branches, as well as its linkage with other technologies and its integration into applications (motor vehicles, machinery, services). We are supporting **microsystems engineering, optical technologies, materials research, and clean processes and production technologies** with a view to expanding existing markets. We are opening up new fields of growth by means of **biotechnology and nanotechnology**. We are thus creating a broad scientific and technical basis for the economy.

The contribution made by research policy to strengthening innovation can be subdivided into four points:

- Stimulating innovation by research funding.
- Increasing the efficiency of the research system.
- Supporting a pro-innovation climate.
- Improving the environment for education and research.

We are linking funding for research and development with longer-term technological, economic and social trends, also in terms of a national sustainability strategy. We are letting ourselves be guided by the results of innovation research: success in innovative markets is rarely achieved where only excellent technological products are being offered; new developments are successful where people are provided with customised solutions.

In fields which are of vital importance for the future (biotechnology/genome research, laser technology, information and communications technologies and nanotechnology), new funding programmes and funding concepts have been published. These include

- The Federal Government's action programme Information Society Germany 2006.
- The framework concept IT Research 2006, a funding programme for information and communications technology including funding concepts for software engineering, knowledge on the web, nanoelectronics, nanotechnology and microsystems engineering.
- WING (Materials innovation for industry and society).
- PRONA (Activity-based sustainability concepts).
- The framework programme Biotechnology – Using and Shaping Opportunities.

The Integrated general concept for life sciences (IGEL) is to promote genome research in Germany in a decisive manner. The concept brings together the next phase of the National Genome Research Network with innovations and technologies from neighbouring scientific disciplines such as bioinformatics, proteome research and systems biology.

With the InnoRegio – Innovative Impulses Programme for regions, we are promoting co-operation between industry, politics, education and research in a variety of different projects within 23 regional innovation networks.

With the aid of the German research dialogue FUTUR, societal issues are being identified, and it is being analysed how research might contribute to their solution. Interaction is being organised on two levels: first, by means of a new Innovations Committee and second, via the newly launched German research dialogue which is based on broad participation. FUTUR topics which have become leading visions of research policy are "Lifelong health and vitality through prevention", "Living in a network world: individual and secure" and "Understanding thought processes".

Furthermore, the Federal Government launched a broad-based innovation campaign at the beginning of the year whose aim is to strengthen the German innovation system at all levels. The individual measures of the campaign are currently being drafted.

With its initiative entitled "Innovation and Future Technologies for Medium-Sized Companies - High-Tech Master Plan", which is part of the innovation campaign, it continues to develop its SME policy in important fields of action. With this initiative the Federal Government has adopted (in February 2004) an additional package of measures in the framework of its comprehensive innovation policy initiative for the year 2004. It is based on the following cornerstones:

- The High-Tech Master Plan is designed to improve key framework conditions for establishing new, technology-based companies in Germany.
- The new design and extended range of research programmes will offer new incentives for the development of research and innovation strategies in small and medium-sized enterprises.
- New models of co-operation between public research and SMEs will open up scientific potentials to the SMEs in innovative competition.

2. Public sector research and public research organisations

Policy changes related to R&D performed by public sector

Helmholtz Association

In Germany, the Federal Government and the states jointly fund 15 national research centres with a total staff of about 24,000 and an annual budget of about €2.2 billion, of which about €1.6 billion come in the form of institutional funding from public coffers. These scientific-technical and biological-medical centres, which together form the Hermann von Helmholtz Association of National Research Centres (HGF), constitute by far the largest non-university research organisation in Germany; their budgets account for about 20% of the BMBF research budget. The Federal and state authorities share the total budget of the Helmholtz centres in a ratio of 90:10.

In the past, the centres were funded as institutions as they were originally founded for a specific purpose. In 2001 the Federal Government, the states and the centres themselves agreed to a reform of the Helmholtz Association. The core element of this reform is the programme-based funding of the Helmholtz Association. This means that the scientific work of the centres is focussed on research programmes and that the distribution of the funds is based on the programmes instead of on the centres as such. This allows priority setting for the Helmholtz Association as a whole and stimulates competition and co-operation between the individual centres while not affecting their legal independence. The Helmholtz centres focus their research on six research fields: Structure of Matter, Earth and Environment, Transport and Space, Health, Energy, and Key Technologies.

Under this new procedure, the Federal Government and the states, as funding agencies, determine a research policy framework for the research fields, while the centres themselves develop the scientific subjects jointly, although on a competitive basis. The decision on the funds to be provided for competing programme proposals and programme parts are taken on the basis of recommendations made by the Helmholtz Senate following external evaluations of the programme proposals. The Senate members do not belong to any of the research centres. A full-time President, who is not dependent on any of the research centres and is provided with the appropriate staff, is responsible for the whole procedure. He ensures the transparency of the procedure as well as fair competition.

Together with the new system, appropriate new budget provisions were introduced, the most important ones being the carry-over of funds to the subsequent year and the abolition of binding staffing schedules. As a prerequisite for these changes, it was necessary to adopt a controlling procedure that is suited to scientific activities and makes it possible to monitor the research centres by applying modern business management methods.

The reform started in autumn 2001. The research fields of Health, Transport and Space, Energy, and Earth and Environment were evaluated in 2002 and 2003. More than 200 internationally renowned scientists – more than half of them from abroad – have taken part in the evaluation so far. The first round of evaluations of all research fields will be finished in 2004 with the evaluations of the last two research fields, Structure of Matter and Key Technologies. The experience gained so far reveals that the introduction of programme-based funding is a major step forward towards strengthening the flexibility, competitiveness and achievement-orientation of the Helmholtz Association.

Max Planck Society

The total level of R&D funding for state research establishments allocated to the Max Planck Society (MPG) in 2002 and 2003 was €35 million per year.

Leibniz Association

Within the framework of joint institutional research funding, the Federal Government and the states granted the Blue List establishments that have joined together in the Leibniz Association funds totalling approximately €96 million in 2002 and approximately €701 million in 2003.

Major initiatives to reform the organisation and governance of universities and public research organisations

Max Planck Society

The latest external evaluation of the MPG proposed the instrument of establishing research groups as temporary institutes in order to strengthen the networking of research activities between universities and the Max Planck Society. In the meantime three MPG research groups have been devised and agreed at universities. One of them is due to start work in March 2004.

Leibniz Association

As the representative body of institutes funded jointly by the Federal Government and the states, the Leibniz Association is not a funding agency. The donors have taken fundamental decisions on the further development of joint funding in resolutions passed by the Bund-Länder Commission for Educational Planning and Research Promotion. A comprehensive quality management system with the elements evaluation, cost-performance accounting and programme budgets will be introduced at the institutes of the Leibniz Association in order to further improve R&D.

Furthermore, the reform of public sector employment law has provided important impulses for increased orientation to performance, and this has meanwhile been extended to non- university research centres. By introducing junior professorships, we have been setting a signal for greater independence for junior scientists. As a result of the reform of public sector employment law, important impulses have not only been provided for performance-based pay but also for a considerably earlier commencement of independent teaching and research by young researchers. The performance-based elements are successively being extended to the HGF and the MPG.

Another important issue is the promotion of the commercialisation of research results. The Commercialisation Campaign of the BMBF is promoting a professional infrastructure in order to facilitate the patenting of research results and their economic exploitation on the part of universities.

The EXIST campaign supports university-based researchers who are willing to start their own spin-off companies by providing them with the necessary training and advice.

Major policies and government-sponsored programmes to foster international collaboration among researchers in universities and public research organisations

Last year the Federal Government gave a new strong impetus for international scientific research with large-scale facilities. It is planned to make long-term investments available to an amount of more than €1 billion for new research facilities in Germany to secure a top position for basic scientific research.

Basic research in natural sciences has a long tradition in Germany, and its success is inextricably linked with the use of excellent large-scale facilities at national and international research centres. The Federal Government's future strategy is based on recommendations by the German Science Council. The decisions on high-performing large-scale facilities for basic natural sciences relate to a new laboratory for pulsed high magnetic fields which is being built together with the State of Saxony at the Research Centre

Rossendorf near Dresden. In the medium term, a high-altitude and long-range research aircraft (HALO) will be built and operated for the atmospheric research and earth observation science communities. Two large-scale facilities have been proposed for realisation together with interested partners in Europe and in the whole world.

- An international X-ray Free Electron Laser (XFEL) facility is to be built at the German Electron Synchrotron Research Centre (DESY) in North Germany. In view of the location advantage, the Federal Government is prepared to cover half of the investment cost amounting to about €700 million.
- Together with partners in Europe and world-wide, the Heavy Ion Research Center (GSI) in Darmstadt is to further develop its accelerator facilities in a phased approach and become a leading European physics centre. At least 25% of the costs amounting to about €700 million are to be contributed by foreign partners.

The largest projects, XFEL and the GSI accelerator facility, have been developed by large international science collaborations. Talks on European and international co-operation are underway so that it will be possible to take final decisions on the construction of these new international facilities for basic research in the next two years.

3. Government support for private sector R&D and innovation

Government Support in the Scope of the Initiative “Innovation and Future Technologies in the SME Sector – High-Tech Master Plan”

Germany depends on the innovative capacity of young companies, which do not only create new products and services but, in particular, new internationally competitive jobs. The Federal Government has therefore set up an integrated concept (“Innovation and Future Technologies in the SME Sector – High-Tech Master Plan”) to remove the obstacles to the establishment and growth of young innovative companies and to ensure financing conditions which promote the growth of these companies. The purpose of these measures is to help and develop the great potentials of young innovative companies. Changes in the design of specific instruments are explained in more detail below.

Venture capital:

On the venture capital market, venture capital providers are currently demonstrating strong reservations with respect to new investments. There are hardly any new venture capital funds, and fund managers are reluctant to invest in young technology companies. The venture capital market for the very early R&D-based phase of start-ups has almost entirely dried out in Germany. In this phase, a new architecture of promotion is required that provides the venture capital market with additional liquidity and opens up new financing sources to R&D-based start-ups.

For this reason, the Federal Government has adapted the instruments of venture capital promotion to the new situation:

- The Federal Government established a new joint venture capital fund consisting of funds of the ERP special fund and the European Investment Fund (EIF) that will invest in German venture capital funds for early-stage and growth companies together with private investors. The capital for the fund will be shared on equal terms by the ERP special fund and the EIF. Both partners will provide a total of €500 million over a term of five years. Including the contributions from private investors, up to approximately €1.7 billion will thus be available to innovative, growth-oriented enterprises in Germany.

- The Federal Government will reorganise its programme “Venture capital for small technology-oriented firms” (BTU programme) according to the market situation. A start fund will be set up that will invest in individual companies together with private venture capital providers. Open investments will also be possible in order to prevent burdening the enterprises with permanent interest payments for dormant equity holdings. If necessary, it will also be possible to provide follow-up financing later on.
- The Federal Government furthermore is examining the possibility of launching a seed fund for R&D-based start-ups. It would be designed to ensure sufficient financing opportunities in the early stage of a start-up in which private investors (VC funds, etc.) have not yet made any commitments.
- Furthermore, it will be necessary to provide more venture capital than before for innovative, well-established SMEs. Under the leadership of the KfW Mittelstandsbank, two pilot projects for medium-sized companies were developed which are to satisfy the venture capital demand in the range between €1 million and €5 million which has so far been largely neglected by the market. The experience made with these pilot projects is intended to create an appropriate foundation for venture capital providers to offer such funding on the market, if possible, nation-wide.

Tax treatment:

Since the removal of an R&D investment allowance and faster write-offs for R&D investment (physical capital) in 1989, no special tax incentives for R&D have been introduced in Germany. However, tax policy is regarded as an important instrument for improving overall profitability of enterprises, thereby giving firms more leeway to finance investments and innovation.

Companies will be offered additional financing opportunities through the tax relief measures adopted for 2004 and 2005. In total, the tax reform provisions adopted by the Federal Government will relieve the tax burden on citizens and companies by approximately €6 billion. Small and medium-sized enterprises alone will save €16.7 billion in taxes. The maximum tax rate has been reduced to 42%, i. e. the lowest rate ever applicable in the Federal Republic of Germany. The corporation income tax rate was reduced to a standard 25%. As a result of the general offset of the trade tax debt with the income tax debt, most partnerships will no longer pay trade tax. Due to the tax measures introduced by the Federal Government, the overall business tax rate is only 23% (2003), i.e., fairly low even by international standards.

In the scope of its tax policy, the Federal Government is pursuing the goal of an internationally competitive taxation of venture capital in Germany in order to provide efficient incentives for the provision of private capital. In tax policy, it is also important to create a reliable planning basis for companies. Therefore, in co-ordination with the federal states, the Federal Government has improved legal certainty concerning a number of previously undefined tax scenarios:

- The Federal Ministry of Finance (BMF) published a letter concerning the income tax treatment of venture capital funds and private equity funds on 16 December 2003, thus establishing clear, reliable criteria for a proper distinction between property management and commercial funds. Therefore, funds may, under clearly defined conditions, to be treated as property management funds for tax purposes even in their early stages.
- According to new tax provisions, only one-half of the increased gain of fund managers (the so-called “carried interest”) will be subject to income tax. Until these provisions come into force (probably in 2005), clear transitory provisions will apply to the taxation of the carried interest.

Direct public funding of business R&D for SMEs:

The Federal Government increased the sums made available for R&D promotion for SMEs by 32% to approximately €732.5 million from 1998 to 2002 (Federal Ministry of Economics and Labour (BMWA): €61million; Federal Ministry of Education and Research: €171 million). It can be assumed that the federal and state authorities and the total support provided by them will reach 5,000 companies and thus a major part of the businesses engaged in R&D activities. (Total: 35,000 firms conducting R&D on a regular basis. The figure of 5,000 companies cannot be compared directly with other countries that have introduced tax credits for R&D because companies in Germany usually apply and qualify for a R&D subsidy on an irregular basis.) Evaluations of the BMBF's specialised programmes confirm the enormous leverage of the measures. Accordingly, the companies use each Euro from R&D promotion as an incentive to increase their own R&D budget by another Euro. Nevertheless, the proportionate share of small and medium-sized enterprises has been declining both in the R&D budget of the German economy and in overall innovative activities since the mid-1990s. Although the number of companies engaged in continuous research increased according to surveys of the Centre for European Economic Research (ZEW), many SMEs which conducted research sporadically have withdrawn from the process of innovation. The Federal Government intends to use the measures listed to efficiently strengthen the involvement of small and medium-sized enterprises in innovative activities.

PRO INNO: Increasing flexibility, improving access (2003 budget line [including other smaller programmes]: €137 million):

The PRO INNO programme, which is aimed at creating a network between small and medium-sized enterprises and research institutions, has a very widespread impact. Since 1999, R&D expenditures of €1.7 million have been initiated by PRO INNO in 4,850 companies. In the year 2003, as in 2002, approximately 1,000 small and medium-sized companies took advantage of the programme for the first time. As of 2004, the PRO INNO II follow-up programme will introduce significant modifications to this successful promotion campaign:

- The restriction of possible overall promotion to a predefined number of 2 projects will be lifted. Instead, the total amount of promotion funds will be limited (regardless of the number of projects promoted). This modification is intended to increase the number of projects, and to also reach smaller projects.
- In order to improve the utilisation of PRO INNO by small and medium-sized companies in the former west German states, the access limitation for these companies (exclusion if promotion has already been received twice between 1993 and 1998 under the previous research co-operation programme) existing since 1999 will be cancelled.
- In order to also support transnational partnerships in the scope of national programmes with a widespread impact, PRO INNO II will provide for a specific promotion bonus for projects involving European partners, also within the framework of EUREKA.

Industrial co-operative research: Improving efficiency, increasing relevance for the SME sector (2003 budget: €90 million):

The programme for the "Promotion of Industrial Co-operative Research and Development" (IGF) supports sectoral innovation networks between industry and science through more than 100 research groups of the Association of Joint Industrial Research "Otto von Guericke" e. V. (AiF) in a project-specific approach. According to the proposals of the evaluation committee, the Federal Government will continue developing this programme:

- The transparency of own contributions by industry will be increased by providing these contributions on a project basis (i. e. no longer proportionately according to the expenses for all research and development work performed by industry in their research departments).
- Additional elements of competition, such as openly awarding research jobs, will be introduced in order to create incentives for more competition among research institutions and to include research establishments not previously participating in IGF.
- The relevance of the projects for the SME sector will be preserved or enhanced by an even stronger inclusion of small and medium-sized enterprises in project development and accompanying committees.
- In co-operation with AiF, the usability of the research results will be evaluated more profoundly and refined through random inspections of the research associations.

Concentrating the promotion of innovation in the east German states on the vehicles of growth:

In order to compensate existing locational disadvantages of the research and innovation activities in the east German states, the Federal Government will provide additional assistance to enterprises and research institutions there. Approximately 3,200 research projects were promoted under the R&D special programme from 1999 until late 2003 (2003 budget: €95 million). Under the InnoRegio programmes, more than 700 research, development and educational projects received support in 36 regional innovation alliances in the east German states. These were designed to implement regional innovation concepts and to build up industrial “clusters” in the respective regions. Approximately 70% of the promotional funds granted up to 2006 will go to small and medium-sized enterprises.

- On 1 January 2004, the new “Programme to Support Research, Development and Innovation for Sources of Economic Growth in Disadvantaged Areas” (INNO-WATT) came into force. Compared with its predecessor, “R&D special programme for the east German states”, this programme will concentrate more on the engines of growth. Applicants have to prove that they have complied with their obligations to use the results of the previously promoted R&D projects and have efficiently marketed these results or transferred them to other companies. In justified cases, the programme will be opened for larger medium-sized companies with an annual turnover, including affiliated companies, of up to €125 million. The promotion of personnel in the eastern states programme will be discontinued because of its decreasing efficiency.
- Currently, €98 million are spent on InnoRegio promotion programmes every year. The BMBF's “InnoRegio” and “Innovative regional growth cores” programmes have successfully implemented the region-oriented innovation policy approach in the east German states over the past three years. By promoting joint projects between SMEs and research institutions, research competencies and innovation potentials are strengthened through innovation-focused self-organisation. The initiative “Interregional alliances for the markets of tomorrow” supports 33 regional networks which are at the very beginning of their development and are experiencing a strong momentum for an innovative, regional alliance through the organisation of so-called innovation forums. The Federal Government's “Centres for innovative competence” approach furthermore prompts the establishment of internationally competitive “centres of excellence” at the universities and research institutions in the east German states.
- The new promotional competition “Network management – East” (NEMO) launched in 2002 will be continued with the 4th round of competitions in 2004 (2003 budget: €5.4 million). The formation of innovative, market-oriented networks between small companies in the east German states will be supported by proportionate subsidies for external management, which will be

reduced over time. This will result in concentrated technological competence, the development of joint market strategies, and the opening up of new employment opportunities.

Increasing the attractiveness of federal research and technology programmes for the SME sector, simplifying promotion processes:

Transparency concerning the existing promotional programmes, unbureaucratic application procedures and targeted programmes are of key importance, especially for the SME sector. For this reason, the Federal Government will further simplify the conditions of using its research promotion as well as its customer friendliness:

- In order to simplify the application procedures, the systems for electronic application and project management will be further improved. Approximately as of mid-2004, the standard processes relating to the application for and management of subsidies can be performed online and given a digital signature. The time span between the idea for a project and the decision about its promotion will be shortened by an additional simplification of the processes (simplification of providing proof of and reviewing the credit-worthiness and – if possible – reduction of external expert reports) for the SMEs in the subject-oriented specialised programmes. At the same time, the efficiency of the promotion granted will be closely monitored and improved, if necessary, by enhanced regular evaluations of the specific promotional measures.
- All SME-oriented technology programmes within the portfolio of the BMWA will be subjected to harmonised terms and uniform calculation methods in the future.
- The wide range of specialisation of SMEs will be specifically accounted for by thematic opening clauses for the SMEs in the new specialised programmes. Furthermore, in suitable cases, SMEs will have the opportunity to apply for inclusion at any time, regardless of deadlines. Where this is not possible, the largest number of deadlines will be offered, thus keeping the waiting time between the project application and the granting of promotion as short as possible. An increasing number of transfer and diffusion schemes within the specialised programmes will allow the SMEs easier and faster access to potential innovations, especially if developed by scientific institutions.

Integrating the SME sector more strongly into European research promotion:

It is the aim of the Federal Government to improve the German share in the 6th EU framework programme concerning research with a total volume of approximately €20,000 billion (2002-2006). The EU is planning an SME share of 15% of the thematic priorities. With “Co-operative Research” (CRAFT) and the “Collective Research”, two important SME-specific measures are furthermore available to the SME sector alone.

- The SME advisory network was regionalised in co-operation with the Innovation Relay Centres (IRC) which exist in all federal states.
- A success-related remuneration for the advisory services of the IRC helped Germany to attain a top position in terms of successful applications for SME-specific subsidies.
- The “Network for international technology co-operation” promoted by the Federal Government maintains 15 contact offices in 13 countries which support German small and medium-sized enterprises seeking technological co-operation schemes with foreign companies and industry-related research institutions. They provide assistance in the search for suitable co-operation partners and accompany the co-operation schemes locally.

- As of 2004, the network will concentrate on the Central and East European countries, the European successors of the CIS states, and on the dynamically growing and technologically interesting Asian states, namely China and India. It will be placed under the uniform leadership of the Association of Joint Industrial Research (AiF).

Ensuring transparent information and advisory services:

A diversified mosaic of promotion, loan and investment programmes, co-operative and network initiatives as well as research and advisory infrastructures has emerged. In research and innovation promotion in favour of small and medium-sized enterprises in Germany. It is designed to account specifically for the special investment opportunities and obstacles of different groups of small and medium-sized enterprises. However, the efficiency of these measures also depends on their transparent presentation and conveyance. The Federal Government has ensured that each enterprise receives a complete overview of the investment promotion opportunities available to it by a simple phone call or on a web page.

- With the newly established SME advisory service programme, the BMBF has created an attractive service for SMEs in search of suitable innovation subsidies and possible partners for a co-operation. This programme mainly consists of information services tailored to the needs of SMEs, counselling concerning all promotion opportunities at the federal, state and EU level, and practical guidance for filing applications.
- The BMWA internet promotion database offers enterprises and new companies an up-to-date overview of all promotional programmes in Germany and the EU. This advisory service is supplemented by promotion counselling by telephone and a hotline for questions regarding financing issues of small and medium-sized enterprises.

Public Procurement Policy

The Federal Government is in favour of an increased use of the so-called "functional" tender procedure in which the client sets the objectives of a project without prescribing the manner of achieving it. This gives enterprises more scope for innovative solutions. A further reform of the legal framework for public procurement is underway with the aim of creating a more transparent and flexible system.

The "E-Tendering" project, one of the most important projects in the "Federal Government Online 2005" initiative, will lend more transparency, quality and efficiency to the process of awarding public contracts. From the bidding stage through to the signing of the contract, the process can be conducted securely and in a legally binding manner, via a single Internet-based platform. In view of the weighty role played by public procurement in the national economy and the more transparent competitive environment, new methods for obtaining government contracts are being born – especially for SMEs. The plan is to provide this federal-level solution to both the state and local government level, too.

The Federal Government's programme to optimise public procurement, announced by the Federal Chancellor, will make its procurement activities more efficient. As of the middle of 2004, all of the Federal Government's invitations to tender will be published at www.bund.de. By the end of 2005, its contract-awarding procedure will be run exclusively via a secure Internet-based e-tendering system that meets the legal requirements. The electronic contract-awarding system developed within the federal administration ("E-Tendering" – www.evergabe-online.de) must be used for this procedure unless there are key economic or technical reasons not to do so in specific cases. Some 175 contracts were processed electronically using the E-Tendering system in 2003.

4. Enhancing collaboration and networking among innovating organisations

No response.

5. Human resources for S&T

Efforts to increase numbers of university graduates with science and engineering degrees

The following table shows the development of science and engineering graduates in Germany between 1997 and 2002:

Table 1: New science and technology graduates in Germany

Level	Year					
	1997 = 1996/97	1998 = 1997/98	1999 = 1998/99	2000 = 1999/2000	2001 = 2000/2001	2002 =2001/2002
TERTIARY						
Total males and females	99,765	91,805	86,171	80,045	76,617	76,698
Males	81,206	73,833	68,184	62,748	59,508	59,028
Females	18,559	17,972	17,987	17,297	17,109	17,670
ISCED 5A						
Total males and females	71,384	66,046	62,033	56,535	53,452	53,188
Males	56,148	51,371	47,251	42,423	39,441	38,551
Females	15,236	14,675	14,782	14,112	14,011	14,637
ISCED 5B						
Total males and females	19,042	16,188	14,581	13,690	14,001	14,859
Males	17,613	15,023	13,442	12,698	13,011	13,847
Females	1,429	1,165	1,139	992	990	1,012
ISCED 6						
Total males and females	9,339	9,571	9,557	9,820	9,164	8,651
Males	7,445	7,439	7,491	7,627	7,056	6,630
Females	1,894	2,132	2,066	2,193	2,108	2,021

Life sciences (ISC42)

Physical sciences (ISC44)

Mathematics and statistics (ISC46)

Computing (ISC48)

Engineering and engineering trades (ISC52)

Manufacturing and processing (ISC54)

Architecture and building (ISC58)

Sources: Federal Statistical Office, Vocational school statistics; Federal Statistical Office, University statistics.

Methods: Data on graduates are collected after the end of the reference year.

Policy initiatives taken to address perceived shortages of scientists and engineers in particular fields (or mismatches between supply and demand for scientists and engineers)

Efforts to arouse people's interest in mathematical and scientific subjects and to promote talent must start in school. This may include encouraging young people to participate in competitions such as the national mathematics and computer science competitions and in the International Olympiads in Mathematics, Physics, Chemistry and Biology. Between 3,000 and 4,000 school students participate in these competitions every year at national level alone.

The pupils' research competition "Jugend forscht" gives major impetus to the development of young people's interest in scientific research, mathematics and technology in Germany. The topic addressed by a young researcher must fall within one of the following seven disciplines: working world, biology, chemistry, geoscience and space science, mathematics/computer science, physics or technology.

Furthermore, the Federal Government is contributing to efforts to arouse general, above all young people's interest in scientific and technological topics with its science years and the broad range of events organised in this connection:

- Year of Chemistry (2003).
- Year of Technology (2004).
- Einstein Year (2005).

Improving study conditions for all:

Despite the considerable progress which has been made in increasing the percentage of young people who enrol in higher education programmes after leaving school, Germany is still below average in this respect in the international context. Highly qualified personnel is, however, the prerequisite for innovation. We are therefore pursuing the goal of achieving the international 40% rate of participation in higher education. In addition to increasing the number of first-year students, we must also shorten study periods and reduce the dropout rate.

Investing in universities:

In recent years, the Federal Government has been increasing its expenditure on higher education institutions considerably more than the states and has thus contributed substantially to improving study conditions on a broad scale. In particular, federal expenditure on university construction, basic funding for the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG) and BMBF funding for projects carried out at university facilities have been increased.

Awarding BAföG grants to enable young people to take up university studies:

In 2001, the Federal Government decided to reform federal training assistance and adopted the Training Assistance Reform Act in order to give young people access to education and qualification which does not depend on their parents' financial means. This reform has been a great success: Between 2000 and the end of 2002, the annual average number of grant recipients rose by more than 100,000 to 467,000. The proportion of first-year students increased from 27.7% in 1998 to 36.5% in 2003, not least as a result of our efforts to restore students' confidence in the system in this way. In 2002, 47% of BAföG recipients had full grants, compared with 33.5% in 1998. This shows that we have considerably improved the chances especially of young people from low-income families and have provided the financial basis for them to

decide to enrol in higher education. This success must not be jeopardised by the introduction of tuition fees, particularly because we cannot be certain that the money collected will actually go to the universities.

Strengthening the international dimension of higher education studies:

Within the framework of the Bologna Process, forty European countries have agreed on the basic principles for establishing a common European Higher Education Area by 2010. This will include among other things a two-tier quality assurance system, a uniform Diploma Supplement and the inclusion of doctoral studies in the process. The Federal Government is prepared to play its part and assume due responsibility. In concrete terms, it is offering support and co-operation to the states and higher education institutions with regard to the large-scale introduction of the two-tier Bachelor/Master degree structure, the establishment of a European credit transfer system (ECTS), the Diploma Supplement, quality assurance in accordance with international standards, and the setting up of doctoral programmes.

Policy changes related to the international migration and mobility of scientific and high-skilled personnel (inward or outward mobility)

The Federal Government is making considerable efforts to increase the number of exchanges of students and scientists. It has a double aim: to motivate more German students and graduates to spend a period of study or research abroad and to attract more highly qualified students, graduates and scientists from abroad. At the same time, it is encouraging the return migration of German scientists. The target is to raise the percentage of German students with at least one semester of study experience abroad from currently 14% to 20% by 2010 and to increase the proportion of foreign students in Germany from currently 8.5% to 10% over the next few years.

Measures being taken to increase the percentage of German students with experience acquired during studies abroad:

- Intensification of collaborations between higher education institutions.
- Fostering of new study courses requiring a study period abroad and leading to a bi-national degree.
- Academic Exchange Programmes/grants for studies abroad (all countries, all disciplines), starting in the study year 2004/2005: Free-mover Programme and European Excellence Programme (www.daad.de).
- A specific campaign to make students aware of the courses offered by foreign universities and research institutions in Central and Eastern Europe “Go East”, www.go-east.daad.de.
- At present, a campaign to motivate students to spend a study period abroad, is under development (“Go Out”).
- Removing mental and language barriers (e. g. contact fellowships, language courses preceding a study period abroad).
- National study grants and loans can be taken abroad for studies within the European Union.

Measures designed to attract foreign students:

- Bachelor and Master structure of studies to be set up until 2010 (European Area of Higher Education), up to now – January 2004 – 1,800 programmes = 15% of all study courses, 60% of them include international co-operation, two thirds of the courses are taught in a foreign language, mainly English.

- Introduction of internationally-oriented study courses/classes taught in foreign languages (goal: increased orientation of study courses to the interests and needs of international students, e.g. by using a foreign language as teaching and working language, encouraging more partnerships between institutions, bi-national degrees).
- Special post-graduate programmes to facilitate the enrolment of highly qualified applicants from abroad.

Examples of specific measures designed to attract university teachers and scientists from abroad:

- Improving working conditions for foreign scientists (the reform of employment law in higher education and the introduction of junior professorships are two structural measures that improve conditions for both German and foreign scientists).
- Specific programmes to attract university teachers and scientists (the Initiative for the Future of Higher Education institutions as part of the Federal Government's general programme for investing in the future provides support for world-class researchers and young scientists from abroad, including German scientists returning home, who will set up their own research groups in Germany or who will be recruited by higher education institutions as visiting lecturers).
- Introduction of attractive Research Prizes for research done in Germany, e. g. Sofja-Kovalevskaja-Prize, Wolfgang-Paul-Prize in 2001).

In addition, efforts are being made to improve general conditions:

- Facilitating the entry of international university applicants: Unlike the Deutsche Sprachprüfung, the new *TestDaF* (Test für Deutsch als Fremdsprache) examination offers two advantages: it can also be taken in the student's home country and it is better geared to the requirements of individual study courses.
- Improving or easing requirements under the aliens law and for labour permits (cf. the draft of the Federal Government's immigration bill).
- Creation of a prize for the friendliest local Aliens Authority (Ausländerbehörde).

Furthermore, more marketing measures are being supported:

In order to strengthen internationalisation the Federal Government and the states agreed in 2000 to establish a concerted action "International marketing for higher education and research in Germany". Measures launched are aimed at

- Marketing for higher education and research in Germany:
Concerted action/umbrella campaign (linking of initiatives, joint action, common slogan "Hi! Potentials – International Careers made in Germany", advertising campaign/roadshows), Internet portal: www.campus-germany.de.
- Consortium for international higher education marketing: www.gate-germany.de.
- Improving support for foreign students and young scientists from abroad.
- Optimising the courses offered and the degrees that can be earned.
- Providing continuing education for skilled staff and management personnel from abroad.

- Courses offered abroad by German higher education institutions and the establishment of German off-shore universities.

6. Policies to boost innovation in the service sector

Programmes to increase the uptake of knowledge-intensive service activities (KISA) by service-sector firms or to increase demand for such services in the manufacturing sector.

The Federal Ministry of Education and Research invited proposals in the area of knowledge-intensive services, thus establishing a cross-sector funding priority. The research and development projects started in 2001. The volume of funding is now approximately €20 million. The projects mainly deal with the intelligent use and further development of new information and communication technologies for developing new or improving existing services. The aim is to test new services in pilot projects and to open up new markets and create new employment opportunities.

Attempts to enhance diffusion of technology to service-sector firms.

One such attempt is the business plan competition to stimulate services in the skilled trades. With the scientific support provided, it has been possible to develop new services and remove specific obstacles to innovation in the skilled trades sector. The implementation of the business ideas, which were not funded, has led to the creation of more than 100 non-subsidised jobs by relevant firms. (One successful business plan, for example, involved a firm of painters and various other companies in the building industry which completely renovated a house. Potential clients were given an opportunity to test living in the house and to experience at first hand the building materials and techniques used before hiring painters, plumbers and heating firms. The number of contracts has increased considerably during the implementation phase and an additional master painter has been hired.)

Enhancing service competence in the skilled trades sector is a means to ensure that future challenges can be met effectively. The projects funded have encouraged an inter-trade approach so that new services can be offered or traditional services pooled in innovative ways. The benefit of new business ideas can be clearly felt by consumers in this sector. Trade associations are promoting the development of new ideas for business activities in the skilled trades once funding has stopped.

Efforts to improve human capital and develop highly-skilled workers

R&D activities concerning qualification for service engineering have focussed in particular on the development of new study programmes and the integration of service aspects into existing programmes. Attention has also been given to the development of company curricula and qualification modules and to learning in the process of work.

All the measures introduced were R&D measures which were to provide scientific solutions and instruments for the economic sector and to stimulate relevant results. Furthermore, it has been possible to successfully integrate the results of service engineering research into education and training.

Service engineering research is a new discipline which combines aspects of services management, marketing and engineering science. Following the pioneering work performed by Munich Technical University, lectures and courses are not only being offered by universities which have been involved in the research projects. Even universities of applied sciences (*Fachhochschulen*) and institutions in other German-speaking countries are now offering such programmes. An international conference organised by

the Fraunhofer Institute for Industrial Engineering (IAO) in November 2002 revealed that Germany is an international leader in this field due to the results that have been achieved.

The service engineering research projects carried out to date have resulted in more than 200 publications (in 2002) and have produced more than 70 *Diplom* and doctoral theses.

Deregulation, labour market reforms, support for standards (e.g. technical standards, interoperability standards), or other policies to enhance competitiveness in the service sector.

As part of its policy to support standards, the BMBF funded a project carried out by the German Institute for Standardisation (DIN) under which standards were developed for services. In this context, efforts were made to include the standards developed in the international debate about the standardisation of services.

Policies to promote the use of open standards via public procurement of open source software.

Successful e-government depends on public authorities having interoperable IT systems. Here, the Federal Government is following a strategy of open standards, interoperability, and diversity. Using systems from the major software makers in conjunction with open source software reduces economic and security-related dependencies. Federal authorities will utilize planned software migrations to bring about this diversity, in accordance with the federal migration guide, which is constantly being expanded (www.kbst.bund.de). Existing framework agreements that make it easier to use open source products along with those of major software producers will serve as models for further agreements intended to allow for more flexibility in software procurement.

The Federal Government will continue to promote the use of open source products in the federal administration. At the same time, standardization and interoperability among applications are moving ahead, using the groundwork laid down in the Standards and Architectures for E-government Applications (SAGA) and the standards for secure data exchange (OSCI) developed in the joint federal, state and local initiative MEDIA@Komm.

The Federation will develop SAGA further and, together with the states, will draft a German standard for e-government applications, including, among others, the development of business models for existing and future basic components used by different ministries and different levels of government, as well as for “one-for-all” applications for procurement and grant funding. The effort to modernize public authorities and provide administrative services online makes the greatest possible use of internal synergies, as systems can also be taken on or utilized by other public bodies.

Information or statistics on the participation of service-sector firms in innovation programmes that are not targeted specifically at the service sector, but are open to service sector firms

Statistical information (BMBF programmes):

Funding is provided for research establishments, higher education institutions and commercial companies, among them a considerable number of small and medium-sized firms (in the skilled trades sector, for example). The distribution of funding between these groups depends on the topic of research. On average, about 40% of the funds go to commercial companies, while higher education and non-university research receive 30% each.

Since 1998, public funds totalling about €75.2 million have been made available. It can be assumed that German industry has provided about the same amount so that the total volume of funds provided to

date for research and development under the Innovative Services funding priority is approximately €150 million.

Statistical information (BMWA programmes):

The number of innovative firms in the service sector that make use of loan schemes for innovation projects is low with only 5% of firms applying and qualifying for the "ERP Innovation Programme" (the most important loan scheme for innovative firms). The percentage of service firms is markedly higher for grant schemes: Approximately one quarter of the budget of PRO INNO, a major research co-operation programme for SMEs, goes to service firms (mostly technical services such as R&D, testing, etc.). The "R&D special programme for the east German states" (project variant) requires that the firms' share of generating value added is less than 50%; these firms can thus be regarded as "R&D service firms" (the 50% restriction does not apply in the "personnel variant" of the programme which was phased out in 2003).

7. Policy evaluation

Experience of the BMBF:

The BMBF has achieved major success in quality assurance:

- The evaluation of the DFG, MPG, FhG and HGF was successfully initiated by the BMBF.
- The departmental research institutions within the purview of the BMBF (i. a. institutes abroad and the BiBB) have already been evaluated.
- Ex-post evaluations and ex-ante audits are compulsory elements of quality assurance in the preparation of BMBF funding programmes.
- In addition, further evaluations are being conducted in order to review the targets and success of the measures on a continuous basis (i. a. evaluation of the National Contact Points under the Fifth EU Framework Programme).

The BMBF is continuously working to improve its quality assurance management.

Experience of the BMWA:

The programmes for promoting research with a view to small and medium-sized enterprises carried out under the responsibility of the BMWA were the object of a comprehensive system evaluation of a new type in 2001. The BMWA redesigned the programmes for promoting research co-operation (IGF, PRO INNO, R&D special programme for the east German states, InnoNet) on the basis of the results of this system evaluation. The system evaluation was carried out by an independent commission of national and international experts from academia and business. It used a qualitative analysis while taking into account preceding quantitative evaluations of specific programmes (these evaluations analysed additional as well as behavioural effects of R&D subsidies).

The implementation of recommendations concentrated on the following topics:

- More transparency and user-friendliness: Harmonising "small print" in guidelines, improving connection with other programmes for innovation financing.

- Focus on SMEs: Participation of SMEs in the generation of research topics in Industrial Joint Research (IGF), more flexibility for PRO INNO (fixed maximum subsidy level instead of limitation of projects).
- Concentrating scarce resources on SMEs with commercialisation prospects (“leaving the losers”): Improved control of success, quality management; standards for evaluation.

The diversity of programme evaluations in terms of methodology and scope is regarded as a challenge for improving the overall quality of evaluations for BMWA programmes. A project group has been set up to develop joint evaluation guidelines for the BMWA’s various departments (e. g. labour, SME, technology [including technical-scientific infrastructure], energy).

The evaluation of PTB, the national metrology institute, in late 2002 demonstrated its technical excellence in the international environment. The catalogue of recommendations not only contains a stronger orientation towards business interests but also the granting of more individual responsibility. Concrete proposals are currently being prepared for implementing the committee's recommendations. The areas of “metrology in chemistry” and “metrological information technology” will be redesigned and strengthened. The activities of the Federal Institute for Materials Research and Testing (BAM) will also be evaluated by an international, independent expert committee in 2004.