



Federal Ministry  
of Education  
and Research



# The High-Tech Strategy for Germany



Igniting ideas!

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# The High-Tech Strategy for Germany

## Foreword



Germany is a land of ideas. The High-Tech Strategy shows how we can continue to be a land of ideas in the future as well: By putting ideas into practice, by igniting ideas! For the first time ever, the German government has developed a comprehensive national strategy for all its ministries with the aim of putting our country at the top of the world's ranks in tomorrow's most important markets. All political sectors that affect research and development will be geared to a clearly defined goal: This strategy puts innovation policy front and centre in government activities.

Our vision is a country that respects and rewards achievement in science and industry. We want to encourage people to strike out on new paths. We want a curious, learning society. We want to foster talent in all spheres and at all levels – from the natural sciences to the humanities, in small start-ups, SMEs and large corporations. We want to turn Germany into the most research-friendly nation in the world by the year 2020.

For Germany, outstanding achievements are not an end in themselves in this connection. Global competition means that we always have to be a shade better than the competition. We need new ideas, new products and new system solutions in order to ensure our standard of living today and our children's standard of living tomorrow. We cannot win the competition on the lowest labour costs. However, we can certainly win the competition on the best ideas. To achieve this goal, we are following up the High-Tech Strategy with concrete action: The German government is investing an additional €6 billion in research and development during the current legislative period. This represents the largest increase in research funding in the history of the Federal Republic of Germany. A total of some €15 billion will be allocated for research and development through the year 2009. This will bring Germany's federal government, Länder (state) governments, trade and industry closer to achieving their common goal: Boosting research expenditure to three percent of gross domestic product by the year 2010.

Germany's High-Tech Strategy reflects our political course: more freedom! We want to eliminate impediments to research and development in Germany wherever they arise. We are opening the door as far as possible for a free and competition-oriented knowledge society. The path we are taking extends from the regional to the international level, from universities to small enterprises. We are creating more freedom for new ideas, greater scope for collaboration between research and industry. Dealing with new technologies requires a receptive, objective eye. We are doing away with the ideological blinkers and focusing on the strengths and opportunities offered by the most important fields of research. We are also creating more freedom for talent and genius – from childhood through adulthood: Starting as early in life as possible, we want to foster and support people and their ideas and awaken their interest in research and science.

More freedom for new ideas – Germany's High-Tech Strategy sets the following three priorities for achieving this aim:

- We will do everything necessary to ensure that lead markets for tomorrow's cutting-edge fields develop in Germany: Markets that attract both investors and researchers, markets that stimulate new products and services that are sold here in Germany and around the world. Germany's High-Tech Strategy establishes objectives for 17 cutting-edge fields of the future – fields that will generate new jobs and prosperity in Germany – and lays down in every field a clear timetable that takes into account both research funding and prevailing conditions.
- We will forge links between science and industry: Collaborative activities and joint ventures will receive more assistance and funding than ever before, such as through the introduction of new type of research grant, the funding of leading-edge clusters and by spotlighting the best examples for this type of collaboration.

- We will ignite ideas: Germany's High-Tech Strategy will generate new impetus for translating research findings directly into products, services and processes and for their rapid dissemination. General parameters will be improved, particularly for small and medium-sized businesses – which not only generate the greatest number of jobs in Germany but also are often highly creative.

Working together in the Industry-Science Research Alliance, players from industry, research and the political sector will jointly organise the implementation of the High-Tech Strategy.

The High-Tech Strategy encompasses a wide range of technologies and their application. We need shorter paths from university institute to company, from research to product. However we also need – throughout our entire country – a culture that appreciates good ideas and spurs their translation into products, services and processes – in other words, a culture that ignites ideas!



Dr. Annette Schavan  
Federal Minister of Education and Research

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## I. We are taking on the challenges of the 21st century

We are feeling the effects of globalisation today more than ever before: On the one hand, Germany is the world's leading export nation, on the other hand however, many companies are moving their headquarters or production facilities to other countries. Germany cannot compete on cost. Which is why we have to be better than the competition. However, competitive advantages and concomitant growth opportunities can be tapped only through innovation – with new products, processes and services. Germany is outstanding in mechanical and automotive engineering and a leader in many areas of laser technology, nanotechnology and medical technology. It could assume a pioneering role in resource-efficient and energy-efficient production processes and innovative service markets, such as in the health care sector. We can't afford to rest on our laurels. On the contrary: We have to step up, focus and mesh our efforts even further.

### 1. A co-ordinated innovation policy is more necessary than ever

Research findings are driving a broad wave of new enabling technologies. At the same time, technological change is opening up fascinating new fields of research. Innovation partnerships between science and industry will continue to change our lives in the coming years: In the area of molecular biomedicine, researchers are working on individualised medicine – a new approach that offers the chance of healing illnesses that have been untreatable to date. New worlds of constantly available information and communication are emerging in all spheres of work and leisure. Today, ultra-thin, wallpaper-like display screens and the 'Internet of Things' are examples of existing, concrete plans in labs that could shape day-to-day life in the near future. New, lightweight materials are opening the door to more environmentally-compatible mobility and resource-efficient production. New technologies are developing solutions for the major challenges of our century such as reducing illness, poverty and environmental pollution in the face of a growing global population.

■ Co-ordinated  
innovation policy



The broad breakthrough of new technologies is bringing fascinating benefits for man and opening up new commercial opportunities the world over. This breakthrough is however also rapidly changing market structures, challenging established business models and taking the security out of once seemingly secure jobs. Anyone wanting a stake in the profits to be gained from technological change and hold their own on fast-changing markets has to quickly translate research findings into products, processes and services that are tailored to suit the needs of the market. Intensive interaction between market-oriented entrepreneurship and knowledge-driven research – both of which should be geared to shared visions – is becoming increasingly crucial in this connection. In light of this, our innovation policy aims to build bridges between science and industry and between technologies and fields of application. Strategic partnerships are becoming increasingly necessary.

## Lead markets of the future ■

### 2. Using Germany's potential to become a lead market of the future

Innovation is shaped by market stimuli and market dynamics. Lead markets develop wherever a large number of innovations arise that build on one another. Such markets mature only when there is close contact with sophisticated, interested and innovative customers. Firms in high-tech sectors launch new products and services in markets that are particularly receptive and innovation-friendly. And they are increasingly locating their R&D activities where they can be close to production operations.

It is therefore important that we establish the conditions necessary for pioneer markets. Modern regulations to protect intellectual property, intelligent initiatives for establishing standards and norms, and a public procurement system that uses the potential offered by new technologies and, in the process, promotes market opportunities are absolutely indispensable. The greater the number of possible applications for research findings, the stronger the motivation to pursue research work will be and the greater the impact research will have. This also applies to the area of green genetic technology. The question of how far German nanotechnology products will penetrate markets also depends on the degree to which international norms and standards are actually used. The provisions regulating compensation for innovations in the statutory and private health insurance systems also impact the prosperity of the fast-growing medical technology sector. E-government can, in the interest of its citizens, show the way for the successful use of ICT solutions. Modern ICT legislation and regulations will determine the future of information and communications markets. Taking consumer interests into account and providing consumer

information at an early stage can boost the level of acceptance for new products. The use of modern energy-efficiency technologies and the expansion of renewable energies can generate enormous potential and reduce our dependence on energy imports.

Developing leading-edge markets is consequently also a task for all political sectors that shape the parameters for industry and society's innovation behaviour.

### 3. Seeing global competition as an opportunity

Today, our country is part of a globalised innovation system that has grown steadily over the years and will continue to grow in the future as well. More than five million people worldwide currently work in the science field or on the development of new products and services. However, today only one out of every 20 researchers and only one out of every 20 developers in the world works in Germany. This figure was one out of every ten in the early 1990s.

This increases the pressure on Germany to produce innovation. The growing innovation potential in Southeast Asia benefits not only the people living in that region. As an export-oriented country, Germany will also be a player when it succeeds in establishing itself as a centre for trade, communication and co-operation while, at the same time, protecting its national interests – in the area of intellectual property rights, for example. The ability to understand and evaluate knowledge that is generated around the world and then translate it into new commercially-viable products and services is of vital importance in this connection.

The German government is investing an additional €6 billion in research, development and innovation during the period 2006 through 2009. This represents the largest public-sector investment in innovation since German reunification. Key tasks for the future will be defined and research institutes and firms will be given stable parameters for their financial planning. The German government is calling on industry and Germany's Länder governments to follow its lead and increase their spending on research and development (R&D). More autonomy, self-organisation, co-operation and competition are the guiding principles for the government's science policy. Its aim is to establish conditions that will allow universities and research institutes – in competition with others – to markedly raise their profile as centres of excellence with international reach.

The internationalisation of vocational training, the advancement of cross-border mobility (which is also to be achieved with the help of policies aimed at attracting top-level workers and experts from abroad) and the expansion of international research and technology networks are key answers to meeting the challenges emerging for today's global knowledge society.

Germany's national research and innovation policy must be viewed as part of the European Research Area. Research and innovation policy will consequently also be a priority during Germany's term as president of the Council of the European Union during the first half of 2007.

### 4. Making Germany an incubator for talent

Germany's innovative power hinges on the educational qualifications of the people living within its borders. Structural change in the direction of those branches of industry that employ workers with above-average levels of training will continue at an ever-faster pace. This will fuel the need for professional qualifications. However, compared to other countries, the share of young people in Germany who have completed secondary or tertiary education has shrunk over the long term – despite the growing need for well-educated workers. It is clear from the current demographic trend that the number of young people entering the job market will decline in the future, posing the danger of a shortage of well-trained skilled labour – the key resource for high-tech locations like Germany. This could have serious consequences for small and medium-sized enterprises in particular. Therefore, top political priority is being given to ensuring that Germany has an education and training system that fosters the potential of every individual in the best ways possible.

In order to meet industry's needs, steps must be taken to create good training opportunities in a sufficiently large number at all levels of education, particularly for the large age cohorts that are currently beginning their training. Suitable high-level continuing training options must also be opened up for older employees and job-seekers. Businesses should prepare their employees for coming challenges by providing in-house continuing training.

■ The opportunities offered by globalisation

■ Germany the talent incubator

The German government will use the opportunities and means available to it to foster outstanding talent, make careers in science more attractive and put universities in a position to offer high-quality scientific training for a fast-growing number of students in the coming years. In this way, talented individuals are to be fostered in research and companies and more room is to be provided for their creativity and involvement. We want to make Germany a talent incubator.

## Knowledge and responsibility



### 5. Knowledge and responsibility belong together

In the long run, scientific and technical excellence and economic prosperity thrive only in a climate of intellectual and cultural vigour and diversity. Each individual's curiosity and openness regarding things new shape Germany's ability to meet future challenges. One of the fundamental lessons taught by experience is that we must be responsible in how we deal with what is scientifically and technically doable. The fact that man is able to do more than he should is part of the history of modern society.

Technological advances are changing the way we see the world at a hitherto unknown speed. The natural sciences are establishing the prerequisites for this change and creating knowledge about its direction and technical 'side effects'. At the same time, it is the humanities' job to ponder this change from a cultural and social standpoint and provide it bearings. In doing so, they are participating in the debate over our conception of ourselves.

What we first of all need in Germany is more enthusiasm for the opportunities offered by new technologies. However, gains in knowledge, advances in our understanding and the early assessment of new knowledge in the interest of mankind are of equal importance and belong together. At the same time, we must address not only the ethical aspects of the protection of human life but also consumer safety and the preservation of our natural environment.

The High-Tech Strategy outlines the objectives and approaches pursued by the German government in its research and innovation policy. The German government holds that innovation policy can succeed only when the persons in positions of responsibility in the education sector, research, the media, trade and industry, the political sector, government and civil society mobilise all available forces for more innovation in Germany. Innovation is the result of individual effort. Therefore each individual bears responsibility for Germany's future.



## II. We are generating new impetus – Our cross-cutting activities

In implementing our objectives, we will take action in five key cross-cutting fields and co-ordinate them with one another: (1) The interface between research and industry, (2) private R&D and innovation work, (3) the dissemination of technology, (4) the internationalisation of research, development and innovation and (5) the fostering and advancement of talent. All of these areas – and their respective measures – are aimed at streamlining and shortening the path from idea to innovation. Competition and co-operation will be the guiding principles in our efforts here:

### 1. We are pooling the forces of industry and research

#### New incentives for collaboration between industry and research

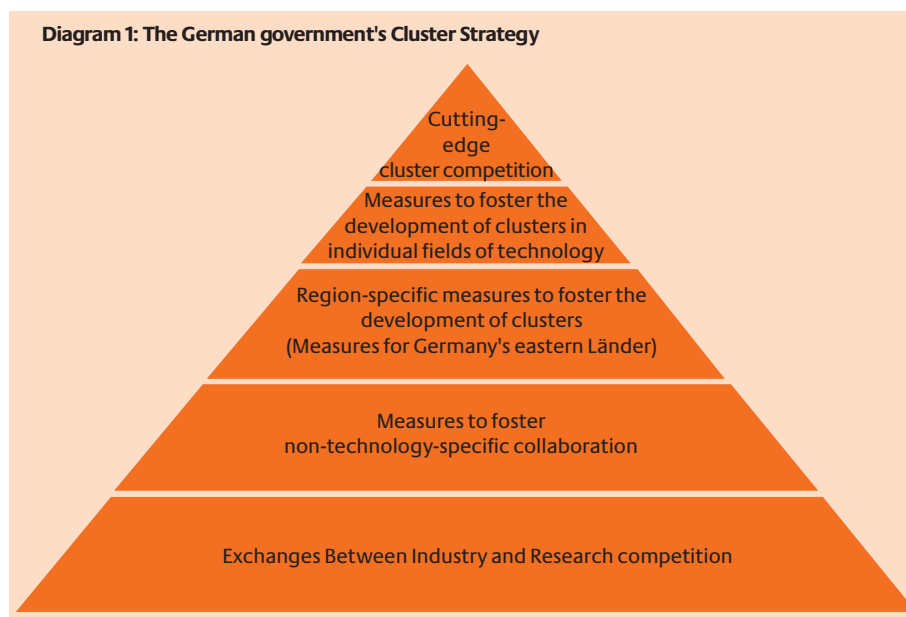
Our goal is to give new impetus to collaboration between industry and research. Which is why the government has developed for the first time ever a comprehensive Cluster Strategy for all its ministries, a strategy whose range extends from measures with a widespread impact to modular, region-specific or technology-specific approaches all the way to fostering and funding high-powered, highly productive leading-edge clusters. The Competence Networks Germany campaign being conducted by the Federal Ministry of Economics and Technology will make the most productive networks more visible not only nationally and internationally – but to potential investors as well. The Cluster Strategy encompasses the following activities (please see Diagram 1):

- **Make exchanges between science and industry visible:** Working together with the Donors' Association for the Promotion of Sciences and Humanities in Germany, the Federal Ministry of Education and Research will conduct a competition titled Exchanges Between Industry and Research. The aim of this competition is to identify particularly successful exchanges between industry and research, present them to the public and foster the progressive development of the concept behind such relationships. The contest is designed to mobilise broad segments of science and industry.

■ Collaboration  
between industry  
and research

- Expand non-technology-specific co-operation funding for small and medium-sized enterprises:** The Collaborative Industrial Research programme under the Federal Ministry of Economics and Technology funds sector-based projects conducted by members of the German Federation of Industrial Research Associations "Otto von Guernicke". Funding for cross-industry projects which is provided through the ZUTECH (Future Technologies for Small and Medium-Sized Enterprises) programme will be increased. In addition, cluster projects that cover the entire innovation process – starting with basic research and extending to the translation of research findings into new products – are also to receive assistance. The basic research part of such projects will be financed by, for example, the Deutsche Forschungsgemeinschaft (German Research Foundation), while the application-oriented research part will be financed through the Collaborative Industrial Research programme, and product development activities through the private sector.
- Optimise innovation processes and put the potential offered by Germany's eastern Länder to use:** With its Innovation Initiative for the New Länder, the Federal Ministry of Education and Research already has a set of instruments in place for developing efficient, high-powered locations for innovation in Germany's eastern Länder on a strategy-driven basis. The Innovation Initiative will be progressively developed on an on-going basis in order to take the special aspects of the innovation processes in the eastern Länder into account and to tap the region's potential to an even greater degree.  
The Federal Ministry of Transport, Building and Urban Affairs – which is responsible for the development of Germany's eastern Länder – will conduct the innovative Industry Meets Research competition which will have a similar focus and be geared to the new Länder
- Support the development of clusters in selected fields of technology:** We are developing new instruments for fostering and funding the development of clusters in cutting-edge fields of technology such as white biotechnology and regenerative medicine. With their help, we want to establish a foundation – particularly by incorporating companies at an early stage – for efficiently translating research findings into products and services (please see Section III for more details about these activities).
- Launch a competition to promote outstanding innovation-oriented alliances:** The Federal Ministry of Education and Research will single out Germany's top cutting-edge clusters for awards and funding in a competition that welcomes all fields. This assistance will enable these

**Diagram 1: The German government's Cluster Strategy**



clusters to boost their profile, eliminate impediments to their strategic development and grow into internationally attractive centres. These activities could open up new markets for German technologies, products and services. We expect this competition to have a mobilising effect comparable to that seen with the initiative for excellence in higher education.

### Application-oriented science and research-friendly industry

The German government is striving to ensure that research institutes are more open to industry's interests. At the same time, industry must be more willing to pick up on the findings generated by scientific research:

- **Implement the Joint Initiative for Research and Innovation:** Through the Joint Initiative for Research and Innovation, the federal government (together with the Länder governments) is giving the Helmholtz Association of National Research Centres, the Max Planck Society, the Fraunhofer Society, the Leibniz Association and the German Research Foundation financial planning stability and is increasing financial grants by at least three percent a year through the year 2010. In return, these bodies have committed themselves to increasing the quality, efficiency and capability of their R&D work and to linking their activities with one another. Most importantly, they are to collaborate with companies more intensively than in the past. For this reason, they have chosen collaboration with industry as their priority theme for the year 2007.
- **Introduce research grants for research contracts awarded by small and medium-sized enterprises:** The Federal Ministry of Education and Research is planning to introduce a special research grant for research contracts that small and medium-sized businesses award to universities or non-university research facilities. These grants are intended to motivate scientific institutes to engage more in industry-relevant subjects and research contracts. They are to be paid out to universities and research institutes.
- **Close the gap between research and commercialisation:** Scientific research findings are often not mature enough to allow their commercial exploitation. To close the gap between research and exploitation, commercially promising applications must be examined to determine their technical feasibility (proof of technology). For this reason, we are planning to develop a module for the validation of results, which will initially be used in suitable specialised programmes conducted by the Federal Ministry of Education and Research.
- **Develop and use public-private partnership models on a targeted basis:** Public-private partnership (PPP) models can facilitate the development and expansion of research infrastructures. In light of this, the German government will thoroughly examine public-private partnerships as an alternative means of financing and implementing investments in high-tech infrastructures. At the same time, it will also take into consideration the Science Council's recommendations regarding public-private partnerships and the privatisation of the health care provided at university medical facilities.

In addition, PPP models – such as joint research centres that are financed by industry and the public sector – offer opportunities for science and industry to conduct strategic research in close co-operation with one another. The German government welcomes these initiatives and calls upon science and industry to make more intensive use of the potential that public-private partnerships hold. With this in mind, it will seek a dialogue with science and industry, particularly on the issue of suitable parameters for this model.
- **The new Construction of the Future research initiative will boost the innovative capabilities of the construction sector:** The new Construction of the Future research initiative launched by the Federal Ministry of Transport, Building and Urban Affairs supports the so-called “Vision for the Construction Industry”. The European market particularly demands a high degree of competitiveness from the construction, engineering and architecture sectors

### ■ Focus on commercial application and access to research

which consists primarily of small and medium-sized businesses. Research and innovation are absolute prerequisites for this. However, both are hard to realise single-handedly for smaller companies in particular. The Construction of the Future initiative will introduce firms to the latest findings from science and research. These findings will then be further developed and tested in a joint dialogue.

## Brain exchanges



### Pushing the exchange of experts forward

Innovations are a result of exchanges of knowledge and information on experience gathered. However, opportunities to see things from a different perspective – such as when researchers from a university or research institute work temporarily at a company where they can contribute their know-how or when R&D staff members from industry receive new insights and inspiration from the science sector – have been too few to date in Germany. Which is why we will foster personal mobility through suitable measures, be it in the form of temporary exchanges between the research sector, industry and government bodies or in the form of collaboration on projects such as through the PRO INNO II programme being conducted by the Federal Ministry of Economics and Technology.

## 2. We are improving the conditions for high-tech start-ups and innovative SMEs

## Start-up support



### Fostering the founding and growth of new technology firms

Innovative start-ups are a motor for economic structural change. Their business ideas expand the range of products and services on offer and challenge established companies to compete on innovation. They create considerably more jobs than conventional start-ups. In light of this, the German government aims to step up the start-up rate, improve access to financing vehicles and establish attractive conditions for private venture capital investments on the part of venture capital lenders and business angels in not only research-intensive industries but in knowledge-based services sectors as well.





- **Activate entrepreneurial thinking and action, support spin-offs:** The start-up climate at Germany's universities and non-university research institutes will be further improved. For this purpose, the Federal Ministry of Economics and Technology will continue its EXIST University-Based Start-Ups programme in a modified form: Working on a nationwide basis rather than just in selected regions, EXIST will fund projects that aim to develop a sustainable start-up culture in the science sector and stimulate start-up activity at universities and research institutes.

The national EXIST-SEED programme to fund individual start-up projects at German universities will be progressively developed. This funding will also be made available for knowledge-intensive services in the future. In the case of technologically very ambitious start-up projects, EXIST-SEED will cover the research and development needs all the way up until the business idea has reached technological maturity. This will also facilitate the individual project's transition to assistance from the High-Tech Gründerfonds seed fund. The Federal Ministry of Education and Research will conduct an intensive dialogue with non-university research institutes regarding the development of new instruments to facilitate spin-offs. Pilot projects will be conducted to encourage the development of good practice models in this area.

- **Improve start-up conditions for new companies:** Technology-oriented and knowledge-based start-ups will benefit from the general measures that are part of German government's start-up campaign. As one example, the startothek central information system which went online in early 2006 offers comprehensive, up-to-date support for start-up consultancy services. In addition, the introduction of an electronic commercial register in 2007 will speed up the registration of new companies.

The overhaul of Germany's Law Pertaining to Companies with Limited Liability will lower the minimum amount of capital required for starting a limited liability company to €10,000 in the future. Further structural improvements in this law will also benefit persons who are starting up a new company. Plans also foresee exempting from attachment the provisions that self-employed persons have made for their retirement in the form of life or pension insurance policies. This will also make the step to self-employment easier.

- **Offer young technology firms access to financing and new markets:** Working together with partners in industry and the KfW banking group, the Federal Ministry of Economics and Technology will expand the High-Tech Gründerfonds fund which makes venture capital available to technology start-ups. Several more German technology corporations are to be added to this group of investors, also with the aim of establishing a foundation for strategic partnerships between technology start-ups and technology firms at early points in time. In addition, the High-Tech Gründerfonds seed fund will be meshed with pre-start-up measures at universities and research institutes and the German government's start-up-related funding programmes. This high-tech fund will be supplemented by the ERP (European Recovery Programme) Start Fund and the ERP/EIF (European Investment Fund) Dachfonds fund which make important contributions to mobilising private venture capital investment and could be further expanded if needed.

The Kreditanstalt für Wiederaufbau (German Loan Corporation) is working together with the German government and suitable partners from industry and science to develop on an exemplary basis regional research transfer funds for financing research spin-offs, with a special focus on Germany's eastern Länder.

- **Improve conditions for venture capital in Germany:** The venture capital market for financing innovation is markedly underdeveloped in Germany. Which is why we must establish attractive tax conditions for investing in venture capital. Limits on the amount of loss that small and medium-sized technology firms can offset and the lowering of the materiality limit for participating interests to one percent have a particularly detrimental effect. We will improve the capitalisation of small and medium-sized businesses in particular and establish internationally attractive conditions for venture capital (through a new private equity law). The private equity law will be passed in tandem with the corporate tax reform.

**SME funding** ■**Increasing small and medium-sized enterprises' share of innovation**

Small and medium-sized enterprises play a key role as partners in value-added chains, as independent providers of innovative products and services and as a motor for employment. Germany has a strong core of more than 100,000 innovative small and medium-sized businesses. Many SMEs hold leading positions in technology. They generate advantages in the innovation arena by being fast and flexible, developing niche markets and specifically responding to customer needs. However, not quite one third of these small and medium-sized businesses conduct research and development on a continual basis. It is therefore our goal to increase the number of small and medium-sized businesses that are actively involved in R&D and to improve the innovation capabilities of Germany's SMEs. The funding provided by the Federal Ministry of Economics and Technology to assist innovation work, irrespective of the type of technology it involves, will be increased from some €460 million in 2005 to more than €670 million in 2009. In addition, the share of SMEs participating in the research funding programmes of the Federal Ministry of Education and Research and the Federal Ministry of Economics and Technology will grow. We are working to:

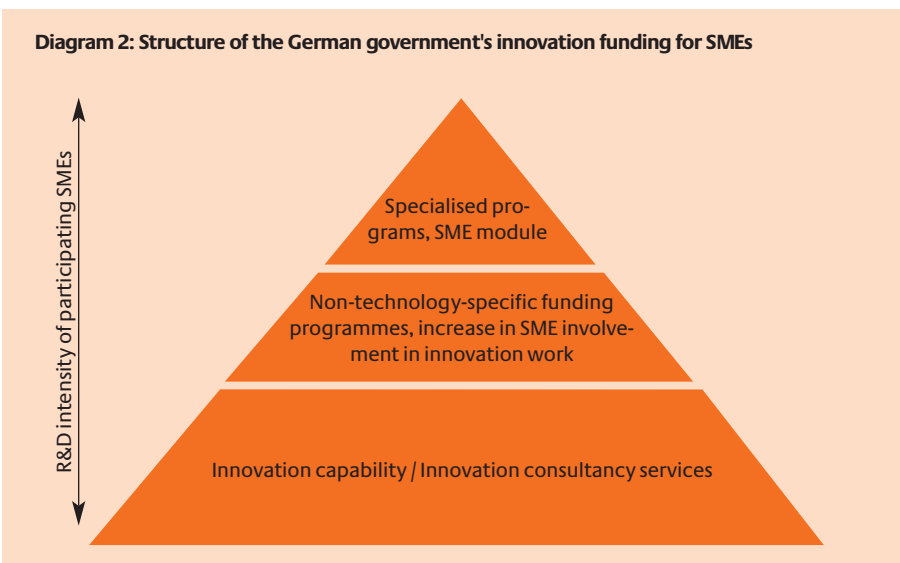
- **Strengthen the innovation capabilities of small and medium-sized enterprises:** The Federal Ministry of Education and Research uses its Potential for Innovation in a Modern Working Environment programme to fund projects that examine innovation processes from the standpoint of personnel and organisation development, and develop, test and translate models into actual company operations. Centre stage is given here to the development and expansion of corporate cultures that are conducive to innovation. The German government is additionally continuing the New Quality of Work Initiative (INQA) and meshing it with R&D activities. Players in the occupational health and safety field are joining forces here to transfer the latest scientific findings to actual practice. The Federal Ministry of Economics and Technology is extending its INNOMAN programme which advises small and medium-sized companies in the eastern Länder and Berlin and supports the technology consultancy services offered by the country's trade chambers. In addition, the government will continue to actively support the Technology-Oriented Visit and Information Programme in which industry offers a practical exchange of experience between companies from different sectors and of different sizes. Measures to strengthen innovation capabilities will be adapted to current needs and better co-ordinated at federal and Länder level in future.
- **Expand funding for R&D and innovation in SMEs:** Substantially more funds will be allocated for PRO INNO II, the Federal Ministry of Economics and Technology's primary programme for funding collaborative R&D activities between companies and research institutes. A new component will also be added to this programme: Newcomers who are conducting research and development work for the first time or after a longer break will receive funding without having to already be collaborating with other companies or research facilities. The ministry's InnoNet programme for assisting innovative networks consisting of several SMEs and at least two research institutes will also receive increased funding and be further improved. In addition, with the help of a new measure, the Federal Ministry of Economics and Technology will stimulate the transfer of technology from its Departmental Research Institutes to innovative, small and medium-sized firms.
- **Strengthen the innovative powers of SMEs in Germany's eastern Länder:** Many external industrial research facilities in Germany's eastern Länder have, through their collaboration with industry, developed into recognised partners in the innovation process. In contrast to the country's major public-sector research institutes, these facilities do not receive basic government funding. To compensate for the competitive disadvantages these facilities face, the 'preparatory research' they conduct is to be funded through the INNO-WATT programme under the Federal Ministry of Economics and Technology. The funding provided through the INNO-WATT programme will also be extended to include new firms. Further, assistance will also be made available to fast-growing companies that shift the focus of their work to production.

- Expand the number of SMEs participating in research funding programmes:** Direct project-funding activities integrate small and medium-sized enterprises into cutting-edge research primarily by involving them in collaborative projects. The volume of this funding has increased enormously in recent years. At the same time, requirements for funding approval are selective and demanding and the standards are very high. The government plans to develop a module for funding small and medium-sized businesses in all suitable specialised programmes of the Federal Ministry of Education and Research. Starting in 2007, it will be possible to conduct calls for proposals on a regular basis with probably two set dates each year. This module will be designed in a way that will allow other ministries to use it for their programmes as well.
- Reorganise funding structures:** Using the measures outlined here, the German government will create a clearly structured range of funding options for all innovation-oriented small and medium-sized businesses. These options will target firms that have no research and development activities of their own, 'R&D newcomers' and high-tech SMEs. Through this undertaking, the German government is responding to the fact that the prerequisites for successful participation in innovation work vary between the different groups of SMEs.

Diagram 2 outlines the new structure underlying the federal government's SME funding activities.

Additionally, during the time remaining in the current legislative period, innovation funding activities under the Federal Ministry of Education and Research and the Federal Ministry of Economics and Technology will be examined again for ways and means of further concentrating and streamlining funding structures. These efforts aim to gear funding even more to industry's needs and concomitantly take into consideration the recommendations issued in the course of external evaluations.

**Diagram 2: Structure of the German government's innovation funding for SMEs**



### Improving the conditions for private R&D investment

The German government will take the following steps to improve conditions for the private sector's involvement in R&D:

- Strengthen bank financing for innovation:** More than €1 billion in loan commitments were made through the new ERP innovation programme during the first half of 2006. This programme provides long-term, low-interest loans which include relaxed terms for the provision of security (and a partial waiver of bank liability). In doing so, this Federal Ministry of Economics and Technology programme tackles a key impediment to loans – the lack of sufficient collateral for high-risk R&D projects – and, through the use of a mezzanine component, strengthens the participating companies' equity capital base.

### Conditions for private R&D

In order to improve loan financing for innovative firms, Germany will exhaust the latitude allowed it under the EU directive for implementing the equity capital requirements laid down by Basel II.

In a dialogue with banks and other players, we will also work to obtain their support for taking intangible assets into greater account when companies are rated. Standards for assessing intangible assets also belong to this. An IT-aided tool that companies can use to evaluate their own innovation performance is currently being developed as part of a project that is funded by the Federal Ministry of Education and Research and originally developed out of the Innovative Strength in SMEs Impetus Group of the Partners for Innovation initiative. Banks and rating specialists are also involved in this project. We want to bundle corresponding activities for developing practical instruments for assessing intangible assets so that new solutions find wide acceptance and quickly establish themselves.

- **Facilitate foundations:** As agreed in the coalition agreement between the ruling Christian Democratic Union and the Social Democratic Party, we will further develop and improve existing legislation on foundations. Private foundations in Germany are to contribute to an even larger degree to assisting and funding education, science and research. Germany will see an enormous transfer of assets in the coming years as a result of inheritances. This situation offers an opportunity to lay another sound foundation for financing innovation which we can prepare by establishing appropriate conditions. In addition, research institutes are looking for private financing options for existing foundations or foundations that are to be set up.
- **Make Germany's tax system innovation-friendly:** The corporate income tax reform that will go into effect on January 1, 2008 will also give businesses more incentives and latitude for innovation work. In the interim, the current 20 percent rate for declining balance depreciation will be raised to 30 percent in a move to improve investment conditions.
- **Substantially reduce red tape:** The German government has taken first steps toward reducing bureaucracy with the Law to Ease Burdens on Small and Medium-Sized Enterprises and a set of corresponding measures. We will systematically use the introduction of the standard-cost model for measuring the cost of bureaucracy to streamline particularly costly elements of regulations that are relevant to innovation and to use modern information and communications technologies to a greater degree for administrative processes (e-government). It is estimated that SMEs currently spend four to six percent of their turnover on administrative activities that are required by law. A reduction in bureaucracy could free up enormous innovative capabilities. The German government's Reduced Bureaucracy and Better Lawmaking programme includes the creation of an independent body to review new laws and regulations.

### 3. We are supporting the more rapid dissemination of new technologies

German research ranks highly internationally and leads the world in numerous fields of technology. However, research findings have to be commercially exploited before they can contribute to prosperity and the creation of new jobs. Mechanisms for protecting intellectual property rights play a central role in this connection. Germany has a special interest in functioning, international regulations for the protection of intellectual property: Measured by the number of patent applications, it takes its place among the world's leaders and as an exporter of high-quality technology products it is often affected by infringements of these regulations. Consequently, improving the protection and utilisation of intellectual property has priority for the German government. It is working to:

- **Put research findings from universities and research institutes to commercial use:** Patent exploitation will be further professionalised. As part of the German government's patent exploitation campaign, the Federal Ministry of Economics and Technology will continue providing funding even after 2006 for the exploitation of inventions generated at universities. Existing exploitation infrastructure will be geared more effectively and to a greater degree to the needs of the companies working the patents.



- Make regulations international and binding:** Together with the other players, Germany is progressively developing and honing existing systems for the protection of intellectual property in ways that will foster innovation. This is being done both within the framework of the World Intellectual Property Organization (WIPO) and at European and national level. For example, the adoption of EU Directive 2004/48/EC will improve the enforceability of intellectual property rights. Plans include the right to obtain from infringers and others parties information regarding the identity of third parties involved in the infringement and regarding distribution channels, rights to the presentation and preservation of evidence, and provisions for remedying the damages incurred. Agreements must be implementable and enforceable for all players. In addition, steps must be taken to increase the acceptance of intellectual property rights internationally.

In light of the German export sector's experience with the growing number of counterfeit products – even in high-tech fields – and the now discernable limits to global regulatory frameworks, such as in the case of Trade Related Aspects of Intellectual Property Rights (TRIPS) in WTO negotiations, Germany will put this issue on the agenda for the G8 summit which it will be hosting in 2007 and use its term as president of the Council of the European Union to work toward a solution to this situation. We want to develop – together with industry and partner countries – a strategy with concrete measures to improve the enforcement of intellectual property rights around the world. This will include supporting the EU initiative to harmonise criminal provisions in this connection.

- Expand the European patent law system:** We will work for the speedy implementation of the pending improvements in European patent law. Once in force, the London Protocol to the European Patent Agreement will markedly reduce patent translation costs. It is vital that the European Patent Litigation Agreement on the creation of a single European patent jurisdiction be adopted. We will support a Community patent when it is designed to be cost-effective and legally secure.
- Bring copyright law into line with the digital age:** Germany's flat-rate copyright fee system will be overhauled and placed in the hands of the parties involved as stipulated by legal regulations. New provisions will make it possible to make modern-day use of today's information and communications technologies for education, science and research purposes – while allowing for the interests of authors and publishers.
- See to it that DRM systems are user-friendly:** Digital rights management (DRM) systems are designed to ensure payment for use of online content and that such content is used as agreed

in the respective contract. Key features of a suitable DRM system include universality (in other words, content can be played on all media without restrictions), ease of use (no long texts or collateral clauses), greatest possible user anonymity and the standardisation of the technical aspects of DRM systems so that media can be exchanged even when different DRM systems are used. Only in this way will it be possible to win the user's confidence and still protect the copyright owner's rightful interests. And only in this way can quality-tested premium content be effectively exploited for today's knowledge society.

In addition to fostering the protection and exploitation of intellectual property rights, the German government will improve the following parameters for the dissemination of technology:

### Standardisation



- **Step up standardisation in innovation processes:** The success of German high-tech products on world markets must be supported with a vigorous standardisation strategy. Giving standardisation early consideration in the research process and when translating research findings into high-tech products and services creates competitive advantages for Germany. One reason behind the leading role played by German laser technology firms today is the fact that standardisation was incorporated into research in the late 1990s, a step that helped put German technologies on the road to success. The German government is therefore supporting the German Institute for Standardization (DIN) – German industry's self-regulating organisation – in its systematic examination of new high-tech fields to determine aspects where standardisation is called for and in incorporating standardisation into the research process. In addition, the German government will take standardisation considerations greater into account in its assistance and funding for research and technology.

### Public procurement



- **Use the innovation potential offered by the public procurement system:** Every year, Germany's federal, Länder and municipal governments award contracts worth some €260 billion. This is approximately 12 percent of the country's gross domestic product. The German government aims to put to greater use the enormous potential this offers as a vehicle for government demand for innovation. Examples of the public sector's technology needs range from e-government to the Toll Collect toll collection system for lorries using the German autobahn, all the way to innovative environmental technologies such as cutting-edge heating systems. Current contract award regulations offer a suitable structure for making improvements. All administrative agencies and procurement offices at federal, state and municipal level must take part in the strategic task of fostering innovation through public procurement. The government is basing its activities in this connection on the findings submitted by an 'impetus group' of the Partners for Innovation initiative. It will continue to pursue this objective in talks with representatives from the country's Länder and municipalities. As is already common practice at public-sector research institutes, government procurement offices should be evaluated to a greater degree by external experts to ensure they meet the future standards for economical efficiency and user-friendliness and thus contribute to greater innovation-orientedness. The German government has created the Government Contractor Innovation Achievement Award. This award is designed to pay tribute to exemplary achievements on the part of public procurers and thus point the way for more innovation in the procurement system. There is an enormous need for further training directed at gearing the process for determining requirements, invitations to tender, assessment concepts and implementation procedures to procurement that targets innovation (integrated procurement management). An improved information system at procurement agencies constitutes an important starting point for public procurement that gives room to innovation. The German government aims to develop an enhanced information infrastructure in the public procurement system. Additionally, procurement agencies are to be encouraged to seek early information about the latest technical developments in the marketplace.

### Modernising government



- **Streamline processes and structures through e-government:** The German government already stipulated in the coalition agreement between the Christian Democratic Union and the Social Democratic Party that it would reorganise co-operation within the machinery of the government

with the help of information and communications technology. We plan to play a major part in creating innovative and cost-cutting government by introducing IT-supported processes for the most important government services. The Federal Ministry of the Interior will develop a new e-government programme that will satisfy these requirements.

Innovations in the e-government field open up, for example, new channels for accessing administrative services, enable shorter processing times and inject processes with greater transparency. Accompanying research and evaluations will further advance the development and use of e-government. Technological innovations are a means to an end in this connection and are being used for a far-reaching modernisation of the administrative system.

#### 4. We are strengthening Germany's international position

##### Improving research and innovation capabilities through international co-operation



The globalisation of today's knowledge society offers enormous opportunities for Germany. We must make use of the advantages offered by the international division of labour to bring our own strengths into the game and draw on the strengths of others to foster innovative advances in high-tech fields.

Not only do we want to participate in a strong global economy, we also want to take on a leading role in solving pivotal problems that concern people everywhere – peace and security, reducing poverty and disease, environmental and climate protection, the protection and sustainable use of natural resources, improved living and working conditions and a secure and sustainable energy supply – and thus have to be tackled by a science policy that is international in scope. This will require bundling measures in a variety of areas and co-ordinating them through a concerted internationalisation initiative to be launched by the German government. These activities aim to:

- **Get Germany into shape for collaborative international research:** We must make Germany more attractive as a location for research and more accessible for international partners. With this aim in mind, we are examining the question of how much more we could open our specialised funding programmes in areas where innovation-related objectives could be achieved faster and more effectively by incorporating international expertise. To achieve this, researchers in Germany will have to network more at international level. Collaborative international R&D activities will also receive more assistance in the future from non-technology-specific programmes conducted by the Federal Ministry of Economics and Technology. For instance, the PRO INNO II programme foresees increased funding for German SMEs that collaborate with foreign partners. Further, InnoNet and the IGF collaborative indus-

■ **International co-operation in education, research and innovation**

trial research programme are participating in ERA-NET, the European scheme to foster the cross-border networking and co-ordination of national research funding programmes, and will consequently offer better prerequisites for co-operation with partner countries in the future. In addition, the Eureka initiative assists small and medium-sized enterprises involved in international R&D co-operation.

The first step toward co-operation with foreign partners often starts with contacts made at major trade fairs. In light of this, the International Technology Co-operation Network is increasingly conducting its events parallel to technology fairs in partner countries. Furthermore, a new programme will be launched next year to fund high-tech SMEs' participation in leading international fairs.

- Expand co-operation in growth markets with countries with fast-growing research activities:** The German government supports co-operation with countries that are substantially expanding their research and development competence and are therefore developing into interesting partners for Germany in its role as a high-tech location. As an example, it has agreed with India to work toward a German-Indian science, research and technology centre. Collaborative relations with the People's Republic of China are also to be intensified. The primary focus in the future will be first and foremost on laser and optical technologies, nanotechnology/new materials, IT and biotechnology. Further potential exists in joint initiatives on standardisation in areas such as radio frequency identification (RFID).
- Mobilise research investments and highly-qualified professionals for Germany:** With a view to tapping existing potential for research co-operation and making its educational opportunities known to a wider audience, Germany will present itself increasingly as a land of ideas in countries with strategically important science and technology resources and in emerging leading-edge markets. As part of this, the Federal Ministry of Education and Research is bundling the internationalisation activities of various players in theme-based campaigns to promote Germany and supports them with its own information and advertising campaign aimed at increasing Germany's overall visibility as a place for conducting research. A pilot project titled Germany and Korea – Partners in Research will be launched in South Korea in 2006. We also plan to use 'R&D ambassadors' who will represent German research abroad and actively promote Germany as a location for research in joint campaigns.

## European research and innovation policy

### Helping shape European research and innovation policies

National research and innovation policies must be understood as part of the European Research Area. The European Union will regularly increase annual funding for its Seventh Research Framework Programme (FP7) over the entire duration of the programme which will end in 2013, at which time the funding for FP7 will be about 60 percent higher in real terms than for FP6. In doing so, the FP7 is pointing the way for research and development work in Europe. This programme is also very important for the German innovation system. In addition to this, the European Union will increase the networking of the innovation players in Europe through its Competitiveness and Innovation Framework Programme (CIP). The German government plays an active part in shaping the European Union's policies through its activities to:

- Make research and innovation policy a priority during Germany's term as president of the Council of the European Union during the first half of 2007:** National activities should tie into European initiatives. We want to provide active flanking support for the new technology platforms in particular and strengthen the co-operation between science and industry in them. The opening event of the European Research Council will be held in Berlin in February 2007 and is being organised by the German Research Foundation. During Germany's term as president of the EU Council, we want to emphasise that 'modern basic research' is a foundation and motor for societal and industrial innovation. A number of top-level symposia on topics of relevance to industry such as nanotechnology, biotechnology, security research and sustainability research and on innovation financing in SMEs will follow.



- **Increase Germany's participation in EU funding programmes:** Germany's level of participation should reflect the importance of German research and development in the European Union. We want to help shape European research and technology policies and ensure that as many German players as possible can take part in European research alliances. With this in mind, we are taking steps to have our national interests systematically represented during the development of the individual annual programmes and are supporting German applicants with a highly efficient consultation services infrastructure (National Contact Points).
- **Seek out bilateral co-operation with other EU Member States:** The German government seeks collaborative activities with interested Member States as a means of pushing important projects ahead quickly or in order to develop shared topics enough that they are sufficiently 'mature' for attention at European level. Germany has, for example, together with France set up a number of collaborative projects in high-tech fields. These include the QUAERO joint research programme which is developing new technologies for the automatic searching and processing of ICT data (text, images, audio and video) – an undertaking that will bring a quantum leap in the area of 'knowledge work'.

## 5. We are investing in minds

Innovation requires talented individuals. The German government is working for a progressive development of the German education system that encompasses all links in the education chain – early childhood education and care, school, initial vocational training, university studies and continuing education and training. Meeting the growing need for highly-qualified skilled workers, fostering junior scientists and scholars, and attractive employment conditions in public-sector research are of outstanding importance. We are working here to:

- **Expand the vocational training system with an eye to meeting the challenges of the future:** Well-trained skilled workers are a key resource for a high-tech location like Germany. There is the threat that they could become a scarce commodity. This would have dramatic consequences for smaller firms in particular.

In light of this, we are giving political priority to building a vocational training system that fosters the potential of every single person in Germany in the best possible way. This objective is being served first of all by the Vocational Education and Training Pact in which industry has committed itself to providing 30,000 new regular training places plus 25,000 training places for introductory training each year. In the summer of 2006, the partners in the Pact underscored their intention to extend it for another three years starting 2007 and to further develop and refine its content. Secondly, the Committee on Innovation in Vocational Education and Training will draft proposals for the continued structural development of Germany's vocational training system before the end of the current legislative period.



■ **Continued development of the vocational training system**

- **Develop and improve lifelong training processes and continuing vocational training:** The new Committee on Innovation in Continuing Training was set up to develop an overall strategy for lifelong learning and continuing vocational training. Initial results are expected in mid-2007.
- **Foster women, tap unutilised training resources on a targeted basis:** We want to improve the career opportunities and increase the share of well-trained women in the workforce, particularly in the science field. Improved tax deductions for childcare expenses, all-day school and the parental allowance are important steps toward combining employment with raising a family. Other measures are currently being investigated. Steps are to be taken to increase interest among girls and women for technology and science. The wide array of initiatives – such as Girls' Day – already being conducted with this aim in mind will be continued. Going beyond this we want to reinforce the positive change in attitude – particularly in the research and development field – toward employing older workers. The 50 Plus initiative of the Federal Ministry of Labour and Social Affairs and the instruments for dealing with ageing personnel that were made available as part of the Federal Ministry of Education and Research's demography initiative could further assist this.
- **Boost investment in human resources:** Human resources are key to both success in the marketplace and successful innovation. This also applies to the high-tech field. Fostering the training, health, motivation and capabilities of all individuals involved in work processes and human job engineering make major contributions to ensuring high-quality products and services. Maintaining the individual's employability and ability to work – particularly in light of current demographic trends – is a prerequisite for our ability to produce the innovations necessary for our prosperity in the future as well. Investments in human resources strengthen our economy: Firms benefit from fewer hours lost due to illness, greater real net output and improved innovative capability on the part of their motivated, committed employees.
- **Develop and expand excellence in research and education on a sustainable, international-ally-visible basis:** Excellence in education and research is measured not in regional or national terms but rather in international terms. The Initiative for Excellence launched by the federal and Länder governments has the task of putting selected universities in a position to be able to compete with top internationally recognised institutions. Three funding lines will provide funding for 40 graduate schools for junior scientists, 30 excellence clusters and ten universities for their plans for the future for cutting-edge research at universities. Projects are selected by an independent jury of peers in the course of a competitive process. Funding decisions will be announced in the autumn of 2006.
- **Pact for Higher Education 2020:** Working together with the Länder, the federal government will ensure that Germany's universities will be able to offer even a growing number of students favourable conditions for their studies and research.
- **Increase support for highly-gifted individuals:** Germany has a diversified system for supporting highly-talented individuals that has developed over the course of many years. We want to build on this system. Germany's 11 organisations for fostering young talent currently assist 0.7 percent of all university students in Germany. Our aim is to incrementally increase this figure to one percent. On top of this, special talents require special assistance before or in lieu of university studies. Competitions for young people and educational grants for particularly gifted individuals in the vocational training sector play an important role here.
- **Recruit talented persons and skilled workers from abroad:** Germany needs an inflow of scientists and specialist workers from other countries to meet its need for skilled labour. Such individuals contribute different points of view and are important points of contact for their own native countries. We are therefore promoting Germany abroad as a location for research and science and are recruiting foreign scientists and students.

The provisions of the Immigration Act that went into force in early 2005 will be supplemented

by the implementation of the European Union's Third-Country Researcher Directive that facilitates the residence permit process for research institutes hiring researchers from other countries.

**Selected research and innovation policy initiatives 2006 – 2009**

**1. We are bundling the forces of science and industry**

- The Exchanges Between Science and Industry competition will be used to single out examples of particularly successful transfer concepts and foster their continued development. BMBF 2006
- Through the Industry Meets Science competition being held in Germany's eastern Länder, universities of applied sciences are, together with local companies, to develop into 'regional anchors' for innovation. BMVBS 2006
- A competition open to all themes will be used to select Germany's top clusters for awards and funding. BMBF 2007
- A new type of research grant will be introduced to increase scientific institutes' focus on industry's needs. BMBF Early 2007
- Promising research findings will be reviewed to assess their technical feasibility. A standardised funding plan will be developed for this in suitable specialised programmes. BMBF 2007

**2. We are improving conditions for high-tech start-ups and innovative small and medium-sized enterprises**

- The EXIST – University-based Start-ups programme will be continued in modified form to improve the start-up climate at universities and non-university research facilities. The EXIST Seed programme for funding individual start-up projects will be progressively developed. BMW i Starting 2006
- The German government together with partners from industry and the KfW banking group will expand the High-Tech Gründerfonds fund for high-tech start-ups. BMW i Starting 2006
- A private equity law will be enacted to establish internationally competitive conditions that will enhance Germany's standing as a location for venture capital (please see page 15). BMF, BMW i 2008
- Innovation funding that is not limited to a particular topic will be increased substantially and supplemented by new programme elements (funding provided through the PRO INNO II programme to help SMEs taking their first steps in the innovation field, preparatory research for external industrial research BMW i Starting 2006

facilities in Germany's eastern Länder, cluster projects that fall under collaborative industrial research, etc.)		
• Funding for SMEs in cutting-edge fields of technology will be harmonised and expanded in all specialised programmes.	BMBF	2007
• The corporate income tax reform will aim at improving incentives for innovation work and giving businesses greater latitude.	BMF, BMWi	2008
<b>3. We are supporting the faster dissemination of new technologies</b>		
• The German government will support the German Institute for Standardization (DIN) in its systematic examination of modern high-tech fields to determine aspects where standardisation is called for and in incorporating standardisation into the research process.	BMWi	Starting 2006
• The public procurement system's potential for fostering innovation is to be put to greater use in the future, by, among other things, setting up a modern information infrastructure and by conducting an evaluation of public procurement offices.	BMWi, BMBF	Starting 2006
• A new e-government programme will be developed.	BMI	2006
<b>4. We are strengthening Germany's international position</b>		
• A comprehensive internationalisation initiative will be launched.	BMBF, AA, BMWi, BMZ and others	November 2006
• Research and innovation policy will be a focus during Germany's term as president of the Council of the European Union during the first half of 2007.	BMBF, BMWi and others	2007
<b>5. We are investing in minds</b>		
• Germany's vocational education and training system will be progressively developed and improved on a forward-looking basis. The Innovation Circle on Vocational Education and Training will develop proposals for this.	BMBF	Starting 2006
• The new Innovation Circle on Continuing Education will draft recommendations before the summer of 2007 on ways to strengthen continuing education.	BMBF	Starting 2006
• The Pact for Higher Education 2020 will aim to ensure that the growing number of students in Germany will find attractive study and research conditions in the coming years.	BMBF, Länder	2007
<i>Please see page 107 for an explanation of the abbreviations used here.</i>		

The German government will spend some €2.7 million on central, cross-cutting and cross-technology activities in the years 2006 through 2009 (additional funds are planned for the Pact for Higher Education).



### III. Full steam ahead – The individual innovation strategies

#### Introduction

Innovation policy is more than just research policy. Many conditions have to be right in order for new ideas from science and research to be able to develop their potential for benefiting mankind:

Science and industry have to be brought together in application-oriented projects. Entrepreneurs are dependent on venture capital. Quality standards can strengthen consumers' confidence in innovative products. And fast-growing sectors need sufficient numbers of young skilled workers. Which is why the German government is using its High-Tech Strategy to bring R&D funding and efforts to shape the general parameters for innovation together in one comprehensive innovation policy. All decisions being taken across a very broad range of policy fields will be examined to determine their implications for research and innovation conditions in Germany.

Aiming to forge links between research and emerging, cutting-edge markets, the government is developing 'prototypal' innovation strategies for 17 high-tech sectors: Nanotechnologies, biotechnologies, optical technologies, microtechnologies and information and communications technologies are considered driving technologies the world over – technologies that enable a wide variety of applications and are transforming a wealth of economic sectors. Mastery of these technologies is of vital importance for a high-tech country. However, for an export-oriented country such as Germany, it is even more important that these enabling technologies be integrated into fields of application such as automotive or mechanical engineering – which provide the basis for Germany's economic strength – or environmental or energy technology which are needed for solving urgent problems of the future. The German government wants to expand Germany's strength as a provider of systems technologies.

Using a SWOT (strengths, weaknesses, opportunities and threats) analysis of Germany as its point of departure, the federal government will develop specific measures for each high-tech sector for the next several years. These measures will all include the following essential elements:

- R&D funding in thematic programmes,
- The establishment of innovation-friendly conditions and
- Agreement between science, industry and the political sector on connected strategies.

The German government's thematic R&D funding programmes are particularly suited to responding flexibly and quickly to new technology trends and to linking science and industry. Providing funding for collaborative projects in which companies and research institutes work together has particularly proven its worth. Such projects are geared to application and incorporate all necessary partners into the innovation and value-added chain. Collaborative projects offer special advantages for SMEs in particular: On the one hand, they bring SMEs into direct contact with excellent research institutes. On the other hand, the participation of large corporations in these research alliances gives participating SMEs access to global markets and the chance to do business as a supplier.

- Suitable, thematic R&D funding programmes are to be organised in the future as framework programmes with a timeframe of up to ten years. This will give them the necessary staying power for pursuing longer-term strategies and promising technological trends.
- These framework programmes will be developed on a joint basis with the active participation of representatives from industry, science and the political sector. Working together, science and industry will draft roadmaps for technological advances in suitable areas. This will be done to co-ordinate the activities being pursued in the respective field.
- Specialised programmes will be brought together and organised to be more transparent. This will inject greater transparency into the competition over funding resources.
- The new funding programmes for information and communications technologies and for security research will follow this new concept on a pilot basis.
- This means that research policy will play an even larger role as moderator in the innovation process. In the process, it will provide impetus for shaping and organising framework conditions to reflect the needs of innovation work.

The German government will continue to develop its sectoral innovation strategies in the course of a dialogue with science and industry. The newly created Industry-Science Research Alliance will be in charge of this task (please see Section IV).

These technology-specific strategies and measures will augment the German government's non-technology-specific activities such as the cross-technology research funding programmes for SMEs, the environmental innovation programme under the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the High-Tech Gründerfonds fund for high-tech start-ups and the SME programmes conducted by the Federal Ministry of Economics and Technology.

## Innovation for a safe and healthy life

### Health research and medical technology – Sparking a growth market

#### Better quality at less cost



Research in the health field has been a major factor behind the steady increase in general life expectancy seen over the last 50 years. Despite this progress, most diseases are still incurable. Basic biomedical research has produced promising insights into the pathogenesis of many diseases. Using this information it is possible to develop diagnostics and highly-specific therapeutic agents with reduced side effects. The new findings from nutrition research and predisposition research will make it possible to offer customised prevention strategies for the individual, strategies that will allow people to assume more responsibility for their own health. Sector-spanning IT interconnectivity is making it possible to give patients improved information, organise the health care system more efficiently, and improve multicentric clinical studies that make new medicines available to patients sooner.

Besides being of vital importance to each individual, good health is also extremely important for society. Spending by Germany's statutory health insurance system alone accounts for nearly seven percent of GDP every year. Hospital treatment comprises some 35 percent of this spending, medical care 15 percent and medicine 16 percent. At the same time, the health care system is a growing market of the future.

The German government aims to further improve patient care and, at the same time, make it more cost-efficient. To achieve this, it supports the transfer of research findings to their use in the development into new diagnostic and therapeutic agents. Germany wants to take a leading role in the area of regenerative medicine. The German government is working to re-establish Germany's attractiveness as a location for pharmaceutical research and production by improving conditions for clinical studies and to maintain Germany's standing as a lead market for medical technology. The potential offered by information and communications technologies is also to be put to use for health care.

#### ■ Field of innovation

#### ■ Objective

**SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Medical technology sector:</b> Germany's medical technology sector is second only to the USA in patents and global trade share. R&amp;D represents a large share of turnover (ca. 10 percent). The very latest product range; growing number of firms; internationally leading companies in imaging, radiopaque media and biochips.</li> <li>• <b>Biomedicine:</b> Internationally recognised authorities in basic research, research laboratories of individual, highly-specialised pharmaceutical companies.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Development of new therapeutic and diagnostic agents:</b> Customised and less treatments with fewer side effects.</li> <li>• <b>Health care, the growth market:</b> Ageing population and an increase in chronic illnesses.</li> <li>• <b>IT infrastructure:</b> Patient care processes could be optimised.</li> <li>• <b>Medical technology:</b> Protect and expand Germany's leading position.</li> <li>• <b>E-health care:</b> Introduction of the electronic health data card and the electronic patient file.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Pharmaceutical industry:</b> R&amp;D expenditure has fallen far behind the USA and UK. Licensing trials are being conducted primarily abroad.</li> <li>• <b>Biomedicine:</b> Little collaboration between the pharmaceutical industry and basic and clinical research. There are few products that are sufficiently well developed to be used.</li> <li>• <b>Clinical research:</b> Germany needs to develop competence in conducting clinical trials.</li> <li>• <b>Fragmented EU market:</b> Lack of uniform market conditions for new products.</li> <li>• <b>Legal framework:</b> Possible impediments for innovation, such as problems with the financing of the medical care part of clinical studies.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Regulations:</b> The question of how the reimbursement of costs is regulated in the health care system determines whether medical products can become a lead market.</li> <li>• <b>Cost pressure:</b> Health economics aspects of medical and medical technology innovations have to be taken into greater account than in the past.</li> <li>• <b>Enormous need for R&amp;D is coupled with high financial risk:</b> The development of new methods of treatment in the regenerative medicine field is very cost-intensive and beset with risk.</li> </ul>

*Please see page 107 for an explanation of the abbreviations used here.*

**Areas of action**

**Research for applications to be used in the medical field**

The innovation models posting the greatest international success in the biomedicine field show that the close intermeshment of science, industry and medicine produces the best results in this high-tech sector. For this reason, the Task Force on Improving Locational Conditions for the Pharmaceutical Industry in Germany and the Interministerial Working Group for Regulatory Issues Involving Biomedicine and Bioethics incorporate all players in the health care system. Working together, they jointly adopt recommendations. The Health Research Council has initiated a roadmap process in preparation of the next medical research programme which is to be adopted in late 2007.

**Research in the basic research field**

A detailed, comprehensive understanding of the causes and development of diseases is a prerequisite for developing innovative diagnostic and therapeutic agents. A central component of



research in this field is the intermeshing of systematic research methods with disease-related genome and post-genomic research. The German government funds work being conducted in this area by the National Genome Research Network.

New methods for using nanoparticles to transport active substances will make it possible to treat diseases at their foci, reduce side effects and enable the use of new medicines which could not be used to date due to their chemical properties. Plans foresee the creation of a new funding priority for this area.

### **Research in the area of translation**

Insights into the molecular and cellular causes of diseases must be harnessed with the help of translational research methods in order to develop innovative molecular diagnostics and new methods of treatment. The area of preclinical research offers enormous potential for improving the predictability of the clinical efficacy and safety of active substances in humans. This is achieved using pathophysiologically relevant animal models and in vitro test procedures that are relevant for humans and have a validated mechanism of action. Work in this area is targeted by the planned Innovation in Medicine Development call for proposals and fits into European projects and programmes (FP6 and FP7).

Regional Integrated Research and Treatment Centres will boost patient-oriented clinical research, give patients access to new methods of treatment and support health care at university clinics by creating trail-blazing structures. Germany's best researchers are working together with practicing doctors in national-scale medical research networks that have been set up for individual diseases. This method of bringing players in the research and medical treatment fields together is to be continued in medical research networks for specific diseases. Industry can also participate in these activities. As a result of this approach, research findings will quickly make their way into medical treatment and research will tap into the concerns and issues of the health care field.

The German government funds the establishment and operation of Centres for Clinical Trials at university medical schools and clinics. These centres help optimise trials that are initiated by medical researchers and trials that are conducted on behalf of the pharmaceutical or medical technology industry. Their work will give patients early access to new methods of treatment.

These three co-ordinated approaches will advance patient-oriented clinical research in Germany to the top international ranks. Focussing these activities will therefore strengthen Germany as a location for research and industry and make it attractive for the pharmaceutical industry. More clinical trials will be conducted in Germany once again and patients given early access to new medical treatment.

### **Research endogenous regeneration processes and harness them for therapeutic use**

Increasing life expectancy has led to a shift in the focus of medical care – from acute illness to chronic disease where in many cases only the symptoms can be alleviated. In contrast to this, new concepts in the field of regenerative medicine hold the promise of treatments that actually cure. The aim of regenerative medicine is to replace damaged cells or tissue. This can be accomplished through cell therapy and other methods that use stem cells' ability to regenerate. The transition from simply treating symptoms to truly curing disease through regenerative therapies promises not only to improve patients' quality of life. This approach will also eliminate the need for long-term treatment and consequently substantially reduce the burdens on our health care system and economy as well.

Experimental methods for regenerating myocardial tissue, nerve cells and pancreatic cells in animal models already exist. A few have already been tested on patients. The medical and economic possibilities offered by regenerative medicine are many and diverse, and cannot yet be fully foreseen. In light of this, the German government is funding two different measures: Firstly, research alliances in the basic research field are investigating and expanding the potential of regenerative medicine. Secondly, so-called translational research clusters are to be used in technologically-advanced, clinically-relevant areas to support new scientific and organisational

methods that are aimed at shortening the transition from scientific basic research to clinical and pharmaceutical practice. These activities will incorporate the entire value-added chain in the regenerative medicine field, as well as Germany's health insurance companies and regulatory agencies. Prototypical translation concepts will tackle translation-related deficits that are typical of this field.

### **Continue to develop medical technology**

Innovative medical technologies can – besides bringing benefits for patients – also reduce costs and boost efficiency in the health care system. The medical technology field which is primarily comprised of small and medium-sized enterprises has a long and successful tradition in Germany. Products that are less than two years old account for more than half of the turnover in this sector. These include surgical instruments, devices to assist patients and new in vivo and in vitro diagnostic devices that go hand-in-hand with the development of new therapies. The Imaging funding priority aims at proving biological processes in the early stages of a disease. The methods used must recognise signals that are specific to the particular disease. If required, it must be possible to use these methods directly during surgery. Approval procedures for new, validated diagnostic agents must in future give greater consideration to the macroeconomic benefits of their cost-reducing potential.

Medical technology in an ageing society can help patients with disabilities lead an active, independent life and participate in society. If medical advances are to be put to quick use, efforts must be made to link technology with medicine at an early stage and boost co-operation between science, health insurance companies and industry.

A medical technology action plan will be developed to bundle and focus funding activities. This plan will bring together all the activities that the Federal Ministry of Education and Research is pursuing in the medical technology field – first and foremost, the innovations being generated in enabling technologies such as optical technologies (for example, biophotonics) and microsystems engineering (for instance, intelligent implants). As a rule, these activities will be carried out in collaborative projects which are jointly conducted by science, clinics and industry, with industry usually serving as the main co-ordinator.

Preserving the German medical-products market's role as a lead market is a prerequisite for further improving Germany's position on the global market. The introduction of new medical products depends not only on the level of the R&D costs and the costs for obtaining approval but crucially also on whether health insurance companies will pay for the particular product. The health care system therefore needs transparent reimbursement rules.

### **Increase prevention**

Many illnesses can be prevented or controlled through healthy habits, prophylactic measures and early diagnosis. This can improve the quality of life of the persons affected and possibly reduce costs for the health care system. The Prevention Research funding priority is already funding projects that revolve around preventive medicine. Further research work is necessary, such as in the area of genetic predisposition, movement and nutrition research, and nutritional genomics research which provide a foundation for a knowledge-based prevention strategy. Prevention is also a matter of lifestyle. Information that reinforces and supports the individual's commitment to a healthy lifestyle is therefore indispensable.

## Increase the use of information and communications technologies in the health care sector

The introduction of the electronic health data card and the electronic patient file will, in the long term, lead to a patient-centred reorganisation of existing medical care processes. The electronic health data card will establish the information system necessary for integrated health care delivery processes. It will also provide the foundation for integrating medical technology-based health care delivery processes into medical treatment chains that involve different disciplines and span ambulant and stationary care. The electronic health data card will significantly expand the patient's right to play an active role in the provision of health care. Once the health data card has been successfully launched, the German government will move ahead with the introduction of the electronic patient file.

### A lighthouse project – The electronic health data card

An interconnected health care system not only improves the quality of health care, it also operates more efficiently and saves costs. Such a system requires all participants in the health care system to be interconnected with the help of information technology – as is being targeted with the electronic health data card and its telematics infrastructure. The electronic health data card provides a foundation for and thus opens the door to other important telematics applications such as the electronic patient file.

Germany's Health Care Modernisation Act which went into effect on January 1, 2004 provides the legal foundation for incrementally converting the current health insurance card into an electronic health data card. The trial phase involving lab tests began in late 2005 and will lay the groundwork for testing the electronic health data card in eight of Germany's 16 Länder. Besides demonstrating that the technical solutions being deployed are suitable for practical use, these tests also aim to prove that the electronic health data card meets Germany's stringent data protection requirements which are designed to protect patient privacy.

## Tap into neurosciences' potential for innovation

We must put the neurosciences' potential to use by adopting the latest approaches being used in research. The interdisciplinary approach taken by computational neuroscience (CNS) makes it possible to accelerate neuroscience research enormously, particularly by using the means of computer simulation as an important complement to experiments. Advances in the neurosciences – in other words, insights into the reciprocity between neuronal dynamics and information processing obtained by recording, modelling and simulating vital processes – will lead to the harnessing of biological and information-theory principles for new approaches to treating diseases of the nervous system, for high-performance computer systems and for neurotechnologies. This is also expected to have an impact on the education sector, albeit with something of a time lag.

Through its establishment of the National Network for Computational Neuroscience, the Federal Ministry of Education and Research has bundled, strengthened and given an international profile to Germany's interdisciplinary resources. Today, the National Network includes the Bernstein Centers, Bernstein Partners and the Bernstein Award which is awarded internationally. It is planned to expand the network further with the aim of meshing research and application more closely.

## Organise conditions to be innovation-friendly

Generally speaking, basic parameters must be shaped in such a way that they ensure the necessary foundation for the provision of health care services and impede as little as possible the use of

new products in the health care field. This will be taken into account in the German government's overhaul of the health care sector. The high quality of medical treatment must be maintained. At the same time, treatment must be cost-efficient in both clinical and economic terms. In addition, speedy and safe approval procedures for diagnostic agents, medical equipment and new concepts for health care and medical treatment are of fundamental importance – as is launching innovative medicines at an early point in time. Important improvements that are helping clinical trials include the restructuring of Germany's Federal Institute for Drugs and Medical Devices and the health insurance companies' coverage of the medical costs of hospital patients who are participating in a clinical study. Efforts are now underway to make it possible for health insurance companies to cover the medical costs of individuals participating in clinical trials being conducted in an ambulatory setting. Current discussions are examining whether health insurance companies have the right to commission research work such as clinical trials. European regulations in the medicine and medical devices field should be transposed into German law in such a way that they do not lead to any special impediments to research into or the development of new and innovative methods of treatment. The German government is also working to achieve reciprocal international recognition of GxP certification (which currently does not exist with the USA). In order to facilitate the introduction of new types of treatment, diagnostic agents and medical devices to the market, decisions on whether insurance companies will include them in their coverage must also take into consideration not only the improvements they bring to the quality of health care but also the macroeconomic benefits offered by their long-term savings potential.

Of the advanced biology-based technologies, biomedicine enjoys the greatest trust among the public. The high degree of transparency in the research field, flanking bioethics debates and information campaigns regarding the opportunities and risks of the underlying technologies will continue to strengthen this trust. Political strategies for developing biomedicine will also continue to include bioethical and social aspects.

#### Individual research and innovation policy initiatives 2006 – 2009

• A roadmap process conducted by the Health Research Council will identify future funding priorities in preparation of a new health research programme.	BMBF, BMG	2006/2007
• Basic genetics research will be continued and will be boosted by translational approaches.	BMBF	2007
• Infection research, particularly on zoonoses, will be expanded.	BMBF, BMG, BMELV	2006
• Priority will be given to clinical research.	BMBF, BMG, BMAS	2006
• A funding priority for Molecular Diagnostics and a funding priority for the Development of Innovative Medicines will be established to improve Germany's attractiveness as a location for pharmaceutical research and production.	BMBF	2006
• An action plan will be developed for assisting and fostering medical technology.	BMBF	2006

- |  |           |               |
|--|-----------|---------------|
| <ul style="list-style-type: none"> <li>• The High-Tech for Health funding initiative targets the development of medical procedures that enable early, accurate diagnoses and gentler treatments and make it possible to assess the effects of individual medicines at an early point in time.</li> </ul>   | BMBF      | Starting 2006 |
| <ul style="list-style-type: none"> <li>• The funding provided for initially two Translational Research Clusters in the highly-innovative field of regenerative medicine will support prototypal implementation concepts in which insurance companies and regulatory authorities are also involved.</li> </ul>  | BMBF      | Starting 2006 |
| <ul style="list-style-type: none"> <li>• Prevention and gerontological research will be strengthened and improved.</li> </ul>  | BMBF      | Starting 2006 |
| <ul style="list-style-type: none"> <li>• Conditions for conducting clinical trials in Germany are to be improved through funding initiatives to establish clinical trial centres at university medical clinics, nationwide networks on major diseases, and integrated research and treatment centres.</li> </ul>   | BMBF      | Starting 2007 |
| <ul style="list-style-type: none"> <li>• Provisions under which health insurance companies will cover the cost of medical care during clinical studies conducted on an ambulant basis will make Germany more innovation-friendly as a location for pharmaceutical research and production. In addition, the question of whether statutory health insurance companies should be allowed in future to commission research work such as health care research or studies on issues of relevance to the provision of health care will be examined.</li> </ul> | BMG, BMBF | Starting 2006 |
| <ul style="list-style-type: none"> <li>• The introduction of the electronic health data card will push forward the nationwide use of ICT in the health care system and concomitantly open up untapped potential for greater efficiency.</li> </ul>   | BMG       | Starting 2006 |
| <ul style="list-style-type: none"> <li>• Funding initiatives for tapping neuroscience's innovation potential for applications in the health care field, information technologies and education.</li> </ul>   | BMBF      | Starting 2006 |

*Please see page 107 for an explanation of the abbreviations used here.*

## Security technologies – No chance for crime or terrorism

### Using research to protect freedom



#### Field of innovation

International terrorism, organised crime, political and economic conflicts: The challenges to the security of a modern, complex industrialised nation are many and diverse. Germany is both a society that practices the free movement of information, persons and goods and an export-oriented economy. As such, it is particularly exposed to these threats. Infrastructures – which have long included the Internet and telecommunications – are particularly vulnerable in this connection.

Therefore the aim of security research is to protect the freedom of our citizens and our society – also with the help of advanced technologies and concomitant strategies – against terrorism, sabotage, organised crime and the effects of natural disasters or large-scale accidents. Innovative technologies take their place alongside prevention in this connection: Offering a possible means for rapidly and comprehensively responding to crises, innovative technologies can substantially reduce the effects of attacks, IT incidents and even natural disasters. New security solutions for communications networks, industrial facilities, buildings, utilities and logistics systems could make Germany more robust in the face of disasters and less attractive to attackers.

Security technology not only serves to increase security, it also offers economic potential: In Germany, the fast-growing market for security products and services generated €10 billion in turnover in 2005 alone. IT security accounted for €3.6 billion of this amount. A society that does not engage in the field of civil security technology is throwing away enormous opportunities in major markets of the future.

#### Objective

Through its planned funding activities in the security research field, the German government aims to protect the freedom of its people and society with the help of technical means as well. It is working to tap the economic potential offered by security technology and make timely use of the opportunities emerging on the global market in this area.

■ SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong basic technologies:</b> Good positions in microsystems technology, ICT, optical technologies, plant and reactor safety, construction engineering, biotechnology and sensor technology, all of which are relevant to security technology.</li> <li>• <b>Diversified research:</b> Differentiated research landscape, also in the area of departmental research.</li> <li>• <b>High level of security:</b> High security standards for hazardous incidents and accidents (such as plant and reactor security, transport infrastructure security).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Hazard protection and rapid response capability:</b> Improved security technology and interoperability; broad dissemination of civil security technology thanks to cost-effective solutions.</li> <li>• <b>Expand market position:</b> Larger market share and improved export chances for companies from Germany.</li> <li>• <b>Strengthen core competencies:</b> Support for national suppliers with capabilities that are of strategic importance for security solutions.</li> <li>• <b>Technology transfer:</b> Use advanced technology from other civilian sectors and defence technology for civil security applications.</li> <li>• <b>Increase synergies:</b> Develop joint security solutions at government and private users. Make use of opportunities at European level. Bring the competence and skills offered by technology together with those offered by the social sciences.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Innovative civil security technologies:</b> Germany has no civil security research programmes that use enabling technologies to generate security-related systems innovations.</li> <li>• <b>Some segments of the security technology field are outdated:</b> Procurement is not aimed enough at innovation.</li> <li>• <b>Lack of co-ordination:</b> Platforms that bring players from research, industry and government bodies together nationwide and develop priorities for the research needs for civil security do not exist.</li> <li>• <b>Co-operation in the research field:</b> Lack of co-operation between departmental research institutes and other public-sector R&amp;D institutes on the one hand and industry research on the other.</li> <li>• <b>Fragmentation:</b> Heterogeneous user landscape; not enough players who are specialised in civil security.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Adequate protection of secrets:</b> When security is too rigid research findings do not have much far-reaching effect; when the system for protecting secrets is too lax, information flows to unauthorised persons.</li> <li>• <b>Societal approval:</b> A lack of transparency with regard to planned activities or the effects of new technologies can lead to reservations among the public.</li> <li>• <b>Ensure civil rights:</b> Need for more accompanying research that detects possible negative repercussions for civil rights and liberties early on.</li> </ul>

## Areas of action



### Ensure adequate participation in the European Security Research Programme

The European Commission plans to launch the first-ever European security research programme during the Seventh Research Framework Programme (2007 through 2013). Approximately €200 million a year are being earmarked for this programme. Players from Germany are expected to receive around €40 million a year through competitions conducted by this programme. In order to achieve this goal, the German government is first of all giving top priority to mobilising and advising Germany's nascent security research sector. The Federal Ministry of Education and Research will task a National Contact Point with advising German applicants to the European Security Research Programme.

### Launch a national security research programme

Security research has not been funded on a targeted basis at national level to date. Nonetheless, the German government's departmental research institutes (such as the BAM, BBK and BSI), the Fraunhofer Society, the German Aerospace Center, FGAN and firms and universities are also conducting research aimed at civil security under the German government's R&D funding programmes (in fields such as information and communications technologies, microsystems technology, software, space travel, biotechnology, peace and conflict research).

In a step to ensure that German interests and contributions are included in the planning and organising of pan-European security research, the German government has launched an intensive dialogue between all federal ministries and with the technology and research scene, bringing both researchers and users together. One initial conclusion is that a national funding programme would be both necessary and wise for surmounting present fragmentation and enabling German research to work effectively at European level. Based on current plans, Germany's national security research programme will start in mid-2007. Funding is slated to reach €40 million a year by 2010.

The research topics that are currently being identified in the course of an ongoing dialogue have priority in both the European and national context and revolve around the following areas:

- The optimisation of the security and protection of interconnected systems, the security of infrastructures and public utilities,
- The protection against terrorism and accidents involving biological, chemical and other substances,
- Improving crisis management,
- The interoperability and integration of information and communication systems,
- The linking of spatial data from various administrative levels and departments,
- Improving situation awareness and the culture of security,
- Restoration of security in crisis situations,
- Causal research in areas such as radicalisation and crime.

The German government plans to organise security research in collaborative multidisciplinary projects in which researchers from the engineering sector, natural sciences, social sciences and the humanities develop solutions together. It is crucial here that these collaborative projects also incorporate the persons who will be using and applying the findings. Here the private sector and the public sector must work hand-in-hand with one another.



Collaboration on standards during the research stage greatly facilitates system interoperability. In addition, innovation and technology analyses conducted in tandem with security research will put us in a position to assess at an early point in time the impact that new technology and innovation will have on society and basic rights.

**Create joint innovation platforms**

Innovation platforms for security research are to be created to ascertain R&D needs on an ongoing basis and speed up the introduction of new security technologies in the marketplace. Joint innovation platforms are to foster collaboration between government institutions, private providers and operators so that individual initial activities – for the protection of critical infrastructures, for example – are harmonised outside the research field as well. This could facilitate the co-ordinated procurement of innovation which is more cost-effective over the long term. Furthermore, the co-operation between government bodies, industry and research will open up the advantages arising from early standardisation, regulation and organisational adjustments.

**Individual research and innovation policy initiatives 2006 – 2009**

- The National Contact Point is advising parties interested in the new European Security Research Programme in order to ensure sufficient German participation in the programme. BMBF Starting 2006
  
- The German government will create innovation platforms for security research with the aim of ensuring that research is focused on urgent application scenarios, making forward projections of Germany's research requirements and improving co-operation between users and providers. Federal government (lead ministry: BMBF) Starting 2007
  
- The German government plans to set up its first discrete security research programme. Federal government (lead ministry: BMBF) Starting 2007

*Please see page 107 for an explanation of the abbreviations used here.*

## Plants – New paths for agriculture and industry

### Tomorrow's source for raw materials



#### Field of innovation

Plants offer enormous potential as cost-effective, environmentally-friendly production systems that make efficient use of raw materials and energy, supply raw materials and synthetic building blocks, and, on top of this, produce polymers, pigments, fats and starches that can be used in, for example, the automobile or paper industry.

Plants that are pest-resistant and better able to absorb nutrients open up new areas for cultivation, help make production more economically efficient and reduce environmental pollution. Not only are the basic materials used by the chemical industry and for energy production to date – petroleum, natural gas and coal – currently seeing rapid price jumps. They also lead to further increases in global CO<sub>2</sub> concentrations and will reach their global production peak in the next 20 years. Material-conversion industries such as the chemical or pharmaceutical industry, as well as sustainable fuel production that is coupled with material conversion, are dependent on renewable raw materials as an alternative.

#### Objective

The German government aims to step up the development of a knowledge-based bioindustry in Germany. It is working to make Germany the European leader in plant biotechnology and plant breeding by the year 2015. The share of renewable resources in Germany's energy supply is to be substantially increased by 2015. The use of renewable resources in the chemical industry – which is currently some 10 to 12 percent – is also to be significantly increased.

#### Areas of action

#### Strengthen genome research and systems biology as the basis for plant breeding and plant design

Genome research and systems biology are fields of science that are decisive and fundamental for advances in the life sciences and a prerequisite for the innovation capabilities of the agricultural and forestry sectors, the food industry, medicine, the pharmaceutical and biotech industries, environmental protection and other downstream branches of industry.

■ SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong plant breeding companies:</b> Globally-operating SMEs; large R&amp;D shares; global market leader in sugar beet, rape and barley.</li> <li>• <b>Strong centres for plant genome research:</b> Cologne, Potsdam, Gatersleben, Göttingen.</li> <li>• <b>European integration:</b> Germany is driving European integration in the plant research field.</li> <li>• <b>High level of competence in chemical and process-engineering research:</b> Universities, Fraunhofer Institutes, Leibniz Institutes.</li> <li>• <b>High level of acceptance for plant products:</b> Natural products enjoy a high level of acceptance in Germany.</li> <li>• <b>Efficient agriculture:</b> Entrepreneurially-minded, well-trained German farmers and foresters.</li> <li>• <b>Potentially large amount of area:</b> Suitable production areas available.</li> <li>• <b>Agricultural, mechanical engineering and plant manufacturing:</b> High level of expertise available in Germany.</li> <li>• <b>High rates of use for vegetable raw materials:</b> Compared to other European countries, Germany holds a pioneering position.</li> <li>• <b>Strong security research:</b> The use and handling of transgenic plants is the focus of intensive investigation.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Plants as a source of raw materials:</b> Customised synthetic building blocks for the chemical and pharmaceutical industries; new production processes for enzymes and therapeutic agents.</li> <li>• <b>Plants as bioreactors:</b> Plants furnish products and raw materials for integrated chemical and biotech production.</li> <li>• <b>CO<sub>2</sub>-neutral source of raw materials and energy:</b> Energy crops reduce dependence on fossil resources and fuels.</li> <li>• <b>Cascade use:</b> First physical, then energetic use.</li> <li>• <b>Decentralised value added and broad distribution of the surplus value:</b> Establishment of processing and production chains in rural and, inter alia, structurally-weak areas.</li> <li>• <b>High return on R&amp;D:</b> High macroeconomic return on plant breeding and plant biotechnology.</li> <li>• <b>Technology leadership possible:</b> Particularly in connection with the chemical industry and engineering sciences (internal combustion engine).</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Competitive disadvantages:</b> No rewards for external effects arising from the use of renewable resources.</li> <li>• <b>Fragmented research capacities</b> in the German agricultural and nutritional research field.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Green genetic technology:</b> Creation of an innovation-friendly legal framework needed.</li> <li>• <b>Reputation of genetically modified plants:</b> Low level of consumer acceptance in the food area.</li> <li>• <b>Risk of relocation</b> of plant breeding companies' production and test facilities to other countries.</li> <li>• <b>Non-technical market access problems:</b> Difficulties exist particularly in the area of bio-energy.</li> </ul>

Genetic research on crop plants has developed into an internationally highly-competitive field of research that is associated with rapid scientific advances and significant economic interests. For this reason, the Federal Ministry of Education and Research, together with industry, will fund basic and applied research in the areas of plant genome research, plant biotechnology, bioenergy and plant design. This funding will take systems biology research work into account. The GABI FUTURE programme will develop on a targeted basis the enormous potential for innovation along the interfaces between plant genome research, microbial genome research, animal genome research and molecular nutrition research for these fields of application. The GenoMik-Plus programme funds research which uses the analysis of the interaction between plants and bacteria as the starting point for work on the stimulation of plant growth, crop protection and efficient nutrient uptake.

### **Support plant breeding for hardy, high-yield plants**

Crop plants are to be made more resistant to economically important pathogens, abiotic agents and abiotic stressors, and produce quality is to be improved. This will require more than basic research: New plant-breeding research methods will also have to be used to generate breeding advances more rapidly and efficiently. Centre stage in the area of renewable raw materials will be given to breeding high-yield raw-material and energy plants and collaborative projects that revolve around integrated and particularly sustainable and economic energy crops (EVA project).

### **Tomorrow's source for raw materials**

New approaches in research, development and production are needed in order to switch industry over to using biological raw materials as a resource. The targeted use of all of a plant's parts for pharmaceutical products, chemicals, fuels and other sources of energy has sizable potential in this connection. Of particular interest here are sustainable, integrated extraction processes that separate components for raw materials and in which all constituent parts of the source material can be used in a subsequent biotechnological and/or thermochemical process to obtain synthetic building blocks, fuels or energy.

In addition, assistance will be provided for the market launch of products made from renewable raw materials such as biolubricants, biohydraulic fluids and natural insulating materials and for the near-market demonstration of bioenergy.

### **Deepen international co-operation**

Germany is the driving force behind European integration in the plant research field. However, it can achieve its national goals only when the potential offered by the research and development being done in leading European nations is bundled. In light of this, Germany will deepen its collaboration with the plant genome research programmes in Spain and France, with industry being in overall charge of these activities. ERA-NETs that revolve around plant genome research, bioenergy and the use of renewable raw materials are flanking the process of European integration. Germany's accession to the International Energy Agency's (IEA) Bioenergy Agreement constitutes an important step in intensifying co-operation at international level.

### **Shape the regulatory framework to accommodate innovation**

This type of international, competitive R&D work and the development of new markets requires a foundation comprised of research-friendly and innovation-friendly conditions. National and European regulations – particularly in the area of genetic engineering law – must be formulated in such a way that they advance genetic engineering research, development and application and, at the same time, take into account the protection of man and the environment.

## Intensify the societal dialogue

Although products made from renewable resources meet with a high level of acceptance, people's lack of awareness of them often constitutes an obstacle to their introduction in the marketplace. Technical information and public relations work consequently make valuable contributions in this area. The professional presentation of the subject of renewable raw materials at trade fairs, exhibitions, conferences and other events, publications aimed at the broad public and at experts, and the bioenergy consultation services provided by the Agency of Renewable Resources (FNR) are essential elements of coming measures. In addition, the GABI-FUTURE funding measure (GABI = genome analysis in the biological system of plants) will implement a comprehensive blueprint for a societal dialogue.

### Individual research and innovation policy initiatives 2006 – 2009

• Funding for genome research as a basis for plant breeding and plant design will be continued and supplemented by new funding campaigns in the systems biology field.	BMBF	Starting 2006
• The potential for innovation located along the interfaces between plant genome research, microbial genome research, animal genome research and nutritional research will be developed with the help of new funding measures that have been designed together with industry.	BMBF	Starting 2007
• A research campaign will support plant breeding and plant breeding research with the aim of increasing plant resistance to biotic pests and abiotic stress factors.	BMELV	Starting 2006
• The Renewable Resources funding programme supports the development of conversion methods, pilot projects and the launch of renewable resources for use as raw materials or for generating energy; new priorities.	BMELV	Starting 2006
• International collaborative activities will be deepened through the ERA-NET on plant genome research, by expanding the joint funding initiative with plant genome research programmes being conducted by Spain, France and Canada, and through a new ERA-NET on the use of renewable resources for producing materials.	BMBF, BMELV	Starting 2007
• Germany's genetic engineering law will be amended with the aim of advancing research and the application of genetic engineering, and of ensuring a high level of safety, the co-existence of production methods and the consumer's freedom of choice.	BMELV	2006
• A competitive process will bring about a concentration of agricultural and nutritional R&D capacities in Germany that the federal government in co-ordination with the Länder will support using suitable structure-building R&D funding measures,	BMBF, BMELV	Starting 2007

Please see page 107 for an explanation of the abbreviations used here.

## Energy technologies – The challenge for the 21st century

Reliable, efficient, sustainable



### Field of innovation

A reliable and economical energy supply is the backbone of every modern economy. Challenges are however beginning to emerge today at the start of the 21st century, challenges whose implications were not fully foreseeable in the past: The economic growth being posted by emerging countries such as China and India will further fuel the global demand for energy. Coal, oil, gas and uranium reserves are finite in nature and oil and gas production is increasingly concentrated in politically instable regions. In light of this, it will be increasingly difficult for Germany to meet its energy needs in the future. At the same time, the energy-related emission of climate-impacting greenhouse gases increases the possibility of severe climate change. In light of this, it is urgently necessary that the world convert to other sources of energy over the long term. This conversion can however be done only incrementally because the energy industry is governed by very long investment cycles.

The German energy industry however offers good prerequisites for this: German power-plant technologies are among the world's best and ensure manufacturers a substantial share of this fast-growing global market. German companies are also global leaders in many fields of renewable energy: German manufacturers of wind-power plants, for instance, account for approximately 40 percent of the global wind-power plant market. Sixty percent of domestic production is exported. Germany's renewable energy-related exports totalled some €2 billion in 2004.

### Objective

The German government aims to push the transition to a sustainable energy supply in Germany further forward. This type of energy supply will meet the criteria of reliability, economy, climate-friendliness and environmental friendliness on a balanced basis. The German government is working to establish a balanced energy mix without one-sided dependencies. Objectives include boosting the German economy's energy productivity to twice its 1990 level by the year 2020. The share that renewable energies represent out of total primary energy consumption is to be increased from not quite five percent at the present to at least 10 percent by 2020. And emissions of greenhouse gases such as carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) are to be reduced as cost-effectively as possible.

The German government will outline the individual measures that this will require in a comprehensive energy policy plan in 2007. Energy research will be a fundamental part of this.

The German government is pursuing a double-pronged strategy in its assistance for energy technologies: On the one hand, it gives explicit priority to selected technologies that could contribute in the medium and long term to ensuring a sustainable and secure supply of energy. On the other hand, it is taking a relatively broad approach in less important fields of technology where it

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Productive energy research:</b> Good basic research and scientific/technical infrastructure and outstanding industrial energy research, particularly in promising fields such as modern power plant engineering, photovoltaics, wind energy and fuel cells.</li> <li>• <b>Good co-operation:</b> Functioning co-operation between science and industry.</li> <li>• <b>Technology leadership:</b> German manufacturers are world leaders in power plant engineering, wind energy plants (export rate of more than 50 percent) and photovoltaics (25 percent world market share).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Modernisation of the energy supply:</b> Use of new technologies for pending repair and replacement needs.</li> <li>• <b>New technologies:</b> Enormous potential offered by biofuels of the second generation (synthetic biofuels), hydrogen and fuel cell technology, photovoltaics and nuclear fusion.</li> <li>• <b>Export of technology:</b> Growing technology needs in threshold and developing countries.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Lack of consensus:</b> Different notions within society regarding the future supply of energy.</li> <li>• <b>Introduction of new technologies:</b> Regardless of the enormous theoretical potential, the amount of technical/commercial capacity that would be needed to produce a supply of energy that would be sufficient to meet the challenges of the future can be developed only over the very long term.</li> <li>• <b>Competitiveness:</b> Cutting-edge technologies are frequently not competitive enough.</li> <li>• <b>Energy efficiency:</b> Slow diffusion of energy-efficiency technologies.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Safeguarding competitiveness, growth and jobs:</b> Further development and expansion of an efficient energy-supply system.</li> <li>• <b>Dependency on fossil fuels:</b> Dependency must be reduced.</li> <li>• <b>Nuclear safety know-how:</b> Maintain competence in nuclear safety engineering.</li> <li>• <b>Reduce greenhouse gas emissions:</b> Energy efficiency needs to be increased, renewable energies need to be developed and expanded, and CO<sub>2</sub> sequestering is needed.</li> <li>• <b>Expand and develop renewable energies:</b> The cost of renewable energies needs to be further reduced. To ensure their marketability, plants and equipment need to be suitable for diverse and decentralised use.</li> </ul>

■ **SWOT analysis**

is working to safeguard and expand technological options in order to make the German energy system more flexible and improve its ability to react.

**Developing modern power plant technologies for natural gas and coal**

Coal and gas power plants are and will remain an important pillar in the electrical energy system in Germany. These two sources of energy accounted for some 60 percent of the 'energy pie' in 2005. Coal power plants have increased their efficiency by 20 percent in the last 15 years. For example, the world's currently best brown coal power plant with an efficiency level of more than 43 percent went on line in Niederaußem in 2002. Working together with industry, the German government developed the COORETEC funding programme which is aimed at further increasing plant efficiency by another 20 percent within the next 15 years.

■ **Areas of action**

### The COORETEC lighthouse project

The COORETEC project was set up to develop and build a coal or gas-fired pilot power plant that produces almost no CO<sub>2</sub> emissions and is also capable of generating new products such as synthetic fuels (methanol, synthetic gas, hydrogen). The technologies to be used – ranging from air separation for oxygen production all the way to CO<sub>2</sub> separation and storage – go far beyond current power plant technology. Building on the ongoing development of individual technologies, their operation together is to be tested in a 300 to 400 MW pilot plant which is to be built and put into service by the year 2015. Targets include not only greater fuel utilisation but also a high level of availability, operating flexibility, environmental compatibility, low power generation costs and proof of reliable CO<sub>2</sub> storage.

A modularly-structured master plan will make it easier to replace components at a later date so that it is possible to further optimise the system with the aim of honing these technologies to a marketable level by the year 2020. The project is to be conducted together with energy suppliers and power plant manufacturers. This project will demonstrate Germany's technological capabilities in the field of power plant technology and, not least of all, help strengthen Germany's competitive position in this area.

### Make fuel cells and hydrogen technologies competitive

Water is all that is left when hydrogen and oxygen are combined in fuel cells to generate electricity and heat. This efficient, clean technology could replace the batteries used today in portable devices such as notebooks and, in the case of stationary systems, the conventional combustion technology presently used in power plants and boiler rooms. Although the principle behind the fuel cell was discovered 150 years ago, considerable R&D efforts will still be necessary in order to make them as reliable and affordable as conventional rival technologies. Industry and science are working on long-term scenarios, strategies and research projects for fuel cells. The National Hydrogen and Fuel Cell Technologies Innovation Programme launched in May 2006 will funnel and continue the work done to date and set new priorities. By supporting and advancing the emerging hydrogen and fuel cell sector on a targeted basis in the mobile, stationary and portable fields, this programme aims to speed up the development of a market that is important for Germany's attractiveness as a location for industry, research and investment. A fundamental question that will also have to be clarified in this connection is how the requisite amounts of hydrogen can be made available efficiently and in an environmentally-friendly way.

### Continue to develop energy-optimised building construction

Private households account for more than one third of Germany's final energy consumption, most of which goes to heating. Although heat consumption for buildings has already been reduced from more than 400 kilowatt hours per square meter and year (kWh/m<sup>2</sup>a) in the early 1970s to 100 – 150 kWh/m<sup>2</sup> today, there is still enormous potential for further savings, particularly in the existing housing stock. Energy requirements for buildings are to be halved over the long term: The zero-energy house is the goal with new homes. In the case of existing buildings that are renovated to improve their energy efficiency the aim is a marked reduction in electricity and heating consumption.

The Energy-Optimised Building Construction (ENOB) programme that was developed in conjunction with industry and other research campaigns will support the continued technological development of heating, refrigerating, ventilation and air conditioning systems, measuring and control technology, heat insulation technology, electricity-saving lighting, and the like. Since public buildings are particularly suitable for pilot projects, a new initiative for renovating school buildings to be more energy-efficient aims to boost attention to and acceptance of new energy-saving technologies among the public.



The CO<sub>2</sub> building renovation programme for which some €1.4 billion a year have been earmarked for the period 2006–2009 will speed up the diffusion of new technologies in the marketplace and step up measures to markedly reduce the energy requirements of residential buildings. Such renovation will be pushed ahead with grants and tax incentives.

### Boost the efficient use of energy

Industry accounts for approximately 26 percent of the final energy consumption in Germany, industry, trade and services are responsible for another 16 percent. Although German industry's fuel requirements have – measured in terms of gross value added – fallen by some 30 percent over the last 15 years, there is still enormous potential for greater efficiency: New materials such as metal foams are opening up new possibilities in the heat and refrigerating engineering fields, and new construction principles are making engines, drives, ventilators and pumps more economical in their fuel consumption. Which is why the German government wants to give more attention to 'rational energy use'. R&D project funding gives priority to optimised heat utilisation (through, for example, the development of innovative high-temperature process technology, refrigeration technology, heat pumps and heat storage technologies) and to the efficient use of electricity such as through the use of loss-free superconducting materials in generators and electricity grids.

Many factors however impede the diffusion of energy efficiency technologies: Investors and upstream suppliers shy away from the often higher investment costs because the energy savings will not benefit them but rather the technology users (investor-user dilemma). Given the lack of market transparency and overly weak price signals, demanders rely on tried and tested technologies.

Working together with participants of the national energy summit and other experts, the German government plans to develop measures to eliminate such impediments to diffusion as part of its overall energy policy blueprint in the coming months.

### Expand renewable energies

With a view to bringing renewable energies closer to profitability, the German government supports not only basic research through institutional funding and network building. It also funds R&D projects that target priority topics arising from strategy discussions with science and industry:

- **Bioenergy:** Improve conversion technologies. Use biogas in fuel cells. Feed biogas into the gas grids. Implement combined heat-and-power systems that use solid, liquid or gaseous biomass, particularly in plants with small or medium capacity levels.
- **Photovoltaic technology:** Lower the cost of silicon-wafer technology which dominates today's market. Progressively develop thin-layer technology to help this technology achieve a breakthrough on the market.
- **Wind energy:** Test the 12 multi-megawatt installations at the offshore test field in the North Sea under high-sea conditions before starting serial production. Demonstrate the cable interface and examine the effects that off-shore wind farms have on nature and the environment. Additional projects will be conducted to reduce the cost of the foundations and towers and improve the rotor blades.
- **Geothermics:** Reduce development costs further with the help of, inter alia, seismic methods and adapted drilling technology (large boring depths and diameters).
- **Low-temperature solar thermal technology:** Reduce the cost of low-temperature solar thermal systems and increase their share of heat consumption in buildings through, inter alia, solar panel installations that are integrated into building facades and offer heat-insulating properties. Progressively develop this technology for new fields of application (such as process heat or solar air-conditioning).

- **Solar thermal power plants:** Work will continue on refining this technology. A pilot project for solar thermal electrical power generation with high-temperature heat storage and sea-water desalination in the Middle East or North Africa will be tested.
- **Integration into the power grid:** The development and expansion of renewable energies will necessitate new supply structures and the storage of electricity and heat.

### **Strengthen research into nuclear safety and the final disposal of radioactive waste**

Irrespective of the government's decision to gradually phase out the use of nuclear power plants, Germany will continue to need nuclear technology know-how for decades to come in order to maintain the safety and security of the country's nuclear power plants. The German government therefore plans to increase research into nuclear safety and the permanent storage of radioactive waste, aiming firstly to develop a solution to the final storage issue in this legislative period as stipulated in the coalition agreement between Germany's governing Christian Democratic Union and Socialist Democratic Party, and secondly to prevent an imminent loss of expertise by stepping up efforts to foster young scientists. Research projects will be conducted to preserve the German government's ability to assess the safety of nuclear power plants in neighbouring countries as well and to follow international developments to ascertain the extent to which other countries are achieving increased reactor safety, economic efficiency, proliferation resistance and reduction of radioactive waste.

At international level, the focus of R&D work will be increasingly directed to reactor systems of the future. These efforts will be undertaken primarily through the Generation IV International Forum (GIF) research programme. This programme's members currently count ten nations (Argentina, Brazil, Great Britain, Canada, France, Japan, South Korea, South Africa, Switzerland and the USA) and EURATOM (in which Germany is involved).

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) research programme – to which 26 nations including Germany belong – deals with issues revolving around the research and development needs of the member states in the areas of security, disposal, environmental compatibility, proliferation resistance and economic issues.

### **Push fusion research ahead**

Generating electricity through nuclear fusion poses an enormous challenge for energy research. Germany aims to feed electricity from nuclear fusion into its power grid by 2050 at the latest. This goal can be achieved only through international co-operation. The construction of the International Thermonuclear Experimental Reactor (ITER) in Cadarache, France, will be one important milestone towards achieving this goal. Current partners in this project are EURATOM, the People's Republic of China, Japan, India, the Republic of Korea, the Russian Federation and the USA. ITER will enable a net energy gain from fusion and contribute to the development of suitable systems for transforming this energy into electricity. The German government is participating in the ITER project through the EURATOM treaty and the ITER Agreement. It will contribute key technologies such as superconducting magnets and electrical cable and systems for maintaining the fuel cycle and plasma heating. Germany's Helmholtz Centers are particularly involved in the development of these systems. Highly advanced irradiation chambers for testing materials and, for example, new types of low-temperature systems (helium cooling) will be needed for developing and building a prototype for the International Fusion Materials Irradiation Facility (IFMIF). Testing instruments for assessing and improving plasma containment in the ITER will also be required for later power production. This R&D work will expand Germany's participation in the ITER project beyond its level in past programmes.

In contrast to the ITER system which will contain plasma on the basis of the tokamak principle, the Wendelstein 7-X facility currently being built in Greifswald, Germany, will hone and improve the alternative stellarator method for use in power plants. It will be decided at the end of ITER and Wendelstein 7-X's period of operation which of the two methods will be used for planning and building the subsequent pilot power plant.

## Make use of the opportunities offered by the export of technology

The German government will push forward new partnerships between industrialised and developing countries that are aimed, inter alia, at modernising the participants' respective energy supply on an ambitious scale. The Kyoto Protocol's project-based mechanisms – the Clean Development Mechanism (CDM) and Joint Implementation (JI) – could also be of help here. The German government will facilitate the use of project-related mechanisms in order to increase German companies' opportunities in leading-edge technology markets abroad.

The Renewable Energies Export Initiative is also helping modern technologies that revolve around the use of renewable energy to obtain access to markets. With a view to tapping new sales, sourcing, co-operation and investment opportunities, government assistance particularly targets measures that focus on information and advisory services and on establishing contact with foreign firms in the renewable energy sector. An expansion of these activities to include energy-efficiency technologies is currently under discussion.

### Individual research and innovation policy initiatives 2006 – 2009

• A master energy policy blueprint will bundle all measures for a sustainable energy supply system in Germany.	Federal government	2007
• The National Hydrogen and Fuel Cell Technology Innovation Programme will bundle all activities in this area.	BMVBS, BMWi, BMBF	Starting 2006
• The priorities in future R&D project funding for renewable sources of energy – such as testing offshore wind farms – will be worked out in strategy discussions with science and industry.	BMU	2006
• The establishment of the German Biomass Research Centre in eastern Germany will strengthen research in this field.	BMELV	2007
• The COORECTEC lighthouse project targets the development and construction of a pilot gas or coal-firing power plant that generates virtually no CO <sub>2</sub> .	BMWi	Starting 2006
• Efforts to foster young scientists are to be stepped up in order to prevent a loss of expertise in nuclear safety research.	BMWi, BMBF	Starting 2006
• A campaign to promote the renovation of school buildings to make them more energy-efficient will boost awareness of and acceptance for energy-saving technologies among the public.	BMWi	Starting 2006
• The CO <sub>2</sub> Building Modernisation Programme will be expanded. This programme will reduce the energy requirements of residential buildings through the accelerated diffusion of new technologies.	BMVBS, BMWi	Starting 2006
• The introduction of an energy performance certificate for buildings, the regulation of incentives in the Energy Industry Act and the transposing of the Directive on Energy End-use Efficiency and Energy Services into national law will improve conditions for innovations that increase energy efficiency.	Federal government	Starting 2006

Please see page 107 for an explanation of the abbreviations used here.

## Environmental technologies – Clear water, clean air, fertile soil

### Integrated environmental protection and resource conservation



#### Field of innovation

- In contrast to the 1970s and 1980s when centre stage was given to aftercare environmental engineering – such as filter systems to keep air and water clean – environmental protection considerations are today increasingly being taken into account during the development phase. With this approach, natural resources are to be used efficiently and harmful effects on the environment are to be minimised throughout a product's entire lifecycle. At the same time, new environmental technologies offer economic benefits. Organic solvents pollute ground water and air, have to be separated and recovered – frequently with considerable energy input – and are also questionable in terms of occupational safety. Such solvents could, for example, be replaced in the future by supercritical fluids which – thanks to their easy-to-modify state of aggregation – are much easier to separate.

The German environmental engineering sector – which includes the waste and water management industries and parts of the mechanical engineering and plant manufacturing field – employs some 1.5 million people today. At international level, German firms are particularly successful in the air pollution control, noise abatement and recycling fields.

#### Objective

- With its national sustainability strategy, the German government aims to reduce the air pollution load by 70 percent by the year 2010, double German industry's energy efficiency and resource efficiency by the year 2020 and reduce land development from currently 100 hectares a day to 30 hectares a day. The German government has committed itself to reducing the emission levels of the six greenhouse gases cited in the Kyoto Protocol by 21 percent over 1990 levels by the period 2008 through 2012.

These national sustainability goals cannot be achieved without cleaner and more efficient technology. German industry should therefore be helped with identifying and developing new R&D findings with environmental protection potential and applying them immediately in the domestic market. The German government aims to tap the global market for the German environmental engineering industry and to adapt technologies and know-how to local conditions in threshold and developing countries.

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Export leader in products that could be used for environmental protection purposes:</b> German firms hold a 19-per cent share of global trade volume in this area, with particular strengths in measuring and control technology, air pollution control, noise abatement and recycling.</li> <li>• <b>Leader in environmental protection patents:</b> Germany submits more applications to the European Patent Office (23 per cent of total) than the USA (22 per cent) or Japan (19 per cent).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Intensification of export trade:</b> German environment technology could potentially be used to solve worldwide environmental problems.</li> <li>• <b>Growing international water market:</b> Market predicted to grow by 60 percent by 2010.</li> <li>• <b>Bionics:</b> Applying solution strategies taken from nature to technology.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Cross-sectoral approach has been neglected:</b> R&amp;D funding in the past focused on individual sectors rather than enabling technologies such as surface technology.</li> <li>• <b>Water management:</b> The German water sector is too fragmented and has little international focus.</li> <li>• <b>Internationalisation:</b> The environmental engineering branches – which consist primarily of SMEs – have little access to international markets.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Problems – particularly for SMEs – in obtaining access to the resources of research institutes:</b> Co-operation needs to be fostered between industry and science.</li> <li>• <b>Environmental technology innovations seldom establish themselves in the marketplace:</b> Due to price disadvantages or a lack of trust in their reliability, innovations do not make the leap to the marketplace very often.</li> <li>• <b>Need to adapt know-how:</b> Advanced technologies that are established in Germany have to be adapted for use in developing and threshold countries.</li> </ul>

*Please see page 107 for an explanation of the abbreviations used here.*

■ **SWOT analysis**

**Progressively develop environmental technology for the domestic market**

Economic and ecological targets can often be met simultaneously when a product's entire life cycle is taken into account during the planning and production processes. The Federal Ministry of Education and Research funds collaborative projects in the manufacturing sector with a view to linking new research approaches with problems in actual practice.

Innovative environmental protection technologies such as self-healing surfaces and waste-free processes are a focus of surface technology and spill over into many sectors – from car manufacturing to the construction sector and furniture industry all the way to the shipbuilding industry. Surface technology has not however had a joint R&D platform because the field has a wealth of user industries and is therefore highly fragmented. The Federal Ministry of Education and Research is therefore planning a comprehensive research initiative for this area.

Bionics use nature as a source of inspiration for technology. In order to make it easier to translate creative ideas into products, the Federal Ministry of Education and Research is planning a new research campaign aimed at supporting work to develop such ideas to the stage where they are functioning demonstration models or production-ready prototypes.

The Ministry's Research for Sustainability funding programme supports and funds the development of new environmental protection technologies.

■ **Areas of action**

### **Pilot projects create trust in the reliability of new technologies**

In contrast to years past, when the focus of funding was on the retrofitting of systems and on downstream purification processes (so-called end-of-pipe technologies), financial assistance today is provided primarily for first use of new integrated environmental protection technologies, with priority being given to SMEs. The Environmental Innovation Programme of the Federal Ministry of Research and Development funds these industrial-scale pilot projects. These activities, which receive flanking technical support from the Federal Environment Agency (UBA), establish the prerequisites necessary for defining technical standards and establishing legally binding emission ceilings.

### **Use Germany's strong domestic market as a springboard for tapping the global market**

Sustainability in trade and industry is not just a German aim – it is also a European aim. For this reason, Germany has joined up with Belgium, Denmark, Finland, France, Great Britain, Ireland, Austria, Sweden, Switzerland and Spain in the ERA-NET Sustainable Enterprise (SUSPRISE) project to co-ordinate its national research activities aimed at fostering sustainable enterprises.

Export credit guarantees granted by the federal government (Hermes guaranties) are an important instrument for spurring foreign trade, including in the environmental technology field. The OECD member states agreed in 2005 to extend the maximum permissible terms for export credits for renewable energy and for water and waste-water projects to 15 years. With the new aval guarantee that was launched in 2006, the German government will cover a share of the third-party risk borne by the guarantor. This will substantially improve liquidity, particularly for small and medium-sized exporters. The Federal Environment Agency's Internet portal at [www.cleaner-production.de](http://www.cleaner-production.de) offers extensive information about the capabilities of German environmental technologies and services.

### **Protect the global water supply**

Many threshold and developing countries suffer from an inadequate supply of drinking water and – particularly in megacities – from waste-water problems that can scarcely be handled. The development and sustainability goals adopted by the United Nations Millennium Summit in 2000 include halving the proportion of the global population that has no access to safe drinking water or adequate sanitation services by the year 2015. This goal is a pressing humanitarian task. The development of the requisite water and waste-water infrastructure however also constitutes an enormous investment market.

The German government is supporting the development of an integrated water resource management (IWRM) system in numerous partner countries, particularly in the Middle East and Africa.

In addition to its development policy projects in this field – Germany is one of the world's largest donors in the water sector – the Federal Ministry of Education and Research also funds the continued development of IWRM methods and approaches.

German and regional partners from research institutes, government agencies, engineering offices and the water industry participate in these projects.

The International Postgraduate Studies in Water Technologies fellowship programme has been set up to train German and foreign water specialists who, as future decision-makers in their home countries, could help develop the know-how urgently needed there. The networking this will generate between participants could facilitate the German water industry's access to the growing water markets in threshold and developing countries.

The Federal Ministry of Education and Research and the Federal Ministry for Economic Cooperation and Development will offer funding for ten years for a Water Decade office at the University of the United Nations in Bonn as a step to support collaborative international research activities.

**Individual research and innovation policy initiatives 2006 – 2009**

- |   |           |               |
|---|-----------|---------------|
| • A new research funding programme will be launched to boost resource efficiency.   | BMU, BMBF | 2006          |
| • The Research for Sustainability programme will foster the development of new environmental technologies. Initiatives for surface technology and bionics are planned to supplement the current Innovation as a Key to Sustainability in Business and Industry funding campaign.        | BMBF      | Starting 2006 |
| • Collaborative international research activities, a fellowship programme and the possible establishment of a UN Water Decade office in Bonn will facilitate access to growing water markets, particularly in threshold and developing countries, for German hydrotechnology providers. | BMBF, BMZ | 2006 / 2007   |
| • The Internet portal <a href="http://www.cleaner-production.de">www.cleaner-production.de</a> and the recently launched aval guarantee will foster the export of environmental protection technologies.  | BMU, BMWi | 2006          |

*Please see page 107 for an explanation of the abbreviations used here.*

## Innovation for communication and mobility

### Information and communications technologies – Injecting momentum into the No. 1 innovation driver

Developing Germany's strengths in core sectors and tap new fields of application



#### Field of innovation

Information and communications technologies (ICT) permeate all spheres of life and work in our society. ICT provide the technological foundation for an information and knowledge society and for ever-new IT and service products in business (e-business, e-commerce), administrative bodies (e-government), the health care sector and in private life. On average, the ICT sector – in other words: electronics including microelectronics and nanoelectronics, communications technology, telecommunications, IT services and IT trade – was responsible for ten percent of gross domestic product in all OECD countries, with a sharp upward trend. Information and communications technologies – key technologies for an increasingly knowledge-driven economy – however also act as a growth accelerator for many other sectors.

The German ICT sector provides employment for some 750,000 people. The ICT market is valued at approximately €134 billion a year in Germany alone and more than €2,000 billion worldwide.

#### Objective

The German government aims to strengthen and consolidate Germany's top technological ranking in the ICT field. Germany's competitiveness as a location for manufacturing and jobs is to be safeguarded and strengthened – particularly in the mechanical engineering and plant manufacturing, automobile industry and telecommunications field – through the use of ICT. This will also bring important contributions in the areas of prevention (in the health care field, for instance), civil security, education and research – activities in which the research sector can serve as industry's partner in producing innovation. The German government is working to foster technological developments and processes that will have a particularly strong leveraging effect for the economy. It wants to develop and accelerate ICT's enabling effects for enterprises and government bodies on a broad basis. The security and reliability of information and communications technologies themselves will be very important in this connection.



■ SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Research landscape:</b> Highly interconnected. FhG is Europe's largest IT research institution. All major ICT manufacturers operate R&amp;D labs in Germany.</li> <li>• <b>Market size:</b> Germany is the third largest ICT market in the world and the largest by far in Europe.</li> <li>• <b>Europe's No. 1 electronics location:</b> Dresden cluster; more than one out of every two semiconductors from Europe is "Made in Germany".</li> <li>• <b>Infrastructure:</b> Efficient transport network; high degree of wireless network coverage; functioning competition.</li> <li>• <b>Chip-card technology:</b> German enterprises hold 70 percent of the global market.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Growth markets:</b> Chip production is growing at +25 percent p.a.</li> <li>• <b>Research:</b> Use findings from basic research. New ICT applications in the mobility, medical and production fields are foreseeable in the future.</li> <li>• <b>Infrastructure:</b> Set up viable networks for new stationary and mobile fields of applications (e.g., production, services, health care).</li> <li>• <b>Secure applications and trustworthy business processes:</b> To be developed taking data protection / user requirements into account.</li> <li>• <b>IT market in motion:</b> SMEs are developing into highly specialised product-development, systems-architecture and systems-integration experts.</li> <li>• <b>IT security:</b> Develop and expand Germany in its role as a location for IT security (a field that is dominated by small and medium-sized businesses in Germany).</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Few German global players:</b> Standard software, consumer electronics, chip and display production dominated by Asian and US firms.</li> <li>• <b>Slow technology diffusion:</b> ICT spending as a percentage of GDP is below the West European average. In the e-government field, Germany is to be found in lower midfield in Europe.</li> <li>• <b>Major IT application projects:</b> Project management and general conditions have room for improvement.</li> <li>• <b>International standardisation processes:</b> The influence and effects of standardisation are still not being taken seriously enough.</li> <li>• <b>Not enough investment</b> in ICT Infrastructures (new markets).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Globalisation:</b> Outsourcing of IT services. World trade in ICT products and particularly in ICT services is growing at an above-average pace.</li> <li>• <b>Cyclical markets:</b> Considerable price fluctuations in electronic modules; lack of balance between the supply and demand for IT specialists.</li> <li>• <b>Development of new business models:</b> Network operators are becoming platform operators and content providers, telecommunications companies are coming under pressure as a result of Internet telephony, etc.</li> <li>• <b>Profound change:</b> The information society is taking shape.</li> <li>• <b>Integrated ICT-supported processes and product innovations:</b> Need to push development forward.</li> <li>• <b>Vulnerability of the information infrastructure:</b> Need to develop and implement ICT security solutions.</li> </ul>

## Areas of action

This provides the foundation for the four areas of action in the ICT field:

### **Information society – Push forward diffusion and use E-government – Shape the future**

Working on behalf of the federal government, the Federal Ministry of Economics and Technology has developed an action programme titled Information Society Germany 2010 (iD2010). Central points of this programme will be the modernisation of existing legal and technological parameters, continued efforts to integrate government, trade, industry and private persons into the information society, the improvement of ICT security and the targeted funding of ICT research and close-to-market developments. The iD2010 programme links ICT-relevant aspects of innovation and competition policy with elements of government modernisation and participation in society to form a uniform government strategy. At the same time, the programme is part of the Lisbon Strategy's new focus and supports the EU's efforts to implement the i2010 – A European Information Society for Growth and Jobs strategy. iD2010 will be presented in late 2006, about the same time as the chancellor's IT summit and with a similar focus.

Information, advisory services and the engendering of acceptance are – alongside conditions that foster competition – particularly important to achieving greater diffusion and use of information and communications technologies. Examples of this include the broadband campaign, the Digital Media Forum, the Electronic Business Network and the First Steps in the Internet competition. Collaboration with enterprises, organisations and societal groups is of particular importance in this connection.

The Internet is the iconic business area and field of communications for the 21st century. As such, it has taken on enormous economic importance. The Internet is giving rise to new opportunities for society. These new opportunities could be a motor not only for improving our education and health care systems and making science more productive and competitive, but also for government that is more efficient and more transparent.

To ensure the security and efficiency of electronic communication in Germany, the federal government will develop suitable infrastructures and standards and continue to expand the provision of electronic government services. This will harmonise the presently proprietary IT systems and data formats used by the individual government bodies and improve the use of electronic communication between government, trade and industry. An essential part of this will be the development of secure and binding electronic identities that provide binding assurance of a company's or individual's identity on the Internet and ensure the authenticity of electronic communication and virtual actions. The electronic identity card falls under this category. Besides fulfilling the traditional functions of an identity card, the electronic identity card will contain biometric data, an electronic authentication and, optionally, the holder's qualified electronic signature. The new standardised electronic authentication system which has been introduced for the entire country will lead to numerous, technically new fields of application in the Internet. In addition, government-certified citizen forums will offer residents an Internet platform where they can communicate easily, securely and under their own name. Innovative data protection technologies protect personal data of the people using these forums and, in doing so, support the individual's right to determine what happens with information about one's self. The German government will develop by the year 2010 a new e-government programme that is embedded in a comprehensive strategy for modernising administrative bodies and structures.

### **Protect the information infrastructure – Implement the national ICT security plan**

The threat to our information infrastructure has grown in tandem with the importance of information technology.

Today's information society is increasingly interconnected, permeated by complex ICT systems and subject to numerous risks. Processes and technologies that are able to ward off malicious software and identify threats at an early point have been more theory than practice to date. Not only

solutions for integrity and authenticity issues but also solutions for availability and reliability issues must be studied and developed. Systems in which ICT plays a central role are steadily becoming ever-more complex. Reliable operation is an imperative in critical infrastructures – such as energy and transport – where ICT steers and controls vital operating processes. To ensure this, the National Plan for Information Infrastructure Protection which the federal cabinet adopted on 13 July 2005 will be implemented in collaboration with Germany's critical, privately-operated information infrastructures.

### Research funding – Building strengths, using opportunities, meeting challenges

The Federal Ministry of Education and Research is currently developing the new ICT 2020 research funding programme in consultation with science and industry. This programme will be aimed at expanding collaborative research in the ICT field, improving the exploitation of research findings in Germany and, at the same time, ensuring that project funding and the IT research work being conducted at institutional level mesh perfectly with one another.

The ICT 2020 funding programme will have a time horizon of at least ten years so that it will be possible to pursue longer-term strategies and promising technology developments with the necessary staying power. Plans also foresee designing ICT 2020 to be open to a broader range of subjects than in previous funding programmes. This will make it possible to better respond to current developments and be more flexible in adapting the programme to them. The respective research programme will formulate and continually update its strategic research lines so that research funding can be geared to verifiable targets.

The following ICT areas in particular offer opportunities for industry and require a sizable amount of research:

- **Embedded systems:** More than 90 percent of all processors in use today are not to be found in a PC but rather are hidden away as so-called embedded systems such as anti-lock braking systems in cars, in machinery controls, telephone systems and medical equipment. Germany has a good technological 'starting position' to build on in the embedded systems field. This field can be expected to generate new growth impulses for those German sectors that are industrial strongholds.
- **IT security and reliability:** Systems in which IT plays a key role are becoming increasingly complex. For this reason, it is vitally important that research be conducted into solutions that ensure integrity, confidentiality and availability. Functional reliability is particularly required of systems that function out of sight and are important for security and safety – such as protective installations in manufacturing plants, navigation systems in aircraft, driver assistance systems in cars or transport systems (e-safety). However, processes and technologies to ward off malicious software programmes and to detect threats early also require in-depth research.
- **Human-Computer-Interaction (HCI):** Improved interfaces will make it easier for people to use technology. Today, user-friendliness decides whether a product will be successful under competition and is becoming increasingly more important than having a variety of functions.
- **Simulated reality:** The use of simulation technology is increasingly a prerequisite for internationally competitive research. The calculations produced by this technology are often more cost-effective and considerably faster than boring, expensive experiments. This also applies to applications in science, trade and industry – such as in the calculation and simulation of complex problems and processes in the material sciences, quantum physics, plasma physics and astrophysics, as well as in the development and manufacture of vehicles (cars, aircraft, ships).

- **Multimedia:** Digital convergence enables the interconnection of hitherto separate industries and sparks off completely new business models, value-added activities, synergy effects and diversification. ICT funding measures will be realigned in the multimedia field to link technology policy and economic policy (including relevant framework conditions such as legal and organisational issues) with one another even more than in the past. Planned priority fields for technology funding will include networked intelligent systems (NextGenerationMedia project: intelligent systems and environments, RFID technologies in manufacturing and logistics); knowledge management, e-learning and secure mobile ICT applications in SMEs and government agencies (SimoBIT), the QUAERO Franco-German collaborative projects for developing a new generation of search technologies (semantic technology) and e-energy (ICT control and optimisation of the energy supply system), e-simulations (web-based simulation of components and processes), e-robotics (autonomous control of web-based structures) and the continued development of the Multimedia Start-Up competition.
- **Grid computing:** It is possible to produce supercomputers that are even more powerful than in the past by virtually connecting a large number of computers and equipping them with digital services, complex application software and intelligent information processing systems. These high-performance networks will speed up research processes in the science and industrial sectors and open the door to new forms of work.
- **Internet of Things:** The Internet is currently developing into an Internet of Things. In other words, we will use the Internet to directly access not only information but also many devices (and be able to use them with the help of services) in the future. 'Smart labels' and radio frequency identification tags are becoming increasingly important in trade as the 'successor' to the barcode and are therefore spreading. These innovations represent the first steps toward interconnected ICT systems that work out of sight and toward independent interaction between intelligent terminals (machine-to-machine communication). This is creating new foundations and new potential for forward-looking applications and for designing entirely new services, especially in the information and telecommunications field. The government's technology funding activities are tapping into these developments. Many challenges and opportunities are particularly to be found in the area of microsystems technology as well.
- **Printed electronics:** Using printing or other roll-to-roll processes, it is very easy to turn suitable plastics into electronic components and more complex systems (monitors that can be rolled up). Such plastics have the potential to spawn mass markets in the low-price segment with volumes in excess of 10 million and unit prices of just a few cents.
- **Dresden, the innovation platform:** Dresden has developed into the most important location for microelectronics and nanoelectronics in Europe. It accomplished this by jump-starting and fostering the establishment of networks and by including enterprises in research work at an early stage. The information platform that has developed in Dresden is to be expanded and new innovation platforms are to be developed.

Plans foresee the progressive development as well as a focusing and prioritisation of funding topics in the course of the iD2010 programme and especially through the ICT 2020 research funding programme.

### Parameters – Organised to be innovation and investment-friendly

#### Telecommunications Amendment Act

Adopted by the cabinet on 17 May 2006, the bill to amend the telecommunications regulations in the Telecommunications Act will foster innovation and investment in modern broadband telecommunications networks and strengthen customer protection rights. This will further facilitate innovative enterprises' access to new markets. At the same time, it will encourage acceptance for and the use of electronic services.

**Telemedia Act**

The draft of the Telemedia Act approved by the federal cabinet on 14 June 2006 will first and foremost aid the progressive development of regulations governing telemedia services, as agreed upon by the federal government and Länder governments. The Telemedia Act will bring together and harmonise business-related provisions for telemedia and other electronic media services (such as unrestricted access and liability privileges for service providers) in one law. It will also improve the application and use of data protection regulations by clarifying their relationship to telecommunications data protection. Parallel to the Telemedia Act, Germany's Länder will lay down the content-related provisions (such as the right of reply) in the future broadcasting and electronic media agreement (9th State Broadcasting Amendment Treaty).

**Act on the Re-use of Information**

The draft bill on the re-use of information from public offices which the federal cabinet approved on 17 May 2006 will support the implementation of the corresponding EU Directive 2003/98/EC on the re-use of public-sector information. This bill is aimed at putting companies in particular in a position to utilise the potential offered by such information – for instance, for electronic value-added services – and in the process contribute to economic growth and additional jobs.

**European legal framework**

As part of its i2010 – A European Information Society for Growth and Employment initiative which the Council supported, the European Commission has also announced that it will modernise the legal framework for audiovisual services, continue to analyze Community law until 2007 and draft corresponding proposals for adapting it as required. The Commission has submitted a proposal for developing the EC Television without Frontiers directive from 1989 into an audiovisual media services directive. In light of the evaluation of the E-Commerce Directive, the Commission also established an expert group which it is using to conduct an exchange of information and opinions with the EU member states on issues regarding information society services. The German government supports efforts to push these undertakings forward in accord with 'better regulation' standards.

**Individual research and innovation policy initiatives 2006 – 2009**

- The German government is bundling its activities in the Information Society Germany 2010 (D2010) action programme. BMW, BMI, 2006  
BMBF
- ICT 2020, a new research funding programme, will be developed. BMBF 2006
- The Multimedia programme will undergo further development with the aim of expanding ICT services with priority being given to knowledge management and interconnected intelligent systems. BMW 2006
- The Telecommunications Amendment Act is aimed at fostering innovation and investment in modern broadband telecommunications networks. BMW 2006
- The Telemedia Act will refine Germany's media regulations. BMW 2006
- The Act on the Re-use of Information will enable companies to re-use information from public offices, in order to provide electronic value-added services, for example. BMW 2006

*Please see page 107 for an explanation of the abbreviations used here.*

## Automotive and transport technologies – Mobility for the future

### Germany as Europe's logistics hub



#### Field of innovation



The car of the future will be part of an intelligent, self-organising transport system and thus an active element in traffic management. In the world of tomorrow, vehicles will be able to communicate with one another and exchange information with the transport infrastructure. This will not only increase transport safety, it will also open up new paths for increasing the flow of traffic and making better use of our limited infrastructure.

The logistics industry is one of the most important growth sectors in Germany. Every year, its 2.5 million employees generate some €178 billion in turnover. Thanks to its central location and good infrastructure, Germany is an ideal logistics location for all of Europe.

Germany is to be found in the top rankings in the vehicle, traffic and transport technology fields. The automobile industry in particular is of central economic importance for Germany: Approximately one out of every seven jobs is directly or indirectly dependent on the car industry.

#### Objective



The German government aims to turn Germany, the transit country into Germany, Europe's logistics hub. It is working to increase the efficiency of the overall transport system, improve the competitiveness of the German automobile and transport industries, reduce the negative impact had by traffic and ensure adequate and safe mobility for the entire population. New technologies will be used to lower the average CO<sub>2</sub> emissions of new cars to 120g CO<sub>2</sub> /km by the year 2012, with a certain percentage of biofuel being taken into account in the calculation. Further, it aims to increase the use of biofuels to six percent of total fuel consumption in the transport system by the year 2010.

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Technology leadership:</b> German manufacturers are global leaders in light-weight design, alternative drives, engine and transmission design, driver assistance systems, car-to-car and car-to-infrastructure communication, sensor technology for smart cars, traffic management technologies and bio-genic fuels such as biodiesel, bioethanol and second-generation fuels.</li> <li>• <b>Strong foundation for research:</b> Good, interdisciplinary basic research and an efficient infrastructure for scientific and technical research.</li> <li>• <b>Fuel strategy:</b> Strategic consensus between science, industry and the political sector.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Increased efficiency:</b> Environmentally-friendly, resource-conserving and cost-efficient management of the growing volume of traffic is possible thanks to innovative, technological and organisational measures.</li> <li>• <b>Germany the transit country:</b> Excellent prerequisites for becoming Europe's most modern logistics hub.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Dependency on fossil fuels:</b> Transport is susceptible to political crises in oil-producing countries and shares responsibility for pollutant emissions.</li> <li>• <b>Traffic management requires a high degree of co-ordination:</b> Only when the different jurisdictions of Germany's municipalities, districts, Länder and federal government and those of national and private traffic information services are better co-ordinated will it be possible to positively influence traffic flows.</li> <li>• <b>Investment in transport infrastructure:</b> Investments are necessary in order for Germany to maintain its current level. These investments will also have to include investment in intelligent I&amp;C technologies for an efficient traffic and mobility management system in the future.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Increasingly scarce resources:</b> Finite fossil energy reserves in combination with increasing consumption are driving the rise in fuel prices.</li> <li>• <b>Increased mobility:</b> Although resource consumption and CO<sub>2</sub> emissions could be reduced in the past, this progress has been eroded by the growing volume of traffic – caused in part by changing mobility habits.</li> <li>• <b>Job relocation:</b> Production sites are being moved abroad in response to cost pressure and increasingly international intermeshment. This threatens job growth in the German automobile industry.</li> </ul>

■ **SWOT analysis**

**Launch new research programme for automotive and transport technologies**

The new research programme of the federal government which the Ministry of Economics and Technology is planning will be particularly aimed at securing and expanding Germany's status as Europe's most modern logistics hub, ensuring individual mobility on a long-term basis and improving the infrastructure's efficiency and performance through the use of I&C technologies. In tandem with this, the Federal Ministry of Transport, Building and Urban Affairs is developing a Master Plan for Freight Transport and Logistics and will provide flanking support for work to translate research findings into practice – such as with the cashless, easy-to-use electronic fare management system which customers will be able to use in the future to pay their fares in buses, trains and trams throughout Germany.

■ **Areas of action**

Hearings with selected experts from industry, science and organisations will be held to aid the drafting of the new research programme. The programme's implementation will be supported by conceptual studies on new transport technologies and infrastructures and studies on the future of mobility. In addition, ad-hoc advisory and expert committees will be consulted regarding important lines of action.

### **Develop intelligent transport systems and services**

Lighthouse projects will be conducted in the area of assistance systems, active safety and traffic management with the aim of developing optimal designs for intelligent methods of connecting vehicle-based and infrastructure-based systems. These collaborative projects will also draw on spatial data and put synergies to use. Supported by large segments of the German automobile industry, components supplying industry, transport industry, science and transport authorities, this work will be geared to boosting the active safety for vehicles and traffic systems, making driving easier, harmonising the flow of traffic and increasing the efficiency of Germany's road system.

### **Continue developing and refining alternative propulsion systems**

The use of vehicles with hybrid propulsion systems can – in addition to the continual improvement of internal combustion motor technology – do much to reduce fuel consumption and lower CO<sub>2</sub> emissions. But in order to have a chance in the marketplace, hybrid vehicles will have to match conventional vehicles' road performance, handling characteristics and riding comfort. This has to be kept in mind when developing propulsion technologies for hybrid vehicles.

Potential for innovation is particularly sizable in connection with fuel conservation, application-oriented refinements of key components, and the safe and reliable intermeshed functioning of the entire power train system. If this technology is to be quickly translated into application, the results of this development work will have to be demonstrated under practical conditions and vehicles that can be used under everyday conditions will have to be developed.

Alternative propulsion systems and fuels have to be seen in context. Biofuels – together with innovative propulsion technologies – can reduce our dependency on fossil fuels and make transport substantially more environmentally compatible. A quota will be introduced with the aim of increasing the biofuel share of total fuel consumption to six percent by the year 2010. After this time, first-generation biofuels (biodiesel, pure vegetable oil and bioethanol from starch or sugar) will be successively replaced by second-generation biofuels with greater energetic value (biomass to liquid (BtL), ethanol made of lignocellulose, etc.).

The German government confirms that it will continue providing assistance and funding for second-generation biofuels. Innovation in this area is one focus of a government programme being conducted during this legislative period. It is expected that as a result of this assistance second-generation biofuels will generate jobs in structurally weak parts of the country as well. In addition to gearing its R&D funding more strongly to this in the future, the government is also planning tax breaks through the year 2015 to enable more research and technological advances in this field.

### **Expand collaborative international co-operation**

German transport research is well positioned to tap the considerable potential offered by EU-funded transport research. Further, the Federal Ministry of Economics and Technology is a member of ERA-NET TRANSPORT ([www.transport-era.net](http://www.transport-era.net)). This project revolves around the co-ordination of national transport research programmes to ensure more efficient use of funding and facilitate collaborative cross-border research activities.

DEUFRAKO ([www.deufrako.org](http://www.deufrako.org)) is an important platform for scientific and technical co-operation between Germany's and France's transport research programmes. DEUFRAKO concentrates particularly on collaborative activities in the areas of operational safety/interoperability of railway systems, transport safety, alternative propulsion systems/hybrid concepts and environmentally-friendly road freight transport.



**Transrapid lighthouse project**

The Transrapid high-speed magnetic levitation train has good market prospects not only in the long-haul market but also for point-to-point links with short-to-medium distances and large passenger volumes.

The world's first commercial Transrapid line in Shanghai has proven that this technology is fundamentally suited for mass transport. The Transrapid is a fast and environmentally-friendly alternative to other forms of transport. Since this technology was developed in Germany, the government is assisting the planning of Transrapid lines at home and helping the German industrial consortium market this technology abroad:

- The Transrapid route currently being planned from Munich Airport to Munich Central Train Station provides a suitable reference project in Germany. The Transrapid will run every ten minutes and complete the 38-kilometer trip in ten minutes. Deutsche Bahn AG railway has agreed to plan, build and operate the Munich Transrapid route. It expects the project approval procedure to be completed in the autumn of 2007 and construction to last four years. The German government has budgeted federal funds for the project.
- One project abroad will involve extending Shanghai's existing Transrapid line to Hangzhou by way of the Expo 2010 exhibition grounds. The Chinese side views the project very positively and is expected to complete a feasibility study on it sometime in 2006. Transrapid routes are also being examined in the USA, Great Britain, The Netherlands and the Gulf states.

**Individual research and innovation policy initiatives 2006 – 2009**

• The German government's fuel strategy will be accompanied by the Hydrogen and Fuel Cell Technology Innovation Programme and a Biomass Action Plan.	BMVBS, BMWi, BMELV, BMU	Starting 2006
• A new research programme for automotive and transport technologies will be developed. This programme will be aimed at ensuring and expanding Germany's standing as Europe's logistics hub, ensuring individual mobility and modernising Germany's infrastructure with the help of efficient I&C technologies.	BMWi	Starting 2007
• A comprehensive Master Plan for Freight Transport and Logistics will be developed to provide, inter alia, a concrete application level for new automotive and transport technologies.	BMVBS	2006/2007
• Alternative power train systems and intelligent transport concepts are priority fields for current research funding.	BMWi	Starting 2006
• Federal funds will be provided to assist the construction of the Transrapid route from Munich Airport to Munich.	BMVBS	Starting 2007

*Please see page 107 for an explanation of the abbreviations used here.*

## Aviation technologies – Making flying safer and cleaner

### Less pollution despite growing air traffic volume



#### Field of innovation



The European aviation safety organisation EUROCONTROL predicts that the number of flight movements in Germany alone will double in the years between 2003 and 2025. This will benefit Germany's aviation/aerospace industry: Its turnover grew some 16 percent to €18.6 billion in 2005, a new record. This growth generates new jobs at airports and at aircraft manufacturers. And for each new job created in the aviation/aerospace industry, there's an additional new job in another sector.

However, the growing volume of air traffic also has a sizable downside: noise pollution, the emission of pollutants and greenhouse gases, and a continuously growing demand for fuel. For the present, air traffic is responsible for only some three percent of worldwide greenhouse gas emissions. But given that it is also the fastest-growing mode of transport, its share will increase enormously unless we find new ways to reduce specific fuel consumption. If we are to be able to cope with the increase in air traffic that has been forecast for the coming decades, we must develop technologies that allow growth in traffic volume without substantial increases in the strains this places on man and the environment.

#### Objective



The German government aims to implement the European aviation industry's Vision 2020 strategic research agenda. It is working to strengthen the core competences of the German aviation industry, reduce environmental pollution from air traffic, and improve and refine air traffic control while reducing servicing costs. The German government is focusing on boosting transport capacity, safety and passenger-friendliness, efficient aircraft, and maintenance and repair.

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Research and development:</b> At 15 – 20 percent, R&amp;D accounts for a large share of turnover.</li> <li>• <b>Export:</b> Large export share (more than 65 percent).</li> <li>• <b>Efficient research infrastructure:</b> Research in enterprises, universities, national research centres (DLR) and national research facilities (wind tunnels, test aircraft, etc.).</li> <li>• <b>Stable growth:</b> Air traffic growing at a rate of approximately five percent p.a.</li> <li>• <b>Strong industry:</b> Industrial core with high-quality jobs in a growth sector.</li> <li>• <b>Broad technological foundation:</b> German enterprises have secure technology leadership in products and production processes.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Growth drivers:</b> The aviation industry's positive development can provide impetus for more growth in other sectors.</li> <li>• <b>Less environmental pollution:</b> Thanks to new technologies, it is possible to 'uncouple' the worldwide increase in air transport from environmental pollution.</li> <li>• <b>Strengthen industry:</b> Research and production networks can broaden the industrial base and open the door to the possible acquisition of high-value added shares.</li> <li>• <b>Motor for innovation in other sectors:</b> Aviation industry is a pioneer user of key technologies (new materials, fuel cells, mechatronics, etc.).</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Differences in funding conditions:</b> For example: In Germany, civilian projects are not cross-subsidised through military programmes, in contrast to international competitors.</li> <li>• <b>Difficult R&amp;D financing for SMEs:</b> The subcontracting industry rather than the prime contractor bears the R&amp;D risk.</li> <li>• <b>Time to market:</b> Must be shortened considerably if Germany is to remain internationally competitive.</li> <li>• <b>Bottlenecks in R&amp;D capacity:</b> Such bottlenecks impede faster growth and the securing of further shares of value-added.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Decline in value-added:</b> Germany's value-added shares (as a 'mass' that can be deployed for market strategy purposes) are being relocated to growth markets (Asia, Eastern Europe).</li> <li>• <b>Know-how drain:</b> Germany's knowledge base is being threatened by technology leaders 'buying up' its best minds and by the relocation of parts of company operations to other countries.</li> <li>• <b>Insecurity about funding levels:</b> Possibility that funding conditions could worsen compared to European and other international aviation locations.</li> </ul>

■ **SWOT analysis**

**Co-ordinate European research**

Vision 2020 – the European aeronautics industry's strategic research agenda – is helping to co-ordinate national and European research programmes in a way that enables the effective use of scarce R&D resources. At Germany's initiative and under its direction, 27 partners from 17 countries have teamed up in one of the largest co-ordinating networks with the aim of avoiding duplicate funding and co-ordinating national research programmes with one another.

■ **Areas of action**

In this connection, the 2020 Vision network has defined the following goals for European aeronautics sector:

- Reduce specific fuel consumption by 50 percent
- Reduce specific CO<sub>2</sub> emissions by 50 percent
- Reduce specific NO<sub>x</sub> emissions by 80 percent
- Reduce aircraft noise during take-off and landing by 50 percent
- Reduce the aircraft accident rate by 80 percent
- Reduce production and maintenance costs by 30 to 40 percent while maintaining high safety and quality standards
- Completely avoid unauthorised intervention in flight movements.

### **Support innovation processes in the aviation industry**

These ambitious goals can be achieved only when we succeed in translating innovations into marketable products more quickly and comprehensively than in the past.

The aviation industry is faced with particular challenges in this connection: Product life cycles of 50 years or more and stringent safety standards and certification requirements have led to a situation in which long lead times are required for introducing technological innovation. At the same time, even when market share is large, the quantities sold on the global market are relatively small compared to other industries. Small quantities and long lead times pose limiting factors for conventional instruments for the preliminary financing of high-risk technology projects. They also prevent less cash-rich enterprises – and large corporations to an increasing degree as well – from investing enough in innovative technologies. Despite this, the aviation industry spends an average of 15 to 20 percent (measured in terms of sector turnover) on research and the development of new products and processes.

The German government supports innovation in the aviation industry with a number of measures that are aimed at shortening lead times and speeding up the introduction of new technologies:

- Government support for research institutes contributes to the development and securing of competence by enabling the training of young scientists and by creating a competitive research environment. The German Aerospace Center (DLR) is Germany's largest research institute in this area. It focuses on both basic and applied research questions and maintains a number of important wind tunnels and test aircraft for this work.
- Government support for the creation of networks in industry and science forges links between basic research and the industrial application of new ideas. It also helps integrate different research fields with one another to enable the development of interdisciplinary solutions for complex problems. This results in the creation of productive research networks comprised of universities, national research centres and industrial enterprises which cover the entire innovation process from the initial idea to its industrial application.
- Government support for research and technology projects focuses research capacity on specific technology questions. This creates a 'critical mass' of personnel, financial and infrastructural resources for developing the essential technological foundations for the next generation of air transport systems.

### Strengthen Germany's core competences in the international arena

With its very efficient research infrastructure, Germany is well-positioned by international standards. Industry-led collaborative research alliances from the space research programmes sponsored by the Federal Ministry of Economics and Technology have developed into focal points around which thematic networks comprised of enterprises, universities and national research centres have formed in recent years. In the long term however, Germany's aviation industry will be able to maintain its value-added shares only when the technically best solutions as well as competitive production processes are developed in Germany. We must therefore work to incorporate hitherto self-contained assemblies from Germany's part of the value-added chain into overall aircraft optimisation. This would make it impossible to move the production of individual assemblies – as a 'mass' that can be deployed for market strategy purposes – to other locations in growth regions such as China or India and would keep value added in Germany. Moreover, only an integrated approach to research which goes beyond the traditional focus on individual disciplines offers a chance for actually achieving the environmental conservation goals agreed upon in the European aviation industry's strategic research agenda.

### Foster the creation of networks

Which is why the Fourth Aeronautics Research Programme (2007–2012) being conducted by the Federal Ministry of Economics and Technology attaches particular importance to greater collaboration between industry and science. National research centres and universities participating in research alliances are to be networked with industrial partners in the sector to a greater degree than in the past. Only in this way will it be possible to link a broad scientific approach (which is necessary for optimising the air transport system on a transdisciplinary basis) with a clear-cut industrial application strategy. Funding conditions will give preference to bringing research partners closely together with industrial research alliances on a long-term basis. It will also help bundle tight R&D resources and use them effectively to develop technologies for a future air transport system.

#### Individual research and innovation policy initiatives 2006 – 2009

- |  |      |               |
|--|------|---------------|
| • Fourth Aeronautics Research Programme.   | BMWi | 2007–2012     |
| • Continuation of the joint Franco-German research work being done in the area of helicopters and transport aircraft.        | BMWi | 2006–2008     |
| • Lead management of the ERA-NET European co-operation network to improve the co-ordination of national research programmes. | BMWi | Starting 2006 |

*Please see page 107 for an explanation of the abbreviations used here.*

## Space technology – Going into space for Earth

### Satellites for earth observation and navigation



#### Field of innovation

As the spectacular pictures of our neighbouring planet which the European space probe MarsExpress sent back once again show, space has lost none of its fascination in the years since 1969 when man first set foot on the moon. What is decisive here however is that space technology has become one of modern industrial and information society's key tools in the intervening years. Television and telephoning via satellite, for instance, are just a part of everyday life that is hardly associated with space any more. The applications market for satellite communication totals some €45 billion a year in Europe alone. The American GPS system revolutionised positioning on earth, water and in the air Europe's civilian Galileo navigation system which is currently being set up will significantly improve this technology and open up new growth opportunities in Europe. Space-based earth observation – alongside navigation and communication – is on the threshold to broad use. It will increasingly play a decisive role in the discharge of government and societal tasks – in, for instance, the areas of environmental protection, traffic surveillance, disaster management and in connection with security matters. Thus, actual benefits to man and the development of new markets take centre stage in the work being done today to progressively develop and refine space technologies.

#### Objective

The German government aims to expand the top-ranking positions Germany holds in space research and space technology and offer German companies that are competing in the European and global arena good chances on the markets taking shape in these areas.

Which is why at the European Space Agency's (ESA) ministerial conference held in Berlin in December 2005, the German government assumed charge of the Global Monitoring for Environment and Security (GMES) programme which is presently the world's largest earth observation programme. It also initiated the ARTES-11 (Advanced Research in Telecommunications System) ESA programme for the nascent small geostationary satellite market and, in doing so, secured a leading role for German industry in this area.

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Partner who are much in demand:</b> Thanks to their high level of expertise, German firms are much in demand as partners in collaborative international activities.</li> <li>• <b>SMEs well-positioned:</b> Broad range of products extending from individual components to systems capability for scientific satellites and space probes.</li> <li>• <b>German EADS sites:</b> Important prime-contractor responsibilities for major space systems (e.g., earth observation, navigation, the Ariane 5 ECA upper stage, and the ISS)</li> <li>• <b>Galileo and GMES:</b> Germany plays a leading role.</li> <li>• <b>Space-based science:</b> Outstanding German participation.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>New markets:</b> Galileo and GMES will enable innovative new products and services.</li> <li>• <b>Formative role:</b> Strategic influence on the future aerospace infrastructure (launchers, independent European access to space).</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Little participation in EU programmes:</b> German space firms are not yet fit enough for European competition or EU programmes that will be strengthened in the future.</li> <li>• <b>Inadequate commercialisation:</b> Space technology and research findings are not being worked enough to produce market-able products and applications.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>European balance:</b> Shifts in focus and changes in priorities in the European space industry that would be taken at Germany's expense must be avoided.</li> <li>• <b>Capital intensity:</b> SMEs often do not have enough financial strength for long-term or large-scale space projects.</li> <li>• <b>NASA dependency:</b> Further work on the ISS will depend on whether the space shuttle is deployable.</li> <li>• <b>Competition over launcher systems:</b> Ariane 5's success will depend on developments on the international market.</li> </ul>

■ **SWOT analysis**

**European and national space funding – Tightly meshed to the benefit of German space activities**

Today, 17 European countries are working together in the European Space Agency which was founded in 1975 to enable members to jointly play an important role among the world's leading space players. Germany conducts most of its space activities through collaborative European-level projects. It is the second largest contributor to ESA after France and accounts for more than €550 million of ESA's total budget of some €3 billion a year. ESA finances scientific missions to explore the universe and awards contracts to space firms with the aim of executing major projects such as Europe's participation in the International Space Station (ISS) or the Ariane launcher system.

The next ESA ministerial conference is scheduled for June 2008 when important decisions will have to be taken regarding the continuation and progressive development of various activities, including in particular activities involving the launcher system field and the ISS.

■ **Areas of action**

Becoming a prime contractor is particularly important to German space companies. Which is why the Federal Ministry of Economics and Technology will systematically continue its leading involvement in the broad field of earth observation and satellite communications – also with an eye to the growing role that space plays in security policy. The Federal Ministry of Economics and Technology will also see to it that the Franco-German equilibrium in key areas of the European aerospace industry is maintained.

The European Union will make space a thematic priority in the Seventh Research Framework Programme (2007-2013). As a result, it will increase its involvement in the financing of space activities – in addition to its ongoing work on setting up the Galileo global satellite navigation system. In contrast to the European Space Agency (ESA) whose focus is on technological developments and the provision of infrastructures, the European Union concentrates on space applications in the fields of earth observation and navigation. The Federal Ministry of Economics and Technology supports a clear separation of ESA's and the EU's functions and is intensively involved in the current work on a European Space Policy that will provide a joint strategic and programmatic foundation for ESA and EU activities.

Germany is active not only in ESA projects and EU space programmes. The National Space Programme has the important task of ensuring that Germany's strategic goals are reflected in ESA and EU programs and that German industry and science can compete successfully in EU and ESA programmes. To achieve this, German industry and science must be prepared for the competition awaiting them in the EU and for tasks to be discharged in connection with ESA. Secondly, expertise and skills that fall outside ongoing European programmes must be developed. For this purpose, the German government is financing individual and collaborative projects, particularly when they involve SMEs, universities and research institutes.

Germany's National Space Programme is augmented by the government's provision of basic financing for institutions, first and foremost the German Aerospace Center (DLR) which not only conducts scientific and technological research but also operates important facilities such as the German Remote Sensing Data Center (DFD) and the German Space Operations Center (GSOC).

Germany's involvement in the ESA, the National Space Programme and in the work being done by the German Aerospace Center (DLR) gives priority to the following tasks:

### **Gain new scientific insights**

Space exploration has generated findings that have radically expanded our knowledge of the solar system. This has been impressively demonstrated by the current Cassini/Huygens Mission to Saturn and the MarsExpress mission to our neighbouring planet. Automated systems such as the Mars Rover are being built to continue our exploration of outer space. Besides being able to take the place of astronauts, such systems are also pacemakers for technologies that can be used on earth as well. Research under zero-gravity conditions on the International Space Station (ISS) and experiments in the Drop Tower in Bremen, parabolic flights and missions with small rockets are all being used to obtain insights into gravity's effects on animate and inanimate natural systems.

### **Develop satellite navigation and earth observation for commercial use**

Europe's Galileo system has been synonymous with satellite navigation since 1999. With a constellation of 30 satellites orbiting the earth, Galileo will make it possible to determine position and time with extreme precision starting in 2010. Another European project is the Global Monitoring for Environment and Security (GMES) project which develops services and satellites for environmental observation, disaster management and security purposes.

The national TerraSAR-X mission was created with a view to further strengthening Germany's competence in the earth observation field. The RapidEye project – like the TerraSAR-X mission, a national space project being conducted through a public-private partnership – will also provide geographic information products from outer space quickly and, most importantly, updated on a daily basis starting 2007. Two further national earth observation missions are currently in the



### The Galileo lighthouse project

Galileo is an independent, civilian and global system for satellite navigation, timing and positioning that is currently being set up and is slated to go into operation by the year 2010. With its Galileo programme, Europe is making itself independent of systems operated by the military and strengthening its sovereignty and economy. The European Space Agency and the European Union adopted the Galileo programme in 1999. Since then, it has been regarded as Europe's most important technology project. At an early stage already, Germany began providing assistance for national industrial structures, not only at space companies but also in the area of terminal equipment and value-added service providers. Rapid growth can be expected in the value-added services and terminal equipment fields. These two areas encompass not only typical mass market applications (transport, tourism, leisure time) but also critical applications such as the co-ordination of personnel in emergency situations. The only one of its kind in Europe, the Galileo Test and Development Environment (GATE) is currently being set up in Bavaria with an eye to creating advantages for the German space industry at an early stage. It will be possible to simulate Galileo signals under realistic conditions over an area of some 65 km<sup>2</sup> at the GATE facility yet this year. This 'intermediate step' will allow firms to start testing terminal equipment and services even before the Galileo system goes into operation so that they are in a position to serve the market without delay.

planning: Using radar technology, the TanDEM-X programme will generate an extremely precise elevation model of the earth's surface. The Environmental Mapping and Analysis Programme (EnMap) will measure and record various parameters of the earth's ecosystem using a hyperspectral, high-resolution sensor. This information will help us better understand the interaction between the biosphere and the geosphere. These two missions also promise opportunities for commercial applications since they are also, for example, creating a geodata infrastructure which will include the maintenance and provision of spatial data.

The German government is planning a satellite data security law with the aim of establishing a reliable legal framework for the operation of remote-sensing satellites and the commercialisation of earth observation data. This will provide an important prerequisite for ensuring that German companies can translate satellite applications that they have developed with the help of government funding into economically viable business models and thus tap new sales markets.

### Ensure Europe's access to space

The availability of suitable launcher systems is a prerequisite for any use of outer space. At the same time, ensuring that Europe has its own access to space is of top priority, right alongside economic viability. The need for satellite launches – particularly for the commercially important geostationary communications satellites – has given rise to a highly competitive global market for space transport services.

At the same time, Europe's Ariane 5 launch system is competing with systems which are not always offered under free-market conditions. For this reason, a priority objective in the development of booster rockets is to markedly reduce transport costs in order to make these rockets economically efficient. Germany has been conducting projects for this purpose at national level for some time now. Drawing on the skills and expertise in Germany's industrial sector and universities, these projects are laying the foundation that will allow Germany to take a leading role in Europe in areas that are key to rocket development.

To ensure that the German space industry and space science continue to hold a leading position in the international arena, the German government will initiate a strategic dialogue on updating the German space programme in 2006. This dialogue will be conducted with the aim of determining the interests and priorities for Germany's future involvement at national and European level.

**Individual research and innovation policy initiatives 2006 – 2009**

• Adoption of the European Space Policy.	BMWi	Mid-2007
• Start of a strategic dialogue on German space policy.	BMWi	2nd half of 2006
• Two new missions in the National Space Programme (TanDEM-X and EnMap).	BMWi	Starting 2006
• Crucial role in setting up ESA's GMES space components.	BMWi, BMVBS	2006/2007
• Tabling of a satellite data security bill.	BMWi, BMJ	2nd half of 2006

*Please see page 107 for an explanation of the abbreviations used here.*

## Maritime technologies – Innovation for the oceans

### Being present in the global market with innovative systems solutions



Technologically speaking, cruise liners and naval ships are as complex as aircrafts or power plants. The level of investment in research and innovation – some ten percent of turnover – is accordingly high. New technologies have been systematically integrated into shipbuilding. This has led to productivity gains in recent years that surpass even those seen in Europe's aircraft construction industry. German industries are leaders in the development of highly complex systems and equipment that put the shipping industry in a position to meet stringent international environmental standards at an early point in time or play a part in the onward development of environmental standards.

A wealth of oil, gas and mineral fields lies untapped at the bottom of the world's oceans. Developing these resources places extreme demands on technology and is considered the world over to be one of the largest challenges around. Deep-sea oil and natural gas production (below 500 meters at present and below 1,500 meters in the future) will more than double between 2005 and 2009. Oil and gas resources in ice-covered areas of the Arctic, particularly in the Barents Sea, will play an increasingly important role in the coming decades for the energy supply in Europe and the USA. Gas hydrate has also become a focus of international interest in the last decade as a new source of energy from the sea. Offshore wind energy offers a further avenue for energy policy: As outlined in the German government's Offshore Strategy, windparks with an installed capacity of 20,000 to 25,000 MW are to be set up in the German North Sea and Baltic Sea by the year 2030. This will trigger a surge in innovation throughout the entire maritime industry. The oceans with their streams, waves and temperature differences also offer enormous potential as a source of energy.

The German government aims to develop Germany into a magnet for cutting-edge maritime technology. The shipbuilding industry will consolidate its position on the global market for highly complex special-purpose ships and maintain its competitiveness in standard ships by introducing process innovations. The German government is working to ensure that Germany's maritime technology industry establishes its presence in the global market with innovative systems solutions at an early point in time and can thus benefit from the worldwide growth in the offshore sector.

#### ■ Field of innovation

#### ■ Objective

**SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Successful shipbuilding supply industry:</b> 400 companies (not only on the coast) with €9 billion in turnover in 2004 (No. 2 in the world after Japan) and an export share of 60 per cent.</li> <li>• <b>Shipyards:</b> Major systems competence for the construction of complex ships (e. g., cruise ships, special-purpose tankers, roll-on roll-off ferries).</li> <li>• <b>Marine-technology competence:</b> Innovative technologies in the areas of underwater robotics, drilling engineering, process control and safety engineering and gas hydrate research.</li> <li>• <b>Environmental technologies:</b> German industry has an enormous development lead (ballast water purification systems, inter alia).</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Technology lead in shipbuilding:</b> Shorter production times and more stringent quality, environmental-protection and safety standards.</li> <li>• <b>Exploitation of natural resources:</b> Increasing amount of oil and gas production in deep water (below 500 meters) and ice-covered regions plus large gas hydrate deposits along the shelf edges as a new resource.</li> <li>• <b>Offshore wind energy:</b> Tap potential.</li> <li>• <b>Environmental standards:</b> German industry's participation in the development of international standards.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Shortage of skilled labour in the shipbuilding sector:</b> Only half as many university graduates and highly trained skilled workers as needed.</li> <li>• <b>Lack of interconnectivity:</b> Intra-industry and cross-industry collaboration between industry and science needs to be increased.</li> <li>• <b>Below-average growth:</b> Growth rates posted by Germany's maritime technology industry fall short of the sector's worldwide growth.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Tough competition:</b> Strong international competitive pressure, particularly from Asia and a know-how drain to competitor countries.</li> <li>• <b>Expensive quality:</b> Expensive safety and environmental protection standards can be enforced only through international regulations.</li> <li>• <b>No international heavyweights:</b> No German global players in international offshore markets and no companies that operate deep-sea production facilities for gas or oil.</li> </ul>

**Areas of action**

**Achieve technology leadership by integrating all high-tech enabling technologies**

Ship-building and maritime technology are integrative sectors that use practically all cross-cutting technologies under extremely demanding conditions in the manufacture of high-tech products. Maritime R&D relies on new materials (for transport safety and lightweight construction that conserves resources), on optical technologies (for example, for the precision manufacturing of large structures), on I&C technology (for virtual ship design and the simulation of ship production that incorporates the entire value-added chain), on mechatronics (for manufacturing and on-board systems), on fuel cell technology (for underwater vehicles) and on satellite navigation systems (to improve ship safety).

**Make the transition from a subsidised sector to technology leader**

Funding for maritime R&D and innovation was bundled and placed under the Federal Ministry of Economics and Technology in 2006. This opened the door to a uniform strategy for advancing

and funding shipbuilding innovation. The arc of this strategy extends from basic research conducted at Germany's universities to industrial research all the way to work being done to translate research findings into marketable products.

The Shipping and Maritime Technologies for the 21st Century funding programme under the Federal Ministry of Economics and Technology finances chiefly industry-led collaborative projects in which companies work with universities or research institutes on a joint development objective. In addition to general project funding for which applications can be submitted at any time, special calls for funding proposals focus on specific topics, particularly as a result of resolutions passed at National Maritime Conferences. Production innovations for new markets take priority here. In this way, new types of high-tech ships and components are to be developed with an eye to extending Germany's technology leadership in the field of high-tech shipbuilding. New priorities such as The Energy-Efficient Ship are aimed at boosting the economic efficiency of ship operation over the entire life cycle and reducing environmental pollution. Germany's competitive disadvantage to date vis-à-vis shipbuilders in the Far East can be eliminated by optimising processes to lower costs and increase productivity. Flexible Serial Production is one new priority theme in connection with the development of new production technologies. The other new priority themes Innovative Transshipment Technologies and Adapted Ship Designs for Inland Navigation and Coastal Shipping will produce solutions that can be better integrated into multimodal transport chains, deployed in shallower waters, reduce damage to banks and shores as well as minimise pollution loads. This augments the funding which the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety provides for innovative ships for inland waterways.

The Innovative Shipbuilding Ensures Competitive Jobs programme under the Federal Ministry of Economics and Technology fosters industrial applications from R&D results, new types of ships with an innovative master design and new ship components and systems. This programme funds not only the industrial application of individual innovative products including their implementation in ships but also new shipbuilding methods – in other words, the development and introduction of innovation methods for planning, designing, manufacture and logistics. This also reduces the enormous technical and economic risks involved in building prototypes which in the shipbuilding industry always have to be put to commercial use as well.

### **Extract resources from the sea using maritime technologies**

The amount of oil, gas and mineral resources being extracted from areas that are covered by an ocean or ice will increase in the future. The Shipping and Maritime Technologies for the 21st Century programme has set up the funding priority Development of Systems Solutions for the Exploitation and Environmentally-Friendly Extraction of Energy and Mineral Resources from the Sea to ensure that Germany's maritime technology industry can benefit from this trend. This will boost Germany's strengths: underwater process engineering for oil and gas extraction, underwater vehicles and underwater robotics. Germany must take up R&D collaboration at an early stage with countries that have sizable technology needs in order to facilitate its entry into international offshore markets. With this in mind, the German government is assisting on a targeted basis collaborative R&D activities with Russia and Norway for the extraction of oil and gas in areas that are covered by ocean or ice and for sea transport in the Arctic.

### **Develop a national and European strategy**

A key aim of the LeaderSHIP Deutschland strategy is to establish an extensive research and innovation alliance in the maritime industry. This initiative concentrates on complex types of ships and competitiveness in standard shipbuilding, on the potential for reducing costs in shipbuilding through, for example, the use of new materials and on optimising the shipbuilding process through the effective interconnection of shipyards and ancillary industries. In light of the growing competitive pressure from the Far East and the increasing international division of labour in the maritime sector, Germany cannot however limit itself to national-level activities aimed at strengthening the country's innovative ability and productivity. Germany's shipbuilding indus-

try is therefore participating in the European Union's Leadership 2015 initiative. With the help of this initiative, European shipbuilding companies are working together with representatives of the European Commission and the European Parliament to develop a network that can put the joint potential offered by EU member states to optimal use by integrating and concentrating investments in research, development and innovation.

In addition to this, the Federal Ministry of Economics and Technology has charge of developing two ERA-NETs in the maritime field. Funding through the Shipping and Maritime Technologies for the 21st Century programme is available for all maritime technologies in the MARTEC ERA-NET. Only the shipping field is eligible for funding in the TRANSPORT ERA-NET project.

### Improve the innovation environment

As long as price is the primary factor determining a ship owner's or oil producer's buying decisions, innovative, safer, environmentally-friendly, but more expensive advanced technology will have a hard time establishing itself in the marketplace. In light of this, the Federal Ministry of Transport, Building and Urban Affairs is working at international level to fine-tune the International Maritime Organization's regulations so that they take the demands of ship safety and marine environmental protection more into consideration and dismantle associated impediments to innovation.

Shipbuilding requires complex, international co-operation between all parties involved (shipyards, suppliers, principals, classification societies, universities and service providers). This bears the risk that know-how could flow to unauthorised parties. The shipbuilding industry has not however had a sufficiently well-established culture for the protection of intellectual property to date. The international laws and regulations for the protection of intellectual property which apply to the shipbuilding sector must therefore be reviewed and, if necessary, formulated to be more effective. In addition, the Federal Ministry of Economics and Technology is examining possibilities for collaboration in the area of maritime technologies in its preparation of the Innovation to Counter Product Piracy funding initiative being undertaken by the Federal Ministry of Education and Research.

#### Individual research and innovation policy initiatives 2006 – 2009

- |  |                    |               |
|--|--------------------|---------------|
| • The Shipping and Maritime Technologies for the 21st Century R&D funding programme will be extended and its annual funding volume increased substantially over the 2005 level by the year 2010. | BMW                | Starting 2006 |
| • The Innovative Shipbuilding Ensures Competitive Jobs programme for funding the first industrial use of R&D findings will be extended until 2009.   | BMW                | Starting 2006 |
| • The 5th Maritime Conference will place particular emphasis on naval engineering and maritime R&D, innovation and education, and on tapping resources from the oceans.                          | Federal government | 2006          |

*Please see page 107 for an explanation of the abbreviations used here.*

## Services – On the road to tomorrow's knowledge society

### Innovation driver for high-tech business models



In modern industrialised nations, the services sector accounts for approximately two-thirds of all jobs and gross value added. This figure alone provides an indication of how important services already are today for technological advances in high-tech countries such as Germany.

Modern technologies are an important prerequisite for new services. Not only are services an integral part of new products, the actual process of rendering a service also involves state-of-the-art production technologies. Being a pioneer demander, the services sector is also a driver for technology innovation. Growth in cutting-edge markets ranging from logistics to multimedia, research and development, business services and health care all the way to personal services and creative occupations is inextricably linked with service innovations.

The German government aims to duplicate throughout the individual services sectors the same level of high quality in innovation management that Germany has already achieved in the manufacturing sector. It is working to improve both investment and development conditions for new types of services arising from the increased interplay between service advances and technological advances.

#### ■ Field of innovation

#### ■ Objective

## SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Service engineering and standardisation:</b> The engineering sciences – as 'traditional' product developers – have taken up this subject.</li> <li>• <b>Integration of production and services:</b> Interdisciplinary, application-oriented research initiatives are well-established in key German sectors such as the mechanical engineering and automotive sectors.</li> <li>• <b>High level of education and training:</b> High education levels particularly in those fields of employment that require academic training and in traditional services.</li> <li>• <b>Well-developed infrastructure:</b> Examples include mobile telephony, digitisation, cable networks, transport system.</li> <li>• <b>Art and culture:</b> Tradition, vigour and diversity of the European art and cultural scene.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>New markets:</b> Knowledge-intensive services will benefit from the EU Services Directive. Moreover, Germany and its European neighbours are lead markets for services that focus on our ageing populations and changing social structures / consumption patterns.</li> <li>• <b>Innovation potential of hybrid products:</b> The manufacturing industry and engineering services have a very good international reputation. Germany's service industry can benefit from this through integrated models ("Services made in Germany").</li> <li>• <b>New employment opportunities and specialised services:</b> Services open up new fields of work in many areas, particularly at intermediate education levels.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Investment in research and development:</b> R&amp;D expenditure by German service companies falls short of the international average.</li> <li>• <b>Export:</b> Only a few companies in Germany operate internationally in important service fields. The German services sector is only slightly geared to export business.</li> <li>• <b>Regulation:</b> Regulated, small service markets; after-effects of monopoly structures.</li> <li>• <b>Underdeveloped research landscape:</b> Measured in terms of the economic importance of services.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Innovation management in the services sector:</b> Systematic service development – comparable to product development with all the aspects of research, science and education – exists only in rudimentary form (service engineering). Scientific underpinnings have to be improved.</li> <li>• <b>Exportability and originality:</b> Knowledge-intensive services are not yet fit enough for export. Lack of intellectual property rights protection for service innovations.</li> <li>• <b>Services sciences:</b> R&amp;D methods that are compatible with services must be developed (including suitable measuring and indicator systems).</li> </ul>

The German government supports the development of technologies for service processes primarily – and often in conjunction with the development of services – in specialised technology-related programmes being conducted in, for example, the transport, energy, multimedia or ICT research field. In addition the new Innovation with Services R&D programme specifically targets the services sector. This programme's thematic emphasis is on innovation management, innovation in fast-growing fields, and people who work in service companies. All of these R&D measures are intended to help Germany's services sector achieve the same excellence that has traditionally been a hallmark of the production sector.



**Innovation management methods and tools**

**■ Areas of action**

Computer-aided service engineering and attendant simulation processes are just in their early stages but already indicate a direction that the combination of cutting-edge technology with service management can take. Existing simulation technologies are however not advanced enough to include customer-employee interaction. The approach that the Fraunhofer Society is taking with its creation of a ServLab is a step in the right direction. It must however be further developed and expanded.

In addition, 'technology-neutral' management methods and tools plus new business models play a key role here. One example is the research funding that the Federal Ministry of Education and Research provides in connection with production-related services with the aim of incorporating such services into companies' innovation and value-added processes as an integral part of their corporate strategy and then developing management models for this.

**Recognise innovation in growth fields at an early stage**

Being able to recognise even 'weak signals' for innovation and growth potential makes it possible to kick-start the necessary technological R&D in the service field at an early stage. Certain areas are already emerging today that could be considered growth fields: knowledge-intensive services, particularly in connection with the export of services; new services that are based on the development of new media; and services arising out of demographic trends.

The close interaction between technology and services is particularly evident in the latter growth field. Demographics-driven services are important for research because the integrated development of services and technologies constitutes the prerequisite for new offerings and thus for new marketing opportunities. Examples of technologies that enable this include microsystems technology and multimedia. Possible fields of application can be found in the areas Wellness/Health and Facility Management/Home Management.

**General conditions, research and innovation policy dialogue**

The German government pursues a continual dialogue with the services sector and services research. During Germany's term as president of the Council of the European Union in 2007, services research is to be further developed as an area that is important for Europe's future, building on the groundwork laid by Finland and the European Commission.

**Individual research and innovation policy initiatives 2006 – 2009**

- A number of technology-related research programmes provide funding for the development of technologies for service processes, in conjunction with the development of corresponding services. For example, the Multimedia programme under the Federal Ministry of Economics and Technology uses, inter alia, its funding priorities Knowledge Management and Networked Intelligent Systems to assist the development of ICT services.

BMWl, BMBF Starting 2006
- The Innovation with Services research programme specifically funds the services sector through its funding priorities Innovation Management, Innovation in Growth Fields, and People in Service Companies.

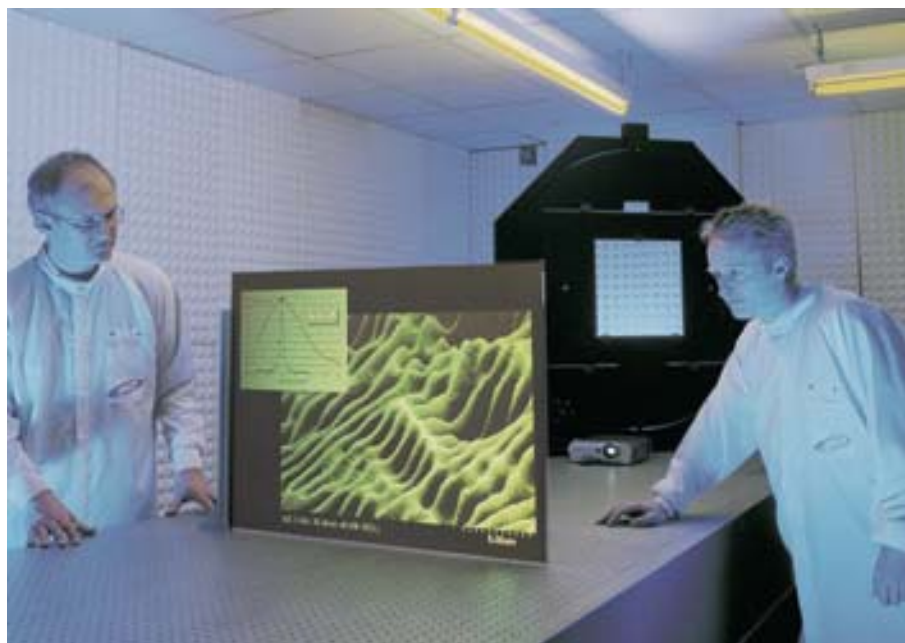
BMBF Starting 2006

*Please see page 107 for an explanation of the abbreviations used here.*

## Innovation through cross-cutting technologies

### Nanotechnologies – A small scale with enormous economic potential

#### Innovations from the quantum world



#### Field of innovation



Thanks to new tools such as the scanning tunnelling microscope and the physical phenomenon of self-organisation, it is possible to selectively manipulate structures that are a thousand times smaller than a human cell and a million times smaller than the head of a pin. These enable coatings that clean themselves, nanoparticles that can fight tumours on a pin-pointed basis, and tiny data memories that can hold entire DVDs on a surface the size of a cent.

The use of nanostructures will affect all branches of industry. Total market potential is expected to reach €1 billion in the year 2015. Measured in terms of research expenditure in relation to gross domestic product, the USA, Japan and Germany are more or less tied in basic research on nanotechnology. Germany ranks third when scientific publications are used as a yardstick.

#### Objective



The German government aims to speed up the translation of nanotechnology research findings into a wide variety of innovations. It is working to introduce more sectors and enterprises to nanotechnology and eliminate obstacles to innovation by co-ordinating the relevant policy fields at an early stage. The government will conduct an intensive dialogue with the public about the opportunities that nanotechnology offers. This dialogue will also examine the risks nanotechnology involves. These activities will be brought together in the Nanoinitiative 2010 campaign and presented in late 2006.

■ SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong basic research:</b> Germany ranks third in publications worldwide, following the USA and Japan.</li> <li>• <b>Diversified research landscape:</b> Strong involvement by HGF, MPG, WGL, DFG, FhG, universities, departmental research and industrial research.</li> <li>• <b>Positive general mood:</b> The public is receptive to nanotech innovations.</li> <li>• <b>Interest among future scientists:</b> Growing demand for new training and degree programmes in the nanotechnology field.</li> <li>• <b>Good industrial base:</b> Some 560 companies (including approximately 440 SMEs) are already involved in nanotechnology.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>More versatile and efficient materials:</b> New properties and functions for conventional materials.</li> <li>• <b>New application diversity:</b> Materials with customised properties, particularly through the use of self-organisation processes.</li> <li>• <b>Competitive advantages:</b> Nanotech innovations are possible in all sectors.</li> <li>• <b>Good innovation climate:</b> Society is incorporated into the dialogue over opportunities and risks.</li> <li>• <b>Potential investor interest:</b> Strong interest in the nanotechnology field.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Shortcomings in translating research findings into products:</b> Although Germany is the leader in Europe, it trails substantially behind the USA and Southeast Asia in terms of patent volume and the number of companies involved in nanotechnology.</li> <li>• <b>Difficulties for start-ups:</b> Not enough venture capital being made available, bureaucratic obstacles.</li> <li>• <b>Lack of information in industry:</b> Potential investors do not in some cases have a clear picture of the opportunities that nanotechnology has to offer.</li> <li>• <b>Poor political co-ordination:</b> The interfaces between the federal ministries and between the federal ministries and the Länder have not been adequately defined to date.</li> <li>• <b>Engineering deficits:</b> The lack of sufficient expertise in the mass production of nanotech products leads to high costs which hinder their introduction to the market.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Safe, responsible handling and use of nanotechnology:</b> Consumer information, consumer protection, industrial safety need-ed.</li> <li>• <b>Scientific risk assessment:</b> The possible toxic effects of nanoparticles have not yet been sufficiently investigated.</li> <li>• <b>Adequate risk communication:</b> A dialogue must be conducted that includes all societal groups.</li> <li>• <b>Standardisation and testing strategies:</b> Germany needs to take a more active role.</li> <li>• <b>Lack of a 'nano label':</b> The lack of agreed labelling opens the door to possible misuse and misunderstandings.</li> <li>• <b>Risk of 'nano hype':</b> Cannot rule out the chance that there is exaggerated marketing with the word 'nano'.</li> </ul>

## Areas of action



### Put the potential offered by nanotechnology to use for Germany's industrial strongholds

Nanotechnology can also benefit those sectors that are particularly important for Germany – the automobile industry, mechanical engineering, chemicals, electronics, medical technology and the optical industry. The Federal Ministry of Education and Research is consequently concentrating its R&D project funding on lead innovations – giving strategic focus to collaborative research activities that are geared to the value-added chain – in order to help these sectors solve the challenges of the future with advances in nanotechnology. Nanotechnology will be funded to a greater extent in the areas nanomaterials, micro/nano systems integration, organic light emitting diodes (OLEDs) and production technology in the coming years. More applications have to be developed for environmental protection and resource conservation use (such as photovoltaics and paint production).

### Introduce more sectors and companies to nanotechnology

Many sectors and companies have not yet however recognised the opportunities that they will be handing their foreign competition when they ignore the possibilities nanotechnology has to offer. Which is why the Federal Ministry of Education and Research and the Federal Ministry of Economics and Technology are planning a dialogue with those industries that have not had access to date to the findings generated by nano research. Efforts will aim to jump-start the development of innovative products and processes in the textile, capital goods and construction industries.

Today, more than 440 of the some 560 companies that work with nanotechnology are small and medium-sized businesses. Consequently, the NanoChance funding programme has been tailored especially to the needs of SMEs in order to get even more companies involved in nanotechnology. Technology-neutral funding programmes that the Federal Ministry of Economics and Technology conducts support the translation of nanotechnology research findings into actual products and processes. The High-Tech Gründerfonds seed fund which the Federal Ministry of Economics and Technology and partners from industry have set up has particularly improved access to venture capital.

### Play a part in laying down norms and standards

Norms and standards not only make the market for a new technology more transparent, they are also an important prerequisite for competitive advantages. In the nanotechnology field however, Germany has not been sufficiently represented to date in international standardisation bodies, most particularly in ISO and CEN. In order to remedy this situation, the German Institute for Standardization (DIN) and the German Commission for Electrical, Electronic and Information Technologies at the German Institute for Standardization and the German Association of Electrotechnical Engineers (DKE) have set up mirror committees which will ensure that our national strategy is well-co-ordinated and that Germany is effectively involved in the international advances being made in the nanotechnology field.

The development of processes that can be used to determine and characterise structures and materials in the nano realm is closely linked to the search for new fields of application for nanotechnology. This is because only suitable determination processes that ensure the reproducibility of findings make it possible to say anything about specific requirements or risks. The Federal Institute for Materials Research and Testing (BAM) is pushing quality assurance in the nanotechnology field ahead by developing testing methods and reference materials. As part of international efforts to develop testing strategies for determining possible health and environmental risks, Germany's Federal Institute for Occupational Safety and Health (BAuA) and the Federal Environmental Agency (UBA) are involved in the OECD's Working Party on Manufactured Nanoparticles.

### Investigate and analyze the effects of nanotechnology at an early stage

Nanoparticles often have different properties than macroscopic bodies of the same substance. This opens the door not only to new potential applications. Another possible upshot is unwanted side effects and concomitant risks for consumers, workers and the environment. The German government is stepping up accompanying research in order to identify these side effects and risks and take appropriate steps to control them at the earliest possible stage. Working together with the Federal Environment Agency, the Federal Institute for Occupational Safety and Health and the Federal Institute for Risk Assessment, the collaborative NanoCare project being financed by the Federal Ministry of Education and Research is examining the possible health and environmental risks that nanoparticles might bear. Other projects take into account employee, environmental and consumer protection concerns. In addition, the Federal Ministry of Education and Research and the Federal Ministry of Labour and Social Affairs want to determine how the production and use of nanoparticles and the release of nanoparticles from nanoproducts could influence worker safety and health. The New Quality of Work Initiative has the task of examining whether nanotechnology-influenced production processes or the use of nanoproducts can reduce the level of contamination with hazardous substances that workers experience.

### Conduct a societal discussion on the opportunities and risks

The possible risks of nanotechnology have to be assessed and appropriately communicated. The soundest-possible knowledge on exposure and toxicity and the development of corresponding testing methods will provide the basis for assessing and communicating potential risks. The objectively differentiated and early communication of this information will determine how society deals with this technology. This will require accompanying sociological research.

#### Individual research and innovation policy initiatives 2006 – 2009

• The German government's nanotechnology-related activities will be bundled and co-ordinated on a cross-ministry basis in the Nanoinitiative 2010 initiative.	Federal government	Late 2006
• Individual sectors that have had nothing to do with nanotechnology to date will be introduced to nanotechnology on a targeted basis in an industry-specific dialogue.	BMBF, BMWi	Starting 2006
• The NanoChance R&D programme will be extended in order to introduce SMEs to nanotechnology on a targeted basis.	BMBF	Starting 2005
• Funding will be increased for research in the areas of nanomaterials, micro/nano systems integration and nanotechnology in production engineering.	BMBF	Starting 2006
• The German government supports greater German participation in international standardisation processes.	BMWi, BMBF, BMAS	Starting 2006
• Accompanying research will clarify how nanomaterials influence worker health and safety.	BMAS, BMBF	Starting 2006
• Dialogue processes on the opportunities and risks of nanotechnology will shape the public discussion.	BMU, BMBF, BMAS, BMELV	Starting 2006

Please see page 107 for an explanation of the abbreviations used here.

## Biotechnology – Life sciences on the threshold to broad application

Innovations based on the defining sciences of the 21st century



### Field of innovation



Today, biotechnology is the point of departure and motor for numerous applications in medicine, the food and fodder industries and the chemical industry. Biotechnology is used for a wide range of applications, from the manufacture of medicines to new diagnostic and treatment methods, from the production of fine chemicals all the way to wastewater purification methods and the production of energy from biomass.

Germany is home to some 300 biotech companies, more than any other European country. Eighty-three percent of them operate in the health/medicine fields ('red' biotechnology), 19 percent in the animal health field, ten percent in agriculture ('green' biotechnology) and 13 percent in the area of industrial applications ('white' biotechnology) (in these statistics, companies could be assigned to more than one category). The economic sectors where biotech processes and products are or could be of relevance accounted for some 14 percent of Germany's GDP and 17 percent of all jobs in 2003.

### Objective



The German government aims to put Germany as a biotech location at the top of the European rankings not only in terms of the number of biotech firms but also when measured by turnover and jobs. It is working to identify and dismantle impediments to growth. The government's funding strategy is geared to the individual links in the innovation chain. New key fields such as white biotechnology and nanobiotechnology are to be tapped and developed.

■ **SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Broad knowledge base:</b> Excellent basic research in many areas.</li> <li>• <b>R&amp;D personnel:</b> Highly-qualified and motivated researchers.</li> <li>• <b>Well-developed infrastructure:</b> Modern research resources and structures, numerous facilities for technology transfer and new start-up businesses.</li> <li>• <b>Broad and diverse business landscape:</b> Germany has start-ups, SMEs and multinational companies. All relevant user sectors are present.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>White biotechnology:</b> The chemical industry is a major user, with collateral impact on agriculture. Accepted by the public as a sensible application.</li> <li>• <b>Maturing biotechnology firms:</b> Thanks to increasing consolidation, products (medicines), new processes and services are expected to be entering the market.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Pharmaceutical and chemical industries:</b> Today, innovation drivers are located in the USA, UK and Switzerland. There is too little vertical development co-operation in Germany. SMEs are hesitant to incorporate biotech processes.</li> <li>• <b>Lack of experience among entrepreneurs:</b> Start-up teams often have no entrepreneurial experience. Germany lacks 'serial entrepreneurs'.</li> <li>• <b>Little personnel mobility:</b> Crossovers between research, industry and venture capitalists too seldom.</li> <li>• <b>Venture capital:</b> Private offerings for early-stage finance are few. Only a handful of venture capitalists have specific industry expertise.</li> <li>• <b>Permits, licenses and approvals take too long:</b> Very slow approval procedures.</li> <li>• <b>Few pilot plants:</b> Lack of proof of 'technical feasibility'. Lack of process data.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Green genetic technology:</b> Low level of consumer acceptance for its use in connection with food and for the establishment of innovation-friendly conditions.</li> <li>• <b>Competition over 'high potentials':</b> Tough international competition over the best minds.</li> <li>• <b>Danger of exodus of key industries:</b> Loss of major corporations in the pharmaceutical and food industries and the concomitant loss of potential customers for biotech providers.</li> <li>• <b>Commercialisation abroad:</b> Successful German biotech firms are acquired by foreign competitors and then moved abroad. Pharmaceutical patents are out-licensed, primarily to other countries.</li> <li>• <b>Competition from the Far East:</b> Particularly on non-R&amp;D-intensive technologies and intermediate technologies such as fermentation, biogenerics and antibiotics production.</li> <li>• <b>Clear consumer benefits:</b> Products with convincing advantages need to be developed and consumers need to be informed about them.</li> </ul>

## Areas of action ■

### Lay the scientific foundation for product and process innovation

Three fields of research are of central importance for expanding the scientific foundation of biotechnology: (1) Genome research analyzes the genetic blueprints of microorganisms, plants and animals, extending all the way up to man. (2) Systems biology aims to develop a quantitative understanding of the dynamic life processes by modelling them on computer. (3) Molecular medicine sheds light on the molecular foundations of human diseases. Funding for near-basic research projects is provided to supplement the basic funding allocated to major research organisations. This is being done to make it possible to tap and develop new innovation and value-added potential in the chemical, food, agriculture and medical sectors and – going beyond the life sciences – in the information technology field.

### Use the opportunities offered by white biotechnology and nanobiotechnology

Biotechnology leads to new products that can be used for industrial purposes and makes industrial processes more environmentally compatible. For example, researchers are working to develop environmentally-compatible biochemicals, biologically-based materials for replacing plastics, fine chemicals, specialty chemicals plus enzymes for use in the conversion of materials not only in laundry detergent. Life scientists and engineers are working closely together with the aim of putting biological systems to industrial use. Economic experts expect white biotechnology alone to generate €50 billion a year in global sales. The Federal Ministry of Education and Research set up the Bio-Industrie 2021 funding measure to ensure that Germany will play a leading role in this new field of biotechnology as well. A cluster competition for the development of new products and processes in the industrial biotechnology field will be launched in this connection to foster the development of expertise and structures.

In the wake of miniaturisation, nanobiotechnology has developed along the interface between biotechnology and nanotechnology. It forms the bridge between animate and inanimate nature and pushes forward the systematic cross-linking of biotechnology and nanotechnology in both research directions. Examples of this already exist: Nanoparticles that release topical agents, nanostructured surfaces for manufacturing bioactive prostheses, and nanosensors that, for instance, make it possible to detect minor changes in protein concentration levels during the early phases of Alzheimer's disease. The Federal Ministry of Education and Research is supporting research in this area through its Nanobiotechnology funding initiative.

### Foster the commercialisation of scientific ideas

Measures that the Federal Ministry of Education and Research is taking to foster biotechnology start with the links in the innovation chain: The BioFuture competition will bring the world's leading junior life scientists to Germany. This competition offers young scientists the opportunity to put their own research team together and be in charge of creative projects.

The GO-Bio campaign to encourage biotech start-ups supports the transfer of research findings to a prototype stage that has discernible marketing prospects. This is being done because projects that have been completed from a scientific standpoint frequently do not offer sound proof for their technical feasibility. Start-ups in the biotechnology field benefit to an above-average degree from the High-Tech Gründerfonds seed fund under the Federal Ministry of Economics and Technology and the ERP Start-Up Fund. Additionally, the Federal Ministry of Education and Research is topping up its BioChancePlus programme which funds biotech research projects conducted by SMEs.



## Strengthen the dialogue with industry and society

In order for biotechnology policies to succeed, it is necessary to discuss not only the risks but also and in particular the opportunities that biotechnology has to offer: What is biotechnology? What does it stand for? What biotech products have already been developed? What is the present state of research? What risks would Germany face if it does not make use of its opportunities? Can we afford to abandon or not enter certain areas of biotechnology? Where does human dignity demand limits on research? It is not just the political sector's job to conduct this discussion. Industry, science and society must also take part in this debate.

### Individual research and innovation policy initiatives 2006 – 2009

- |   |               |               |
|---|---------------|---------------|
| • The BioIndustry 2021 funding initiative fosters the use of biotechnology in environmentally-compatible industrial processes.  | BMBF          | Starting 2006 |
| • The Nanobiotechnology funding initiative fosters the linking of biotechnology with nanotechnology.  | BMBF          | Starting 2006 |
| • Due to the strong response, more funding will be provided for the BioChancePlus funding initiative which supports collaborative projects and individual projects conducted by young biotech SMEs.                   | BMBF          | Starting 2007 |
| • The High-Tech Gründerfonds seed fund and the GO-Bio campaign will be continued in order to support the commercialisation of scientific ideas.   | BMWi,<br>BMBF | Since 2005    |
| • Germany's Genetic Engineering Act will be amended in order to foster research and the use of genetic technology, and to ensure a high level of safety, the co-existence of production methods, and consumer choice. | BMELV         | 2006          |

*Please see page 107 for an explanation of the abbreviations used here.*

## Microsystems technology – Paving the way for intelligent products

### Linking individual technologies to create systems solutions



#### Field of innovation

- Microsystems technology typically combines microstructuring technologies with systems and integration technologies, as in the case of packaging. Microsystems technology makes it possible in the first place to integrate biotechnology and nanotechnology into micro and macro environments to make them 'compatible' and harness them to make new products.

For example, miniaturised crash sensors activate car airbags. In the future, pedestrian protection systems will ensure that not only car passengers but other people on the road are protected. Today, more than 10,000 deaf people in Germany can hear thanks to a cochlear implant – a microsystem that takes over the function of the inner ear. Retinal implants that will allow visually impaired people to see once again are also in development.

Today, some 680,000 jobs in Germany are connected with microsystems technology. Fifty thousand of them are to be directly found in the production of microsystems. Products involving microsystems technology generate more than €277 billion in turnover a year. Germany is running a neck-and-neck race with the USA and Asia's leading industrialised nations in microtechnology and nanotechnology innovations.

#### Objective

- The German government aims to expand German industry's capabilities as a provider of systems solutions. It is working to put Germany's strengths in the microsystems technology field to use to make it easier to integrate nanotechnology into application products. For this reason it is supporting technological advances in the microsystem technology field and their use in key industries.

#### Areas of action

- Ensure Germany's innovation leadership in key industries**

The Federal Ministry of Education and Research is working to help small and medium-sized businesses create innovations by lowering the hurdles they encounter in this connection. These efforts include its Microsystems programme that funds first and foremost collaborative R&D projects between partners in industry and research which could constitute a preliminary stage to product or process development. Medical technology and the automotive industry have traditionally been major users of microsystems technology. Logistics, biotechnology, agriculture, the food sector and the electrical engineering industry are increasingly to be found on this 'A list' of users. Funding priorities for collaborative research between firms and research institutes will be set in these fields of application.

■ SWOT analysis

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong user industries:</b> Automobile industry, medical technology, mechanical engineering and, increasingly, biotechnology, agriculture and logistics are technology drivers.</li> <li>• <b>Materials and equipment suppliers:</b> High level of expertise.</li> <li>• <b>Highly competitive:</b> Operations are seldom relocated to other countries.</li> <li>• <b>Skilled labour:</b> Germany has a unique initial and continuing education and training system at both industrial and academic level.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>New research fields:</b> Enormous potential offered by polymer microsystems and micro/nano integration.</li> <li>• <b>Growth market:</b> Large number of SMEs with above-average, often double-digit growth rates. High-volume markets for security technology, logistics and health monitoring.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Mass markets:</b> There is no mass production in Germany except in the automobile sector.</li> <li>• <b>Integration of microsystems technology in products:</b> Many SMEs in potential user sectors lack the necessary expertise.</li> <li>• <b>Provision of capital:</b> Technology companies – which are generally capital-intensive – have cautious, national-level financial backers.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Shortage of skilled labour:</b> Early action must be taken to prevent a possible shortage of new recruits.</li> <li>• <b>Product-oriented R&amp;D infrastructure needed:</b> Support on the basis of developed microsystems technologies needed, particularly for SMEs.</li> <li>• <b>Establishment of more networks:</b> Germany needs more collaborative, production-oriented networks between research units, suppliers and systems producers.</li> </ul>

In the medical technology field, portable sensor systems are being developed that can be worn directly on the body without restricting the individual's freedom of movement. These systems telemetrically monitor cardiological parameters such as blood pressure and heart rate. Micro-laboratory technology is improving the possibilities for developing and manufacturing medicines. In the automotive field, microsystems are being used in driver assistance systems to enhance comfort and safety. Radio Frequency Identification (RFID) transponders – also called 'smart tags' – ensure efficient processes and consumer protection in the logistics and food safety fields. Micro fuel cells are being developed as a power source for portable devices such as notebook computers.

**Ensure Germany's technology leadership in new fields**

R&D funding aims not only to increase the use of microsystems technology in key industries but also at making Germany a technology leader in new fields:

Polymer microsystems have the potential to open up mass markets in the low-price segment with quantities in excess of ten million and unit prices of a few cents. Examples of this include RFID smart tags in the logistics field, inexpensive biosensors or gas sensors, medical applications, and membranes for micro fuel cells in the power engineering field. Organic polymers can be made into components and more complex systems very easily with the help of, for example, printing or other reel-to-reel processes.

Artificial nanomaterials – which are also increasingly being used in mobile applications that even extend to mobile telephones – are expected to bring breakthroughs in sensor technology. For example, an integrated gas sensor can warn its owner of harmful gases in the surrounding area. Applications of this kind would be inconceivable without a microsystems technology that bridges the area between nanostructures and the macroscopic application environment.

### Step up the diffusion of technology

Innovation-supporting measures serve standardisation, the transfer of R&D findings, initial and continuing education and training, and the public understanding of science and technology. One example of this are measures to fund and assist application centres at research institutes. Such centres offer SMEs an opportunity to conduct R&D work and small batch production – and draw on the centre's personnel, knowledge and equipment in the process. This gives SMEs access to the infrastructure and know-how of research institutes that they themselves do not have. Following a period in which they receive knock-on financing, these application centres are to offer their services on a commercial basis in the long term.

### Push European integration forward

Together with industry, the German government is bringing its influence to bear on the European research agenda with the aim of enabling adequate German participation in the European Union's Seventh Research Framework Programme. The Federal Ministry of Education and Research is especially engaged in two areas that are important for German firms and research institutes. In the future, intelligent – for example, voice-operated – household appliances could relieve senior citizens of various tasks so that the growing number of elderly people in our society can live independently into very old age. The German government currently serves as co-ordinator for the Ambient Assisted Living (AAL) for the Ageing Society programme – one of the first EU initiatives to be based on Article 169 of the EC Treaty. Its objective here is to bundle corresponding R&D activities with other EU member states. The Federal Ministry of Education and Research has initiated the European Technology Platform on Smart Systems Integration (EPoSS) with the aim of bringing together all relevant European industrial enterprises and research institutes operating in the microsystems technology sphere.

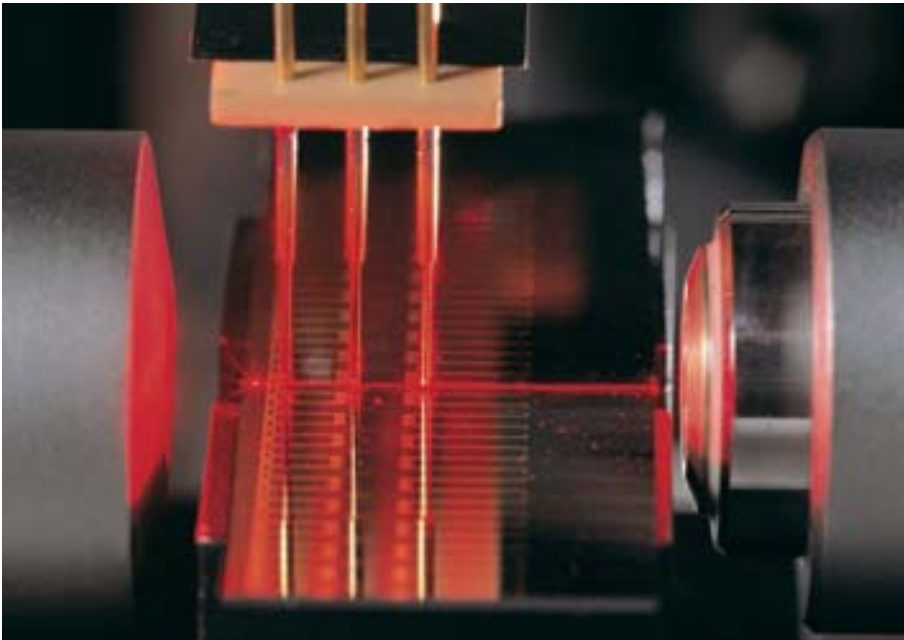
#### Individual research and innovation policy initiatives 2006 – 2009

- |   |      |               |
|---|------|---------------|
| • With its Polymer Microsystems and Micro/Nano Systems Integration funding initiatives, the Microsystems programme aims to secure Germany's technology leadership in new areas.                                 | BMBF | Starting 2006 |
| • The Microsystems programme funds innovative microsystems technology applications in the logistics and security technology fields and the development of intelligent implants in the medical technology field. | BMBF | Starting 2007 |
| • Measures to foster and fund application centres aim to facilitate SMEs' access to the infrastructure and know-how of research institutes.   | BMBF | Starting 2006 |
| • Germany will participate in the Europe initiative (under Article 169 of the EC Treaty) on Ambient Assisted Living with the aim of developing technologies that will enable independent living in old age.     | BMBF | Starting 2007 |

*Please see page 107 for an explanation of the abbreviations used here.*

## Optical technologies – Light is generating growth and jobs

### The century of the photon



Today, digital photography, scanners at store check-out counters, music on CDs, optical biochips for new medicines and lasers for material processing are a regular part of everyday life in industrial societies. This list does not however cover the entire potential offered by optical and photonics technologies: Bold visions such as televisions that are made of organic light-emitting diodes (OLEDs) and can be applied to walls like wallpaper, or computers that use light to process data are inspiring developers working in research laboratories. In contrast to the 20th century when the electron was at the heart of the ICT revolution, the 21st century could become the 'century of the photon'. Germany has an excellent starting point in this field.

Optical and photonics technologies are not only an important lever for many sectors – ranging from electronics to mechanical engineering all the way to medicine – they have also developed into an impressive branch of industry: The lighting sector, manufacturers of lasers, optical components and optical systems together provide jobs for some 110,000 people in Germany. The some 1,000 small and medium-sized enterprises in the area of optical and photonics technologies with their 36,000 employees expect the number of jobs they offer to grow more than 40 percent by the year 2010. At €2.5 billion, Germany holds 40 percent of the global market for high-power lasers for material processing.

The German government's aim is to realise the job growth that has been predicted for the optical and photonics technology field. It is working to quickly put to use new technological opportunities and win lost volume production back for Germany where possible as well. Achieving this will require a complete command and use of the photon with all its properties. For this reason, the German government is speeding up the creation of joint strategies on the part of science and industry and is supporting their implementation.

#### ■ Field of innovation

#### ■ Objective

**SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong community:</b> High degree of sectoral and regional interconnection. Industry, science and the political sector pursue joint strategies.</li> <li>• <b>Technology leader:</b> Leadership in high-brilliance LEDs, disc lasers and fibre lasers.</li> <li>• <b>Global market leader:</b> Leadership in lasers for materials processing, optical microscopy and innovative lighting technology.</li> <li>• <b>Strong user industries:</b> This list is headed by the automobile industry, medical technology, lighting industry and biotechnology.</li> <li>• <b>Rapid technology diffusion:</b> Wide variety of applications, also at SMEs and the trades.</li> <li>• <b>Highly competitive:</b> Successful production in Germany.</li> <li>• <b>Skilled labour:</b> Germany has a unique, well-established initial and continuing education and training system.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Expansion of fields of application:</b> Just 10 – 20 percent of all potential applications for laser materials processing have been developed. High-power LEDs are predicted to grow their share of general lighting from five percent today to 13 percent by 2009.</li> <li>• <b>New fields of research:</b> Terahertz radiation, biophotonics, organic light-emitting diodes (OLED), optical metamaterials, silicon optics and more.</li> <li>• <b>Job growth:</b> The number of jobs at Germany's some 1,000 SMEs is expected to increase 40 percent by 2010.</li> <li>• <b>Consumer optics:</b> It should be possible to recapture the mass markets.</li> <li>• <b>New lighting systems:</b> Can cut energy requirements by a factor of 10.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Consumer products:</b> Germany has very little production for mass markets (displays, cameras, etc.).</li> <li>• <b>Permeability of the innovation system:</b> The exchange between basic and industrial research is too slow.</li> <li>• <b>European integration:</b> The EU is not visible as a single research and economic area.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Need for skilled labour:</b> Early action must be taken to prevent a possible shortage of new recruits.</li> <li>• <b>Competitors:</b> Germany's technical leads over Asia and North America are at risk.</li> </ul>

### Pursue ongoing strategy development

Having a joint strategy that is supported by industry, science and the political sector is just as important as the amount of government funding being provided. For this reason, all strategic activities being pursued by the Federal Ministry of Education and Research in the optical and photonics technology field are discussed, co-ordinated and examined for their benefits on an ongoing basis with an advisory body in which industry is also represented. An interim audit of the Optical Technologies funding programme that runs until 2012 will be conducted in late 2006. This programme is aimed primarily at collaborative R&D projects between companies and research institutes. To ensure that the innovation pipeline is always full, some ten percent of the programme's funding goes to more exploratory research which is mainly conducted at research institutes and universities.

### ■ Areas of action

### Respond quickly to technological opportunities

Germany was still importing laser technology as late as the mid-1980s. After that time, the German government's R&D funding helped German firms to obtain laser technology from the science sector's laboratories and develop reliable tools from it. If Germany is to repeat this success, it must occupy cutting-edge fields early on.

The German government will be giving the following areas centre stage in the coming years:

- Organic light-emitting diodes (OLED) are extremely efficient in converting electricity into light, are flexible and flat and can be produced in large sheets ('OLED wallpaper'). In light of these advantages, OLED products are predicted to have billions of euros in market potential. The Federal Ministry of Education and Research is allocating some €100 million for research through its OLED initiative. German firms have committed themselves to investing an additional €500 million in R&D funding when the initiative is successful. This funding will target the establishment of an OLED manufacturing operation in Germany.
- New optical processes could make it possible to conduct dynamic studies of, for example, metabolic processes in living cells without having a negative effect on them. This would open up entirely new opportunities in the field of medical diagnostics and treatment.
- Germany lost mass production operations for many consumer products to Asian competitors decades ago. Today, companies in Germany are developing counter-strategies. The Federal Ministry of Education and Research wants to contribute to the development of technologies and products that can be used to open up new mass markets and thus make it possible for production in this sector to be undertaken in Germany once again.
- Further, new research concepts seem to indicate that it might be possible to tap the 'terahertz gap' – a part of the electromagnetic spectrum which could not be used to date due to technical constraints. The potential offered by terahertz technology will be used in particular for security technology, industrial metrology, sensor technology, medical technology and communications technology.

### Overcome obstacles to technology diffusion

Innovation-supporting measures under the Innovum trademark are an important priority in the Optical and Photonics Technologies programme being conducted by the Federal Ministry of Education and Research. These measures include projects for setting standards, studies to identify and evaluate the trends of the future, and training campaigns. The major challenges today are meeting the anticipated need for skilled labour and getting young people interested in optical technologies. The activities currently being conducted in this connection – such as study guides, training open houses, collaboration with television programmes for children and adolescents,

and the Fascination of Light travelling exhibition – are an important element for successful innovation.

### Strengthen regional clusters

Another important focus is the funding of collaborative activities conducted by science, industry, banks and the political sector in regional clusters. The Federal Ministry of Education and Research has provided successful impetus in this area with regional competence networks for optical and photonics technologies. Six of Germany's *Länder* have set up supplementary *Land*-level funding initiatives of their own for optical and photonics technologies. At the same time, these optical networks are service providers for enterprises. For this reason they have not only had to be self-financing to date but will increasingly have to be so in the future as well.

### Reach critical size through European integration

Given the increasingly tough competition in the optical and photonics technology field, Europe will be able to hold its own only as a whole. In future, national and European research funding will be more closely co-ordinated with one another. For this reason, the Federal Ministry of Education and Research is presently already involved in an ERA-NET (ERASPOT) and actively supported the establishment of the Photonics21 European Technology Platform. European industry defined the important research tasks in this area with this technology platform. Germany also conducts collaborative research work with individual countries that include France, Russia and China. These activities are aimed at opening up new prospects for German industry.

#### Individual research and innovation policy initiatives 2006 – 2009

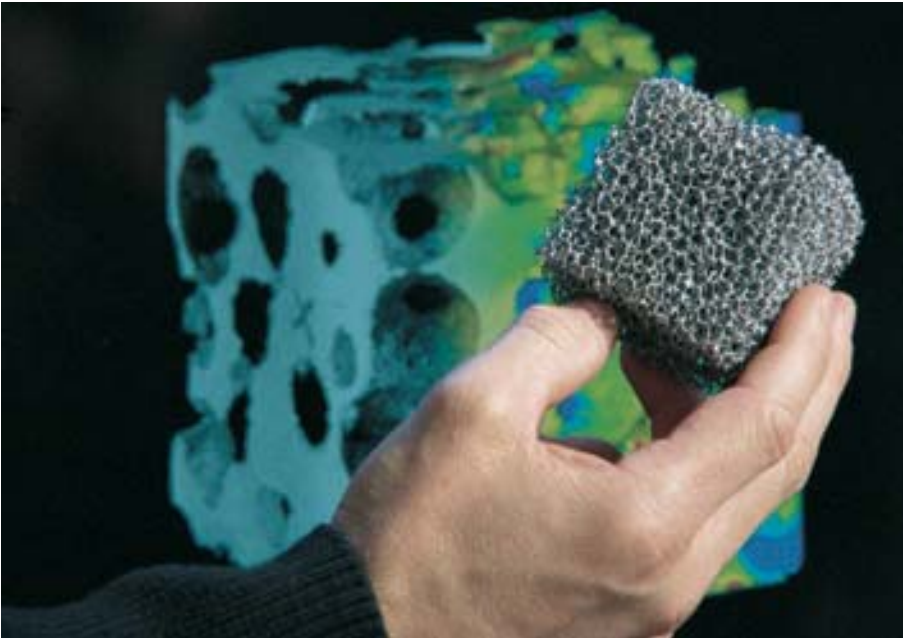
- |   |                    |                  |
|---|--------------------|------------------|
| • Start of the OLED Initiative organised by the Federal Ministry of Education and Research and German industry; interim audit of the Optical Technologies funding programme.  | BMBF               | Late 2006        |
| • New funding initiatives will be started under the Optical Technologies programme: Biophotonics III will target the development of new optical examination methods for the medical field. Volume Optics will help recapture lost mass markets and the Terahertz Technology funding initiative will be aimed at extending the usable range of the light spectrum. | BMBF               | Launch 2006/2007 |
| • The German government and industry will conduct a joint conference to bring together the different optical and photonics technologies in Germany and position them both internationally and among potential investors as technology drivers and a growth field for a successful cutting-edge sector.  | Federal government | 2008             |
| • Collaboration with the media and specially-developed instruction materials are to be used to increase children and adolescents' interest in optical technologies so that the shortage of skilled labour that threatens to develop over the long term can be prevented.  | BMBF               | Starting 2006    |

Please see page 107 for an explanation of the abbreviations used here.



## Materials technologies – New designs for matter

### New properties, greater material efficiency



Some 70 percent of all technical innovations hinge directly or indirectly on the properties of the materials they use. Material innovations can be used in practically all technology sectors and branches of industry: Starting with nanostructured – and therefore particularly scratchproof – paints in the automobile industry and extending to high-temperature-resistant metal alloys which increase the efficiency and lifespan of power plants, all the way to particularly light and tough fibre-reinforced plastics for use in, for instance, the new Airbus A 380. Material innovations have the potential to reduce environmental pollution (through, for example, the development of novel filter systems and gas separation membranes for power plants), save energy (through, for example, new thermal insulation materials), conserve resources (through, for example, the efficient, eco-efficient use of new materials), make mobility less dangerous (through, for example, the use of fibre composite plastics with adaptronic 'intelligent' properties in the automobile and aircraft industries) and improve the quality of life (through, for example, high-performance ceramics and new metal alloys in the medical technology field).

Materials-based industries in Germany – such as the automotive industry, mechanical engineering, the chemical industry, energy technology, electrical engineering industry, electronics industry and metal production and processing – generate combined annual turnover of nearly €1 trillion and employ approximately five million workers.

The German government aims to boost the competitive strength of important branches of German industry with the help of innovative materials technologies. Funding provided for materials technologies is also directed at improving the conditions for the environment and people's health. It is working to ensure the development of resource-efficient materials. It thus supports the so-called Factor Four approach – the visionary goal of producing twice as much with just half the resource input.

#### ■ Field of innovation

#### ■ Objective

**SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Strong materials science:</b> Good infra-structure in university and non-university institutes.</li> <li>• <b>Strong user industries:</b> For example: automotive industry, mechanical engineering, aerospace, chemical industry, steel industry, electrical engineering and electronics industries, energy technology as innovation drivers.</li> <li>• <b>Co-operation between science and industry:</b> Good interconnection achieved by collaborative projects funded by the Federal Ministry of Education and Research.</li> <li>• <b>Skilled labour:</b> High level of education and training.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Strengthen other sectors:</b> New materials can serve as technology drivers for those German sectors that are big exporters (automobile industry, chemical industry, tool-making, mechanical engineering, optics).</li> <li>• <b>Resource conservation:</b> Greater material and energy efficiency thanks to new materials, the broad use of resource-conserving processes in industry, and materials that are based on renewable resources.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Time-to-market:</b> In light of ever-shorter product cycles, development times are too long.</li> <li>• <b>Loss of value-added stages:</b> For example, LCD liquid crystals are developed and produced in Germany but LCD equipment such as flat screens and television sets are produced in Southeast Asia.</li> <li>• <b>Roadmaps for materials development:</b> Industry, science and the political sector's commitment to long-term scenarios is not very strong.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Loss of technology competence imminent:</b> The relocation of further value-added stages to other countries and the difficult financial markets for SMEs are placing Germany's innovative power at risk.</li> <li>• <b>High energy and material costs:</b> Maintaining competitive strength will require increasing the productivity of industrial processes while reducing energy and material consumption.</li> <li>• <b>Shortage of skilled labour:</b> Problems recruiting young people for the engineering sciences.</li> </ul>

**Areas of action**

**New platforms for materials development**

Materials research is highly interdisciplinary: It encompasses not only materials science, physics, chemistry and process engineering but also, depending on the area of application, life sciences and engineering sciences. Materials technologies are, by nature, platforms: A single material – when modified – has the potential for use in numerous applications. However, the use of this platform has changed in recent years: In the past, new materials were developed first and the search for applications for them followed (technology push). Today, users formulate a problem and then look for the best solution from a wealth of possible materials (market pull)

Which is why big industry – being systems developers – will develop in conjunction with its suppliers so-called materials roadmaps or technology roadmaps for the next ten to 15 years and continually update and adjust them in collaboration with research institutes. To support the formulation of these roadmaps, the German government plans to initiate a dialogue with the players involved. It will, at the same time, make strategic use of this dialogue by incorporating the roadmaps into its work to identify at an early point in time thematic fields for its calls for funding proposals.

## Speed up the development of new materials

Research funding will give centre stage to the following topics in coming years: Materials research is pursuing the visionary goal of designing materials, the technologies used to process them and the individual components properties entirely by computer. They can then thus be produced tailor-made for the respective application. This method promises to speed up development and shorten the time to market. In recent years, the nanosciences have gained fundamentally new insights for the materials research field which are opening the door to materials with entirely new properties. Examples of this include nonreflective properties in the glass used for photovoltaics, the self-cleaning properties of materials, and medical applications.

Materials are increasingly fulfilling several functions at the same time, something which in the past required a combination of different materials and components. The production and processing of highly-complex light-weight components with special structural and functional properties will be made possible primarily in the area of transport technology and mechanical engineering.

Microelectronics is running up against the limits of the materials in use today due to strides in miniaturisation and the increasing integration of functions. In the future, the materials used in microelectronics must fulfil entirely new requirements with regard to system security, cooling, screening and stability. For this reason, funding will be provided for the development of new highly-integrated, multifunctional electronics materials and for the development of electroactive and photocatalytic surfaces for components in the electrical engineering and electronics industries.

There are thermal, mechanical, chemical and electrical limits to what a material can withstand. Extending these limits is crucial to achieving efficiency gains in many industrial processes. For this reason, the limits restricting a material's performance are to be pushed back.

## Increase material efficiency

The cost of materials is – alongside the cost of labour – an important cost factor in industry. In the manufacturing sector, materials account for 40 to 50 percent of total production costs. There is considerable potential here for boosting efficiency – which could increase German industry's competitive strength and relieve stress on the environment at the same time.

For SMEs which have neither the requisite personnel means nor the financial means due to the demands of day-to-day business, the Federal Ministry of Economics and Technology has launched a funding programme to help identify and use their savings potential. This programme makes it possible for SMEs to receive the specialised consultation services so that they can increase their material efficiency to a profitable degree in the production or the use of their products.

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety will launch an action programme to increase resource productivity at macroeconomic level with the aim of recognising and putting to use so-called win-win situations that foster both environmental protection and innovation. Working together with the relevant players, this programme will identify areas with potential for greater efficiency and develop concrete measures for using this potential.

The German government's long-term goal is to establish a closed substance cycle system based on the model provided by nature. The recovery of residential waste is to be developed to such a point that by the year 2020 the surface storage of this type of waste will largely be unnecessary. National-level provisions governing landfill sites (Ordinance on Environmentally Compatible Storage of Waste from Human Settlements and on Biological Waste-Treatment Facilities, Ordinance on Landfills and Long-Term Storage Facilities, Ordinance Pertaining to the Recovery of Waste at Surface Landfills and accompanying administrative regulations) are to be bundled into one ordinance. This ordinance will incorporate more recent findings and provide additional impetus for developing the state of waste technology. Furthermore, federal legislation is being drafted to regulate the requirements for recycling mineral waste in connection with backfilling measures and their use for technical purposes.

### Establish norms and standards for materials

Norms and standards are an indispensable prerequisite for evaluating materials. German research institutes contribute their prenormative research findings to international and national bodies which set norms and standards. In its capacity as part of the federal administration, the Federal Institute for Materials Research and Testing (BAM) is intensively involved in ascertaining the best available technology and takes part in associated standardisation projects. Norms and standards have not been established to date for many new materials such as cellular materials, foams and nanomaterials. National and international bodies have however recognised the need for action and are already working on this.

#### Individual research and innovation policy initiatives 2006 – 2009

• Roadmaps for materials will be developed to co-ordinate the R&D efforts of science and industry with one another.	BMBF	Starting 2007
• The Material Innovations for Industry and Society programme will launch funding initiatives for the virtual development of materials, light-weight design with integrated functions, and the development of new electronics materials, materials with greater capacity to withstand strain at the margins of their limits, and nanomaterials.	BMBF	Launch 2006–2008
• The Renewable Resources funding programme will assist research and development work on materials made from renewable resources; new priorities.	BMELV	2006
• The Programme for Advising Small and Medium-Sized Enterprises on Profitably Improving Their Material Efficiency (VerMAT) will be extended. In addition, the Programme to Foster Networks for the Profitable Improvement of Material Efficiency Primarily in Small and Medium-Sized Enterprises (NeMat) is being launched to boost material efficiency in the industrial sector.	BMWi	2006
• The German government supports the continued development of the EU Waste Directive and will bundle various federal regulations regarding landfills into a single ordinance in order to move closer to the goal of a closed substance cycle waste management system.	BMU	2006/2007

*Please see page 107 for an explanation of the abbreviations used here.*

## Production technologies – Outfitting the global economy

### Mechanical engineering and plant manufacturing "Made in Germany"



The "Made in Germany" mark of quality has a long tradition in Germany's mechanical engineering and plant manufacturing sector. German engineering enjoys an excellent reputation around the world. Every year, scores of researchers develop new manufacturing technologies, production systems and innovative, production-related services. It is this interaction between long-standing tradition, mastery of new technologies, strong production research and a diversified industrial base that constitutes this sector's special strength.

The some 6,000 primarily small and medium-sized businesses in the German mechanical engineering and plant manufacturing sector provide jobs for approximately 860,000 workers. Over the last two years, sector turnover have continuously grown by five percent a year to currently approximately €150 billion. Demand is growing the world over for technical solutions and processes that merge productivity with industrial safety, and environmental and resource conservation. Germany established stringent standards early on and, in the process, stimulated innovation. Today, this is proving to be a strategic competitive advantage.

The German government aims to ensure that German industry remains the global market leader in production machinery, plants and components. Germany is to be the main market for innovative production technology in the future as well because this is also the basis for competitive production at home and for a successful export sector. In this connection, intelligent concepts and innovative technology are to be developed through the team efforts of production researchers, manufacturers and users. The German government aims to improve the interconnection among the players and is creating platforms to stimulate the development of joint, long-term innovation paths.

#### ■ Field of innovation

#### ■ Objective

**SWOT analysis**

Strengths	Opportunities
<ul style="list-style-type: none"> <li>• <b>Healthy sector:</b> Large number of small and medium-sized businesses with stable annual growth rates, many owner-operated firms, long tradition, active trade associations and strong loyalty to location.</li> <li>• <b>Global leadership:</b> Export rate +70 percent, share of global trade 18.3 percent (placing Germany ahead of Japan with 12.7 percent and the USA with 12.6 percent), 28 percent of the world's mechanical engineering patents.</li> <li>• <b>Good networking between science and industry:</b> Contract, collaborative and industrial research, active personnel exchange.</li> <li>• <b>Level of education:</b> Well-training skilled workers, master craftsmen and university graduates.</li> <li>• <b>R&amp;D commitment:</b> Above-average investment in research and development.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Technology leadership:</b> Enormous potential for innovation thanks to the constant implementation of new technology findings in production equipment and facilities.</li> <li>• <b>Strengthen strengths:</b> Excellent foundation thanks to outstanding competitive position and the good image that machinery and plants that are "Made in Germany" enjoy.</li> <li>• <b>Comprehensive approach to efficiency:</b> Increasing demands being placed on production systems worldwide (productivity, safety, environmental compatibility).</li> <li>• <b>High-powered domestic market:</b> Production of cutting-edge technologies with long-established manufacturer-user relations in combination with high wages and high training levels in the industrial sector.</li> <li>• <b>Become a problem-solver:</b> Offer services for products / hybrid products.</li> </ul>
Weaknesses	Threats
<ul style="list-style-type: none"> <li>• <b>Domestic demand:</b> There has been little propensity to invest for a long time now in Germany.</li> <li>• <b>Financial strength and earning power:</b> Utilising existing innovation potential has been made more difficult by the low profits and equity ratios of many SMEs in the mechanical engineering sector.</li> <li>• <b>Decline in esteem:</b> Production's importance as the basis for value added and Germany's prosperity is no longer undisputed.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Product piracy:</b> Massive infringements of intellectual property rights.</li> <li>• <b>Relocation of production to other countries:</b> Risk that value-added chains can no longer be completely covered in Germany and also that development, design and logistics tasks move abroad.</li> <li>• <b>Recruitment problems:</b> Increasingly tough competition in combination with a prolonged shortage of skilled labour is making it difficult, particularly for SMEs, to recruit new personnel.</li> </ul>

## Nanotechnology goes into production

### ■ Areas of action

One of the reasons why the German mechanical engineering and plant manufacturing sector is so internationally competitive today is because it recognised and put to use the possibilities offered by information and communications technologies and laser technology at an early stage. And now nanotechnologies are opening up new opportunities. For this reason, Nanotechnology Goes into Production has been made a new funding priority in the Research for Production of the Future programme being conducted by the Federal Ministry of Education and Research.

This ministry is funding partnership-based co-operation between research institutes and industrial enterprises in collaborative R&D projects with the aim of speeding up the transfer of laboratory findings to industrial use. Approximately two-thirds of the funding for such activities go to firms, with more than 60 percent of these firms being SMEs and some 12 percent of them less than five years old. Since customers increasingly want not only products but also the attendant services, the Federal Ministry of Education and Research recently launched its Integration of Production and Services research initiative.

In addition, the small and medium-sized businesses that make up most of the mechanical engineering and plant manufacturing sector can especially benefit from new financing instruments and the expansion of the Federal Ministry of Economics and Technology's programmes for SMEs and funding for co-operative industrial research.

## Put a stop to product piracy

Approximately two-thirds of the companies in the capital goods industry are victims of product piracy or trademark counterfeiting. In the case of some 43 percent of the companies affected, entire machines have been illegally copied. These counterfeit products are made chiefly in Asia (70 percent) – foremostly in China – where they are also primarily marketed. However, goods that infringe intellectual property rights are also being produced in Europe and the USA.

For this reason, the development of ways for the German capital goods industry to better protect itself against product piracy is a funding priority in the Research for Production of the Future programme being conducted by the Federal Ministry of Education and Research. These efforts are aimed at establishing Germany as the worldwide technology leader in the copy protection field such as product authentication at the time of manufacture (using, for example, holograms, laser techniques, chemical or RFID methods) or through a method that is incorporated into the actual production process as part of the design and production phase (for example, the targeted development of copy-protected key components). This technical approach is closely connected with the German government's efforts to improve the recognition and enforcement of intellectual property rights.

## Unleash the innovative powers in SMEs and family-operated firms

An adequate and secure equity capital base – not least of all in light of the imminent transfer of many companies expected to take place in the coming years as a result of inheritances – and a reduction in administrative burdens are important prerequisites for being able to fully develop the innovation potential to be found in small and medium-sized, often family-operated plant and equipment makers. For this reason, the overhaul of Germany's corporate and inheritance tax legislation that the federal government targets as well as the measures already initiated to trim bureaucracy are especially important for the mechanical engineering and plant manufacturing sector.

## Make mechanical engineering jobs more attractive

Innovation in the production technologies field is particularly dependent on technical training. Given that the number of trained workers is on the decline due to current demographic trends, small and medium-sized companies will find it difficult to recruit qualified personnel for developing and operating production systems when they have to compete with large corporations and attractive jobs in the services sector. Due in no small part to this situation, this supposedly male domain must be made more attractive for women as well.

Small and medium-sized enterprises collaborate primarily with universities of applied sciences which in turn train two-thirds of all engineers in Germany. In light of this, the German government aims to improve – in both quantitative and qualitative terms – the interlinking of research and instruction at universities of applied sciences through its new Research at Universities of Applied Sciences and Enterprises funding programme and the funding it plans to provide starting the autumn of 2007 for young research groups working in the engineering sciences.

The changes that industrial production has seen in technology and in the way work is organised call for occupational skills which – above and beyond manual dexterity – increasingly entail the ability to flexibly recognise practical and suitable ways to reach solutions. For this reason, the Federal Ministry of Education and Research is using the current evaluation of the training regulations for the occupation Industrial Master Craftsman in Metal to examine whether and which adjustments might be necessary. In addition, it is being examined whether changing skill requirements necessitate a new Production Technologist occupational profile that could also make employment in the production field more attractive.

**Position Germany in Europe**

As part of the European technology platform ManuFuture, a group of high-ranking experts from science and industry is developing new research and innovation strategies and other important themes for the European Union's Seventh Research Framework Programme. These strategies will help ensure that Europe continues to be a dynamic and competitive location for production operations in the future as well. The European debate will be conducted at national level with the help of the ManuFuture Deutschland platform which was set up in September 2005 with the participation of the Federal Ministry of Education and Research and the Federal Ministry of Economics and Technology. All the important players will thus be brought together, sector-specific dialogues conducted with industry, and research questions bundled with an eye to the European level.

Individual research and innovation policy initiatives 2006 – 2009		
• Nanotechnology Goes into Production will be a new funding priority in the Research for Production of the Future programme.	BMBF	Starting 2006
• The German government will fund research into ways to protect enterprises against product piracy. It is also working toward worldwide technology leadership in the copy protection field and supports the enforcement of existing intellectual property rights.	BMBF, BMWi, BMJ	Starting 2006
• Measures to foster and fund teams of young researchers working in the engineering sciences at universities of applied sciences will help counteract the shortage of young scientists.	BMBF	Starting 2007
• The corporate tax reform will strengthen companies' equity capital base. Adjustments in Germany's inheritance tax regulations will particularly help owner-operated businesses in this connection.	BMF, BMWi	2007/2008

*Please see page 107 for an explanation of the abbreviations used here.*





## IV. Our implementation of the High-Tech Strategy

With its High-Tech Strategy, the German government is kicking off a process for the entire legislative period. This process will be both long-term and involve all ministries. A wealth of new programmes will be launched during the first year. A list of the government's key initiatives in the coming 12 months can be found at the end of this section.

The German government plans to invest some €14.6 billion in its High-Tech Strategy in the years 2006 through 2009. Some €12 billion of this amount will be earmarked for research and the dissemination of new technologies in 17 high-tech sectors. Another €2.7 billion will go to important, technology-spanning, cross-cutting measures. Expenditure for basic funding for institutions and the Joint Initiative for Research and Innovation will total some €14 billion. Due to statistical constraints, this spending can be broken down by individual high-tech sector only in a few cases.

The process for the further implementation of the High-Tech Strategy is to be organised by all relevant forces for innovation in industry, science and the political sector. To support this work, the German government has set up two platforms to establish and expand an ongoing dialogue between all parties involved. Co-operation between all players with responsibility for innovation work is particularly important for the success of the High-Tech Strategy.

Brought into being by Federal Minister of Education and Research Dr. Annette Schavan and composed of representatives from the industrial and science sectors, the Industry-Science Research Alliance on the Technology Prospects of Markets of the Future will provide flanking support for the implementation and continued development of the High-Tech Strategy. This will entail advising on the strategic elaboration of the concrete cross-cutting measures as well as drafting recommendations for individual fields for innovation work with the help of the relevant ministries. This will be done in close co-operation with high-ranking specialist bodies (such as the Energy Summit and the IT Summit). Working as personal promoters, members of the Industry-Science Research Alliance will push forward selected thematic areas in the High-Tech Strategy. These efforts will aim to identify and close any gaps in the respective value-added chains.

As the advisory body to the chancellor, the Council for Innovation and Growth will concentrate on overarching problems and issues. It will generate impetus for a more innovation-friendly climate in society in general, for improving the conditions for innovations produced by smaller and medium-sized businesses, and for dismantling obstacles encountered in translating ideas

into new products and processes. Four working groups have already taken up their work in this connection.

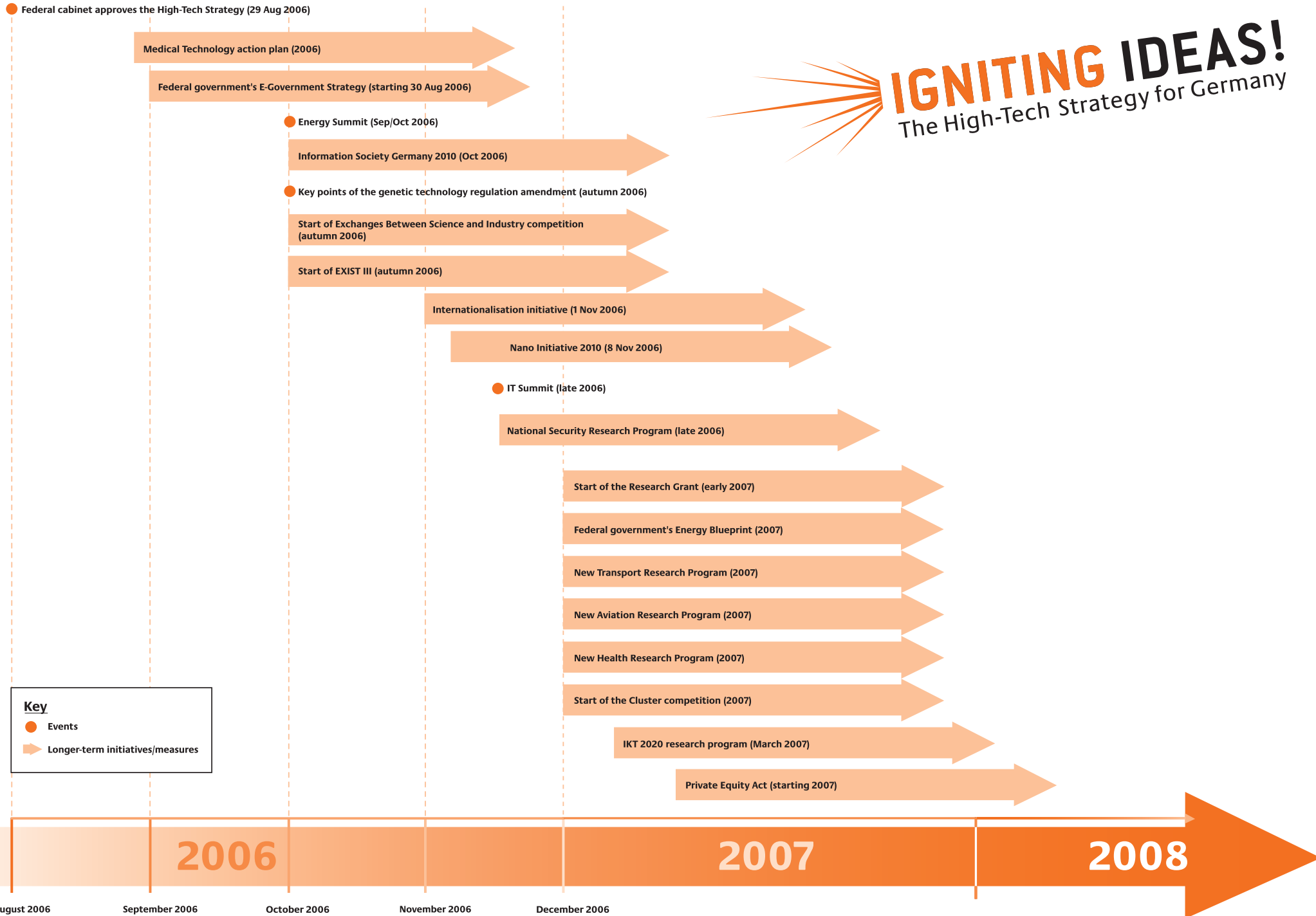
The implementation of the High-Tech Strategy will be reviewed on a regular basis. The German government will conduct an initial review and report on progress achieved to date in September 2007. Starting in 2008, the Federal Government Report on Research and Innovation will document the progress being made.

#### Funding for the High-Tech Strategy 2006 – 2009 (millions of €)

<b>17 High-tech sectors</b>	<b>11,940</b>
<b>Nanotechnologies</b>	640
<b>Biotechnology</b>	430
<b>Microsystems technology</b>	220
<b>Optical technologies</b>	310
<b>Materials technologies</b>	420
<b>Space technologies</b>	3,650
<b>Information and communications technologies</b>	1,180
<b>Production technologies</b>	250
<b>Energy technologies</b>	2,000
<b>Environmental technologies</b>	420
<b>Automotive and traffic technologies</b>	770
<b>Aviation and aeronautical technologies</b>	270
<b>Maritime technologies</b>	150
<b>Health research and medical technology</b>	800
<b>Plants</b>	300
<b>Security research</b>	80
<b>Services</b>	50
<b>Cross-technology measures (selection)</b>	<b>2,660</b>
<b>Bundle the forces of science and industry:</b> Research grants, cluster competition, Exchanges Between Science and Industry competition, Entrepreneurial Regions, Science Meets Industry competition	600
<b>Improve conditions for innovative SMEs:</b> Non-thematic innovation funding for SMEs (PRO INNO, IGF, INNO-WATT, Innonet, NEMO, ERP innovation programme)	1,840
<b>Support technology start-ups:</b> High-Tech Gründerfonds seed fund, the EXIST University-Based Start-Ups programme, best practice models in non-university research organisations	220
<b>For information:</b> Funding for institutional research/ Joint Initiative for Research and Innovation	14,000
Due to statistical constraints, funding for institutional research can be broken down by individual high-tech sector only in a few cases.	

# Milestone plan for the High-Tech Strategy

**IGNITING IDEAS!**  
The High-Tech Strategy for Germany



## Glossary

AA	Auswärtiges Amt / Federal Foreign Office
AAL	Ambient Assisted Living
AiF	Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von Guericke" e. V. / "Otto von Guericke" Federation of Industrial Co-operative Research Associations
BAM	Bundesanstalt für Materialforschung / Federal Office for Material Research and Testing
BAuA	Bundesanstalt für Arbeitsschutz und Arbeitsmedizin / Federal Institute for Occupational Safety and Health (FIOSH)
BBK	Bundesamt für Bevölkerungsschutz und Katastrophenhilfe / Federal Agency for Civil Defense and Disaster Relief
BfArM	Bundesinstitut für Arzneimittel und Medizinprodukte / Federal Institute for Drugs and Medical Devices
BMAS	Bundesministerium für Arbeit und Soziales / Federal Ministry of Labour and Social Affairs
BMBF	Bundesministerium für Bildung und Forschung / Federal Ministry of Education and Research
BMELV	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz / Federal Ministry of
BMJ	Bundesministerium der Justiz / Federal Ministry of Justice
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit / Federal Ministry for the Environment, Nature Conservation and Reactor Safety
BMVBS	Bundesministerium für Verkehr, Bau und Stadtentwicklung / Federal Ministry of Transport, Building and Urban Affairs
BMWi	Bundesministerium für Wirtschaft und Technologie / Federal Ministry of Economics and Technology
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung / Federal Ministry for Economic Co-operation and Development
BSI	Bundesamt für Sicherheit in der Informationstechnik / Federal Agency for Information Technology Security
BtL	Biomass to Liquid
CDM	Clean Development Mechanism
CEN	Comité Européen de Normalisation / European Committee for Standardization
CH <sub>4</sub>	Methane
CNS	Computational neuroscience
CO <sub>2</sub>	Carbon dioxide
CO <sub>2</sub> /km	Carbon dioxide per kilometer
COORETEC	Initiative and research programme on CO <sub>2</sub> reduction technologies in fossil fuel-fired power plants
DEUFRAKO	Franco-German co-operation in the area of traffic research
DFG	Deutsche Forschungsgemeinschaft e. V. / German Research Foundation
DIN	Deutsches Institut für Normung e. V. / German Institute for Standardization
DLR	Deutsches Zentrum für Luft- und Raumfahrt e. V. / German Aerospace Centre
DRM	Digital rights management
EDL-RL	Energiedienstleistungsrichtlinie / Directive on energy end-use efficiency and energy services
EC	European Community
EnMAP	Environmental Mapping and Analysis Programme
EPLA	European Patent Litigation Agreement

EPOSS	European Technology Platform on Smart Systems Integration
ERA-NET	European Research Area Network
ERASPOT	European Research Area Strengthening Photonics and Optical Technology for Europe
ESA	European Space Agency
EU	European Union
EURATOM	European Atomic Energy Community
EUREKA	Initiative for intensified technological co-operation in Europe which offers science and industry and framework for cross-border collaborative projects
EUROCONTROL	European Organisation for the Safety of Air Navigation
EXIST	EXIST University-Based Start-Ups programme
FGAN	Forschungsgesellschaft für Angewandte Naturwissenschaften e. V. / Research Establishment for Applied Science
FhG	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e. V. / Fraunhofer Society
FNR	Fachagentur Nachwachsende Rohstoffe e.V. / Agency of Renewable Resources
Galileo	European satellite navigation system
GDP	Gross domestic product
GIF	German-Israeli Foundation for Scientific Research and Development
GMES	Global Monitoring for Environment and Security
GO-Bio	Biotech start-up campaign conducted by the Federal Ministry of Education and Research
GSOC	German Space Operations Center
GxP	Good x Practice guidelines
HCI	Human-Computer-Interaction
HGF	Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren e. V. / Helmholtz Association of German Research Centres
iD2010	Informationsgesellschaft Deutschland 2010 / Information Society Germany 2010
IEA	International Energy Agency
IFMIF	International Fusion Materials Irradiation Facility
IGF	Industrielle Gemeinschaftsforschung / Industrial co-operative research for small and medium-sized enterprises
ICT	Information and communications technologies
IMO	International Maritime Organization
INNOMAN	Innovation Management funding programme
InnoNet	Funding for Innovative Networks programme
INNO-WATT	Funding for Innovative Growth Drivers programme
INQA	Initiative Neue Qualität der Arbeit / New Quality of Work Initiative
ISO	International Organization for Standardization
ISS	International Space Station
IT	Information technology
ITER	International Thermonuclear Experimental Reactor
I&C	Information and communications technology
IWG	Informationsweiterverwendungsgesetz / Act on the Re-use of Information
IWRM	Integrated water resources management
JI	Joint implementation (of emission reduction targets)
KfW	Kreditanstalt für Wiederaufbau / bank for reconstruction and development
KWh/m <sup>2</sup> a	Kilowatt hours per square meter and year
LCD	Liquid crystal display
LED	Light emitting diode
MPG	Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. / Max Planck Society for the Advancement of Science

MST	Microsystems technology
MW	Megawatt
NEMO	Network Management for Eastern Germany funding programme
NPSI	National Plan for the Protection of Information Infrastructures
OECD	Organisation for Economic Co-operation and Development
OLED	Organic Light Emitting Diode
PPP	Public-Private-Partnership
PRO INNO/ PRO INNO II	Programme to foster the innovative capacity of small and medium-sized enterprises
QUAERO	Collaborative Franco-German project to develop new technologies for automated searching for and processing of ICT data
R&D	Research and development
RFID	Radio Frequency Identification
RoRo ships	Roll-on-roll-off ships
ServLab Project	From the Idea to Success Service – Service Laboratory
SME	Small and medium-sized enterprise
SWOT	Strengths-Weaknesses-Opportunities-Threats analysis
TanDEM-X	National Earth Observation Mission
TerraSAR-X	National Earth Observation Mission
TKG	Telekommunikationsgesetz / Telecommunications Act
TMG	Telemediengesetz / Telemedia Act
TOP	Technology-oriented visitors and information programme
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UBA	Umweltbundesamt / Federal Environmental Agency
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
UK	United Kingdom
VCs	Venture capitalists
PR China	People's Republic of China
WGL	Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e.V. / Gottfried Wilhelm Leibniz Science Association
WIPO	World Intellectual Property Organization
WTO	World Trade Organization
ZUTECH	Future Technologies for Small and Medium-Sized Enterprises programme



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