BOX 09

The Hightech Strategy of the German federal government – a new approach

In August 2006, the German federal government introduced a new approach to the integration of innovation support across all federal ministries. The Hightech Strategy adopts a completely new orientation for R&I policies. Particular attention is paid to the mastery of complex technological systems and the orientation to markets. The goal is to maintain and extend Germany's position in international innovation competition.

The Hightech Strategy defines five cross-sectional activities, namely science-business cooperation, new enterprises, dissemination, international cooperation, and human resource formation. At the centre of the efforts are 17 fields of innovation: Health and medicine, security, plants, energy, environment, information and communications, traffic and transport, aeronautics, astronautics, optics, materials, production, maritime technologies, services, nanotechnologies, biotechnologies, and microsystems engineering.

The strategy focuses on selected fields of innovation. A key element is the inter-departmental formulation of R&I policies, the increased market orientation of R&I and a concentration on the optimisation of the framework conditions. Responsible for the Hightech Strategy in the Federal Government is the Federal Ministry of Education and Research.

onal comparison shows that Germany's expenditure of 1.1 per cent of gross domestic product (GDP) for tertiary sector education is very low. In particular only about 0.1 per cent of this is attributable to private expenditure. The comparison with the USA is instructive: public expenditure for this sector is 1.0 per cent, but the private figure is 1.9 per cent, giving a total of 2.9 per cent. And in Korea out of a total of 2.3 per cent, public expenditure is 0.5 per cent and the private contribution 1.8 per cent.[47] Politicians should find ways to establish new forms of financing in Germany, in particular through more foundations. Enterprises must also participate more, because they have a high benefit from the development of student human resources.

IMPULSES FOR THE HIGHTECH STRATEGY C 5

Strengthening cooperation between government departments

With a complicated federal research and innovation system, it is not always easy to adapt to the dynamics of EU developments and globalisation. Therefore there are some coordination problems in Germany which need to be addressed by policy makers. The intention of political and business forces to make a bold step towards strategic renewal often comes up against a reality of narrow perspectives and institutional fragmentation.[48] Innovation topics have frequently had a hard time finding a platform, and there are no links between disparate forums such as research policy, health, traffic and transport, or agriculture. For the first time, the Hightech Strategy addresses a range of fields with its R&I measures. However, this requires improved coordination between the departments of the German federal government and the *laender*, for which only the first steps have been made.[49] In addition, increased harmonisation is needed at the level of the European Union.

More focus with the Hightech Strategy

As a result of the specific situation in Germany after World War II, the state aid policies of the federal government have taken a different course from those in many other western industrialised countries. There was an initial core of institutional promotion, and various new support instruments were added over time without completely removing the existing ones.[50]

The innovation policies in the USA and in many other countries are generally mission-oriented.[51] State aid is provided with the aim of achieving an ambitious goal. In contrast, the

German model has in the past involved a broad approach. Under the subsidiarity principle, any high quality research and development task deserves state support if it would not come about only through the self-regulated cooperation of the actors involved. Germany is one of the largest economies in the world, and has grown further through the unification of east and west, so that such a broad approach was justifiable, in contrast to the niche strategies adopted by smaller economies, such as the Scandinavian countries.

Against this background, the Hightech Strategy represents a change in policy. It attempts to adopt a selective approach and to concentrate the state aid on selected technologies and cross-sectional measures and thus to address sectoral innovation systems. However, we are not sure whether this can lead to the desired effects as long as the promotion priorities are selected on the basis of the specific innovations strategies. The optimum balance between focussing and a broad orientation requires further discussion.

Strategic further development of the Hightech Strategy

Concerning the further development of the Hightech Strategy, the question is how to make a systematic and well-founded choice of future-oriented topics. Here it is important to consider how the sectoral innovation systems on which the Hightech Strategy is based, and the targeted intermeshing of business and science in Germany, can be brought into effect at the EU level. The Hightech Strategy also involves contributions to the European Space Agency (ESA), aeronautics research, and other projects such as the Galileo positioning system. The topics agreed at EU level have noticeably large budgets.[52]

Forecasting methods for the further development of the Hightech strategy

German R&I policy-developers have been using various instruments of technology forecasting for more than 15 years, and in comparison with other European countries and the USA they have gained considerable experience. In the Foresight Process started in 2007 by BMBF, progress is being made on additional new instruments of technology forecasting, in particular in order to address broad topics and integrate these in a formal evaluation, and a wide range of methods have been implemented. However, it is not apparent how these appropriate and comprehensive forecasting activities are being coordinated with the other federal government departments involved in the Hightech Strategy, for example with some sort of road map. A systematic further development of the Hightech Strategy on the basis of such processes requires that all the departments should be actively involved.

We recommend employing an appropriate mix of technology forecasting instruments for the further development of the Hightech Strategy. It should be taken into account that this process will have to be inter-departmental. In addition, it is necessary to examine how viable and comprehensive the available methods of future research are, how much time they require and how inter-departmental evaluation problems can be resolved. The use of these methods allows actors in politics, business and society to see the criteria by which the next stages of the Hightech Strategy are chosen. We expect that this will result in private actors being more willing to participate financially in the Hightech Strategy programmes.

The budget of the Hightech Strategy

The Hightech Strategy has made it possible to boost the state funds for R&D considerably. Initial surveys[53] show than a satisfyingly large proportion of German companies are now aware of the Hightech Strategy. In addition, the companies surveyed said that they also

BOX 10

Innovative services

Services may be defined in terms of their immaterial nature in comparison with material goods or nominal goods (finances), or their transience (cannot be stored). The customer (individuals, companies, government) is also involved in the provision of the services, so that standardisation is difficult, e.g. the quality of a training course will depend on the activity of the individual participants.

It has therefore become usual either to list certain sectors which are included in the tertiary sector of services, or as a negative definition to include all sectors which do not belong to manufacturing industry, agriculture, or mining. These lists of sectors can vary considerably (wholesale and retail, transport, banking, insurance, computers, technical and commercial services, accommodation, education and training, health, culture, sport, entertainment, leisure, state activities, etc.).

'Services accompanying material goods' are defined as immaterial performances offered to customers or marketed by a manufacturer in additional to the material product. These services are related to the product and its innovative technology and are also traded on the market, with the innovative services being consumed at the time of the completion.

Depending on the sources, the definition of services differs. Innovative services are knowledge-intensive (see comments on 'Schumpeter Goods' Box 03).

wanted to increase their R&D expenditure, on average by seven per cent.[54] Germany would seem to be mobilising its innovative potential. However, the Hightech Strategy still seems to depend on vague budget projections for the cross sectional activities and specific innovation strategies. Of course, it was necessary at the start of the Hightech Strategy to draw on relatively crude budget figures, especially since these had to be drawn from the differing reporting systems of the federal government departments involved. But it is surprising that more precise details are not provided in the first progress report.[55] It is very important to be transparent about the extent of additional funding. Only in this way is it possible to demonstrate to the public and those directly involved how serious and ambitious the Hightech Strategy is.[56] Another very significant aspect is that it can act as a potential signal for companies which are not yet active in Germany.

EFI sees an urgent need to make public details of the budget, in order to show the past achievements and to continue these and spread them further.

Improving the services orientation

The value added by the knowledge-intensive services exceeds that of the R&D-intensive goods by nearly 14 per cent. Knowledge-intensive services meanwhile account for more than 30 per cent of value creation.[57] The services economy of the future will not replace the production of goods and in particular will not replace the production of 'Schumpeter goods'. Germany is specialised to a considerable extent in services which accompany material goods, as has been shown in earlier reports on technological capability.[58] This can be demonstrated by some examples. Environmental considerations have led to much longer working lives for products. But this means that production and disposal are being substituted for, in part, by a higher services input (repairs, spare parts, maintenance, etc.). Product-related services which extend the working life are a precondition and also a consequence of a life-cycle approach. Even imported products with a high portion of value creation gradually become domestic products as a result of the services, with important positive consequences for local employment. These ideas deserve due consideration in the course of the further development of the Hightech Strategy.

Although international comparative statistics seem to show that Germany is lagging behind in the provision of services, this could be a statistical artefact. We will return to this

in one of our future reports and recommend that more research is carried out into innovative services in general.

Currently, the Hightech Strategy is clearly oriented towards technological developments which lead to improved R&D-intensive products. A strategic orientation towards the further development of innovative services is proposed. We urge that this is integrated in the Hightech Strategy.

The innovative products of the processing industries also involve services to an increasing extent, and in an age of global communications these contribute to the success of German exports. It is no longer possible to treat services as a residual sector of commercial activity, because they have key function for future productive activities and employment. There is considerable need for action here, because as far as we can see the Hightech Strategy has hardly addressed this development so far.

The mobilisation for targeted innovation processes by the Hightech Strategy is particularly difficult as far as services are concerned. Novel developments in the services sector have the character of process or organisational innovations and are characterised by relatively low technology intensity. In contrast, a considerable role is played by the acquisition of knowledge, which is hard to quantify, the 'absorption capacity', and the use of the existing stock of knowledge. Providing loans for innovative services is particularly difficult; these financing problems can act as a major constraint on the innovation dynamics of service providers. The intellectual property rights situation is complex and possibly represents a further constraint.

Focusing sustainability strategies

The Environment-Climate-Sustainability complex represents a crucial global problem field to which the German federal government attaches considerable importance. Within the Hightech Strategy, four of 17 innovation fields are directly related to this complex. It seems to us that the Hightech Strategy is still seeking its way here; it has not yet defined a coherent, inter-departmental strategy. In addition to the original formulation of the Hightech Strategy from 2006 and the progress report in 2007, there have been a range of other statements.[59] There is a need for consolidation.

Focusing solely on 'climate' would not lead to the desired goal. The German federal government quite rightly presents global climate change as a key problem faced by the world. But the avoidance of intolerable climate changes and the management of unavoidable ones have to be placed in the wider context of sustainability. We recommend that the Hightech Strategy should focus on 'Innovations for sustainable economic activity'. This would be close to the topic originally chosen in the Hightech Strategy 2006.

Priorities within the sector of innovations for sustainable economic activity

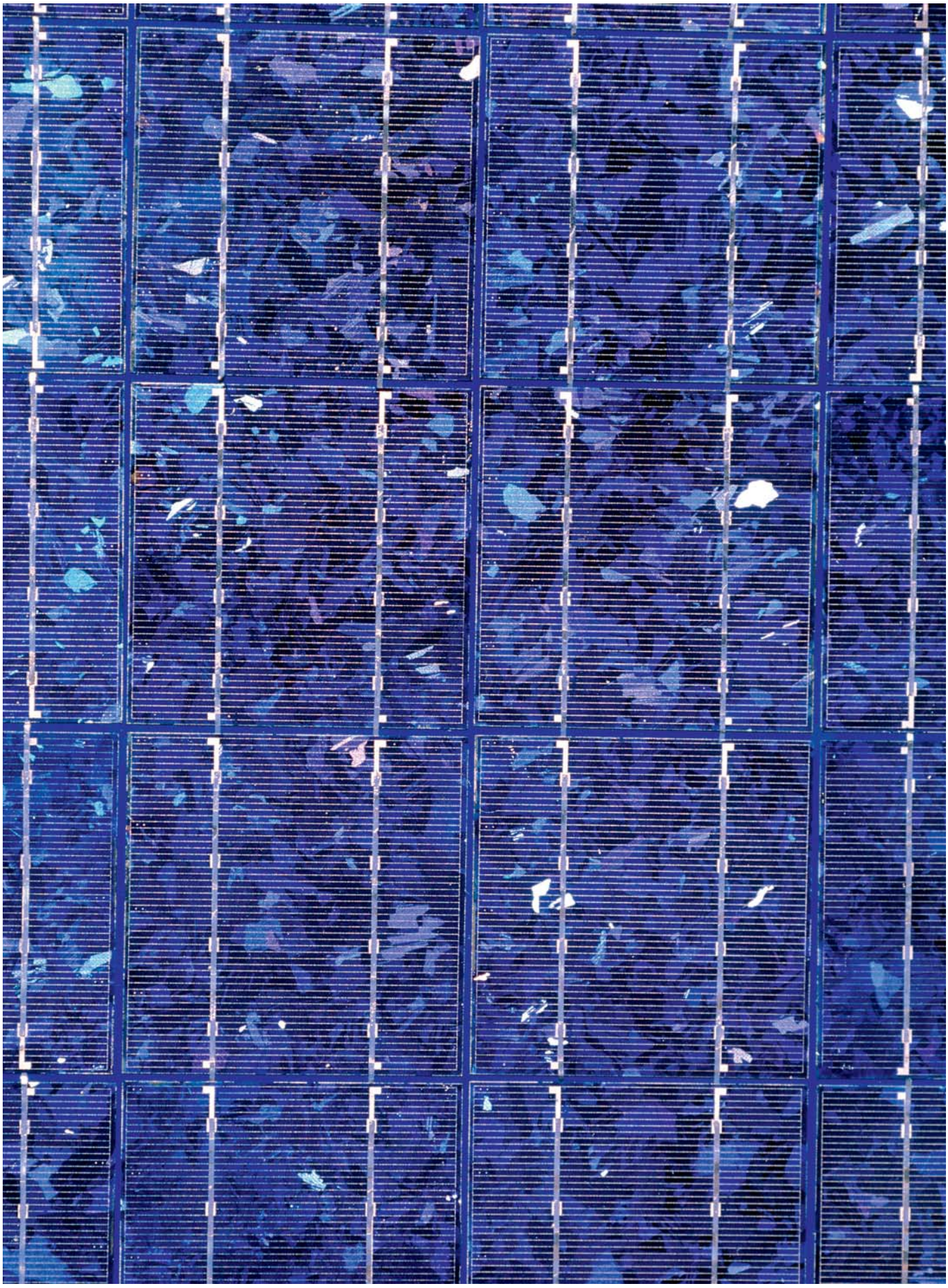
The proposed priority for the Hightech Strategy includes the climate as a topic, but from the point of view of the promotion of high-technology it is more comprehensive and probably also more effective. We propose that this sector should be sub-divided in the sub-sectors sustainable sources of energy, environmental technologies, sustainable production, and resource efficiency, as well as climate research. We feel that such structuring – which is fully in accordance with the Hightech Strategy – can lead to an increased goal orientation and can activate various synergies between the federal ministries. On the basis of its current strength in this sector, Germany also has excellent opportunities to develop relevant technologies and services for the global market.

Some examples of the technological opportunities in the four sub-sectors are provided in Table 02. German producers already have a strong position in these fields of technology on international markets and there is considerable potential for further innovations in these fields.

Most of these research and development topics were referred to in the original Hightech Strategy of 2006 at various places. We would like to make a comprehensive and focused proposal.

Goal-oriented strategies

Establishing priorities in the field of innovations for sustainable economic activity has the goal of ensuring the sustainable economic activity in industrialised countries, and also of promoting innovations for the maintenance and improvement of welfare in Germany.



Photovoltaic cells

Mangroves in the Ganges delta

The examples of innovative technological development given in the first progress report of the Hightech Strategy are impressive. The integration of the Research Union and the orientation to the topics of interests to business companies have contributed to the success of the Hightech Strategy. However, the emphasis is currently on relatively short-term commercial interests.

We think that it is important to establish 'Roadmaps' for the development of technology within the framework of the Hightech Strategy, with targets which would allow progress to be evaluated. Such roadmaps have proved their value for the coordination and control of innovation processes. We recognise that the extent of activated R&D expenditure is an important parameter for the success of the Hightech Strategy. With the aid of detailed roadmaps it would be possible to judge the success of the Hightech Strategy better, in particular in the long-term innovative fields.

Developing lead markets

A number German companies involved in generating power from renewable sources of energy (photovoltaics, wind energy) have been able to generate a lead market in Germany due to the market conditions provided there. A considerable contribution to the development of the technology has come from newly-founded enterprises. An important role in the development of the lead market was played by the Renewable Sources of Energy Act (EEG), which has created stable demand conditions in selected areas of technology. Of course this has also brought macroeconomic costs with it.[60] But to some extent Germany is currently technology leader in the fields of photovoltaics (solar cells) and wind power generation. There is a good chance that the Hightech Strategy will enable Germany to maintain or improve its position with regard to these products.

Improving the coordination of R&I responsibilities

Despite coordination, the responsibilities of two or more federal ministries can sometimes overlap, and they all find themselves involved in the supervision of aspects of the same field of technology. A certain level of political competition between individual departments may not be a bad thing. However, R&I policies are too fragmented in broad areas of energy research – in particular with regard to sustainable technologies. There is potential here for optimisation with respect to transparency, rapidity and efficiency.

Promising fields of technology for sustainable economic activity TAB 02

Sustainable power supplies
Increasing efficiency in the generation, transports and use of energy
Using regenerative sources of energy, including biomass
CO_2-storage in fossil-fuel power stations and for fuels
Environmental technologies
Water and wastewater technologies, hydraulic engineering
Air purification
Sustainable agricultural technologies and settlement strategies
Sustainable production and resource efficiency
Material-cycle technologies, minimisation of waste materials
Production on the basis of life-cycle analyses
Reduction of the material inputs in production, substitution of scarce materials, use of regenerative raw materials
Optimisation of logistics
Energy efficiency in production
Climate research
Improving the local and temporal forecasting quality of climate models
Further improvement of the estimation of the consequences of climate changes
Development of technologies for controlling severe climate changes.

Quelle: EFI (2008).

The following federal ministries are involved in providing state aid for R&I in the field of energy technology: Federal Ministry of Education and Research (BMBF), Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Federal Ministry of Economics and Technology (BMWi), Federal Ministry of Transport, Building and Urban Affairs (BMVBS), Federal Ministry of Food and Agriculture and Consumer Protection, (BMELV), Federal Ministry for Economic Cooperation and Development (BMZ), and Federal Ministry of Finance (BMF).[61] In view of the wide range of activities, some of which overlap, we propose that in the medium-term there should be an appropriate consolidation of responsibilities with the coordination entrusted to the research department.

Pursuing the Hightech Strategy – realising improvement potential

With the Hightech Strategy, the German federal government has adopted a promising new approach. The proposed coordination of federal government

BOX 11 Lead markets

Retrospective analysis of successful innovations, e.g. the video recorder, the fax machine or mobile communications, has shown that the scientific results were known long before a technology 'took off'.[62] It was only with the market breakthrough that local companies were able to obtain an advantage over foreign competitors in terms of experience with production and applications.

If two or more pioneers produce different technological variants of the same functionality, the one which is accepted first by a market, the lead market, establishes itself internationally and displaces alternative constructions in the 'Lag Markets'. The delay cannot be explained by lack of interest in innovation or opposition to technology. One country is not generally late or leading in the application of innovations. A whole series of factors all exert influences (legislation, cultural differences, the market power of good alternatives, regional entrepreneurial knowledge, marketing channels, availability of specialist personnel, etc.). It is therefore difficult to predict future lead markets in any individual case.

activities and the broad mobilisation in Germany represent important tasks and a successful start has been made. We have pointed out potential for further development: improved coordination with the *laender* and within the European Union, transparent information about future budget allocations, a plausible selection of the specific fields of innovation, and increase attention paid to services, and to sustainability innovations. The German government should continue to pursue this course energetically.

C 6 GROWTH POTENTIAL AND CUTTING-EDGE TECHNOLOGY

Innovation successes

Research and innovation are the foundation for the economic success of Germany. This is valid both over the longer-term, and recently for the economic upswing of 2006 and 2007, which was supported in particular by technology exports. Germany accounts for about a third of the world trade with R&D-intensive goods, and for many years has ranked second (relative to its population size) for globally relevant patents. Government and private expenditure on R&D is increasing again. At first sight the balance seems to be positive, but a more detailed analysis indicates structural problems.

Continuing weakness in cutting-edge technology

The analyses of R&D, foreign trade and patent activity in the EFI Innovation Studies show that the German innovation system has systematic weaknesses. Germany achieves its success in the area of high-level technology, but in an OECD comparison is only has a low ranking for cutting-edge technology. In particular the relatively mature sectors of chemistry, mechanical engineering and automotives account for the largest part of German R&D, patents, and exports.

The R&D activities of German companies show marked patterns of specialisation which differ from those of other countries. For the OECD member countries overall, their R&D work has concentrated on cutting-edge technology, that is in areas in which the average R&D intensity is more than 7.5 per cent. For some years there has also been a clear shift in favour of R&D in the services sectors. At the start of the 1990s, about 30 per cent of all R&D capacities in the OECD were deployed in the less research-intensive sectors, including the so-called high-level technology. This proportion has meanwhile fallen to about 25 per cent. Germany diverges considerably from this trend, with a fairly constant level of more than 50 per cent of R&D capacity devoted to high-level technology. Put simply, while other countries are directing R&D capacities increasingly into services and cutting-edge technology in order to benefit from the above-average growth in these sectors, Germany continues to concentrate on high-level technology.

The focus of the R&D is reflected in a corresponding concentration of German patent applications in the field of high-level technology. There are disproportionate numbers of patents in the fields of chemistry, automotive construction, mechanical engineering, and electrical engineering.[64] Figure 5 shows that when it comes to internationally-oriented patent applications in cutting-edge technologies (e.g. computers, electronics, information and communications technology, pharmaceuticals) Germany's position is unfavourable.

It is also possible to demonstrate corresponding patterns of foreign trade specialisation. High-level technology products are exported most frequently from Germany, whereas the German imports are more dominated by raw materials and cutting-edge technology. Cutting-edge technology is only involved in about a quarter of the total exports of 428.3 billion