and include investments in the transport network or investments in public buildings. However, for the innovative potential of Germany it would be more important to increase investments in fields which would promote growth, such as broadband communications or modern electricity networks (smart grids). Such sectors should have received more consideration in the recovery programme.

Particularly in the educational sector, there is an enormous discrepancy between replacement investments and growth-promoting investments. Some 92 percent of expenditure goes on maintaining the existing assets, e.g. building refurbishment. Only eight percent is spent on new laboratories, media facilities, or for up-grading further training structures. But these are precisely the investments which are important for the long-term competitiveness of Germany. A comparison of various economic stimulus packages worldwide reinforces this criticism. A study carried out by the Boston Consulting Group (BCG)[6] shows that the German economic recovery programmes were well suited to mitigate the effects of the short-term drop in demand caused by the crisis. However, in terms of investments in education and technology, the German measures were only given a middle ranking out of the ten national programmes investigated. German laender and local authorities should make full use of any opportunities they have to implement funds from the recovery packages on R&I-relevant projects.

A 2 PROMOTING INNOVATIVE POTENTIAL

Germany can only succeed in the face of growing global competition if it develops a stronger innovative dynamic.

BOX 01

Innovations

An innovation is a novel development which has been or is being implemented. It has to be more than just a "good idea". In the case of a product innovation, a new or improved good is brought onto the market. This can be a product or a service. In the case of a process innovation, a new or improved production process is introduced. An innovation can also be the implementation of a new marketing measure or an organisational novelty.

BOX 02

Technology – concepts and definitions

The Expert Commission uses the following concepts and definitions:
Schumpeter goods refer to R&D-intensive goods and knowledge-intensive services.
R&D-intensive goods are goods for which on average more than 2.5 percent of annual revenue is spent on research and development.
High-value technology goods are R&D-intensive goods for which between 2.5 and 7 percent of annual revenue is spent on research and development. Typical examples are medical technology, machine tools, engines, filters, motor vehicles, and rail vehicles.
Cutting-edge technology goods are R&D-intensive goods for which more than 7 percent of annual revenue is spent on research and development. Examples include products of information and communications technology, aircraft and space vehicles, measurement and control instruments, or active pharmaceutical substances.
Knowledge-intensive services involve a high proportion of employees with a university degree. Examples of knowledge-intensive services are IT services, software services, insurance, architectural and engineering services, legal services, accounting and management consultancy, veterinary and health services, communications, libraries, archives and museums.
A list of research-intensive industrial sectors and knowledge-intensive services is included in the References section of this report.[7]

The Expert Commission has made detailed proposals concerning this in its previous reports.[8] It is essential to maintain a leading role in key sectors. At the same time, Germany should improve its profile as a location for cutting-edge technologies which are growing in international significance. Both challenges must be addressed by R&I policy-makers.

Maintaining a leading position in high-value technology

Traditionally, high-value technologies are a strength of the German economy. In an international comparison, Germany has established a leading position in the automotive sector, in mechanical engineering, in

BOX 03

Innovation incentives and market failures

The key driving force for innovation and progress is the competition between business companies. Innovative companies are more profitable in the long term than non-innovative ones, so that even without state support there should be a considerable incentive for innovation. However, market forces do not always ensure that innovation is pursued at an economically optimum level. In research, development and innovation there are significant forms of market failure which can have negative consequences for individual businesses. Effective R&I policies can cushion or divert the effects of market failures, but the government cannot take the place of the innovation activities of private actors.

There are important forms of market failure involving public goods, external effects and asymmetrical information. Public goods are non-rival and non-excludable. The consumption of the good by an actor does not reduce the availability of that good for consumption by others, and nobody can effectively be excluded from using it. In such cases, it can be appropriate to provide government financing and production of public goods. For example, this applies in part for basic research.

Externalities in research and innovation take the form of knowledge diffusion, which the knowledge producers cannot stem. For example, by inspecting an innovative product, competitors can obtain knowledge about it without having to bear the full costs for the knowledge production themselves. In this case, the private revenues of innovation diverge from the public revenues, and the innovator will not invest enough in knowledge production when viewed from a social perspective. Suitable instruments to employ here can be the creation or strengthening of ownership rights (e.g. by patents), or the provision of subsidies and tax incentives for knowledge production. However, all instruments also have undesirable side-effects. In the case of patents these are the dead-weight losses, which result from the limitation of competition, and in the case of subsidies there are crowding-in effects.

Asymmetrical availability of information can impede the functioning of markets, and the financing of innovations suffers from such effects. If the provider of finance does not have access to the same information as the recipient, then as a result the provider, fearing opportunistic behaviour or at worst the loss of the investment, will restrict the funds which are made available. In particular new enterprises and SMEs suffer due to such reservations. It is generally accepted that under these circumstances, government intervention by means of R&I policies can be appropriate. However, there can be unintended consequences, because all actors are interested in receiving subsidies. For this reason, the empirical evaluation of government intervention is particularly important in the field of R&I policies. Only such analysis will show whether state intervention is leading to the desired results.

electrical engineering, and in the chemicals sector in recent decades. This position can only be maintained by continuing to make high levels of innovation investment in these fields. The leading role in high-value technologies offers Germany the opportunity to continue to achieve above-average levels of exports. Emerging economies with high growth rates, e.g. China, India or Brazil, are already showing increased demand for capital equipment and production systems involving high-value technologies. This represents a considerable potential for Germany. In these sectors, German companies must continue to ensure that they produce first-class products.

However, market forces do not always create ideal conditions for innovations. There are various forms of market failures in the high-value technology sector (Box 03). If companies are to make sufficient investments in research and development, the government should make active use of suitable instruments of R&I policies. These include the tax incentives R&D which the Expert Commission has frequently called for.[9]

Supporting new potential in cutting-edge technologies

Germany has definite weaknesses with respect to cutting-edge technologies and knowledge-intensive services, and it is therefore essential to promote research and development in these fields. But with a share of seven percent of worldwide R&D expenditure, Germany cannot expect to establish a leading position in all fields of technology. It is necessary to specialise in fields in which German scientific institutions or companies already have comparative strengths and in which a further expansion seems

to make sense from a macroeconomic perspective. The market processes involved cannot be replaced by government measures. But in particular in the early phases of development of technologies, the government can provide important impulses through the funding for university and non-university research institutions and the support for knowledge transfer. Start-up companies have a particularly important role to play. The government can also provide support with the acquisition of products of cutting-edge technology – and in this respect Germany only reaches the average level for the EU-15 member states.[10] Support for future technologies must take priority over measures which are primarily aimed at maintaining existing structures.

Over the past decade, Germany has beens able to reduce its structural deficits in comparison with other industrial nations in the field of cutting-edge technologies, although starting from a low base level. In the field of knowledge-intensive services, Germany still has considerable weaknesses[11]. In the new version of the High-Tech Strategy care should be taken that the support in the five fields of requirements (health / nutrition, energy / climate, security, mobility, communications) and in the cross-cutting topics is not only technology-oriented, but also takes into account the associated innovative business models and services.

A 3 NEW APPROACH IN R&I POLICIES – TARGETING THE HIGH-TECH STRATEGY

Cohesive and uniform R&I policies in the new High-Tech Strategy

With the establishment of the High-Tech Strategy in 2006, the previous Federal Government attempted to implement a coordinated strategy for promoting R&I in all government departments. It is not yet possible to assess the medium-term effects of the High-Tech Strategy, but it has been possible to considerably increase the funds deployed for research and development in Germany. The national R&I policies have also been made more effective by improved coordination between government departments. At the same time, the High-Tech Strategy in its original form was characterised by a vaguely defined range of topics and a lack of focus. For the continuation of the High-Tech Strategy, the Federal Government should therefore concentrate more on supporting the most important fields of requirement. The definition of five priorities and cross-cutting topics is a step in the right direction. The increased importance attached to the implementation of research findings is also appropriate and must be extended to cover all priority areas.

Careful selection of support priorities

A systematic approach should be adopted for identifying the most important requirement fields. In the EFI Report 2008, the Expert Commission advised drawing on the results of the Foresight Processes. In addition, a catalogue of criteria must be created for the identification of promising fields of innovation which require government support. The R&I policy should concentrate on areas of knowledge and technology which have a promising future and in which Germany already has a high level of research expertise and a development lead which can be secured internationally, for example by patent applications. As a condition, there should be commercial links in the fields receiving support. Either companies must already exist which are capable of implementation, or it must be possible for new, value-creating industries to grow in Germany. The selected priority technologies should not be dominated by ruinous international competition, and it must be possible to provide a sufficiently large R&D budget in Germany over a longer period.

Advisory bodies

Numerous advisory bodies are active in the overlapping policy fields of the environment, health, energy, and security and they pursue differing policy objectives. In many fields, research and innovation has become increasingly important, but currently there is not an institution which could carry out continuous evaluation of scientific findings and new technologies in order to provide these bodies with adequate information. This point is considered in Section B 1.

The Expert Commission recommends that the Federal Government, together with organisations such as the German Academy of Science and Engineer-