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of Economics
and Technology

Innovation policy, information society, telecommunications

Mobility and Transport Technologies

The Third Transport Research Programme of the German Federal Government

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Content

Summary

Transport is of huge economic and social importance to the Federal Republic of Germany. Modern transport systems are a hallmark of highly developed industrial nations. The ability to meet a range of business and recreational mobility requirements is an essential prerequisite for economic growth and prosperity, and for removing any barriers to participation in all areas of social life.

However, we should not overlook the fact that the consequences of consuming resources for transport and the effects on climate and health are associated with significant costs to the economy. Research and technological innovation provide essential support in confining these consequences to a manageable level.

The current, third transport research programme has been christened "Mobility and Transport Technologies". This distinguishes it from earlier programmes and places its focus squarely on the fostering of technology. Currently pressing issues and emerging challenges relating to land-based transport are tackled with a view to seeking a solution through the concerted efforts of industry and science. The programme forms part of the Federal Government's High-Tech Strategy, and implements its underlying principles in the area of transport. It incorporates all of the general conditions necessary for innovation, and provides particular support for strategic partnerships between industry and science to develop new technologies.

This programme and the associated funding structure have been defined by various government departments, under the auspices of the Federal Ministry of Economics and Technology. As such, it constitutes an official programme of the Federal Government.

The technology component of the programme is based on the following three pillars:

A) Intelligent logistics
B) Mobility of people in the 21st century
C) Intelligent infrastructure

Research and technological innovation in these areas have particular potential to provide solutions for a more efficient use of the various modes of transport, the reduction of dependency on fossil fuels, the adaptation of transport systems in preparation for demographic change, and the further tightening of road safety with assistance systems to provide technical information.

The programme will be funded by the federal budget. The funds allocated will be used both for project funding and to finance contract/departmental research. Public funding will also be allocated to the institutional transport research carried out by the German Aerospace Center (DLR) under this program.

The German transport research programme is coordinated with Community research funding within the European Union. National and European Community funding complement one another, with the EU funding programmes focussing mainly on specifically European objectives. In accordance with the subsidiarity principle, European funding is intended to build on and enhance national programmes.

Bilateral and multilateral alliances based on national transport research programmes have been established as best practice for many years. Deufrako, a bilateral Franco-German scientific and technical research programme, has been in place since 1978. Many years of close collaboration between the two nations is reflected in the identically worded Annex to this German programme and to the French transport research programme PREDIT-4, which will come into force around the middle of 2008. Multilateral cooperation is facilitated by the ERA-Net Transport and Eureka programmes. In contrast to Community research funded by the research programmes of the EU, these bilateral and multilateral programmes are publicly financed by the nations involved.

1 Introduction

With "Mobility and Transport Technologies", its third transport research programme, the Federal Government hopes to plot the course for transport research for years to come. The programme ensures the continuity that is necessary for the research and development of new findings and technologies, and gives all parties involved the reassurance of reliable planning. The programme forms part of the Federal Government's research and innovation policy, and is closely allied with other relevant programmes, such as the fifth energy research programme. It will therefore make a significant contribution to the Federal Government's High-Tech Strategy.

The programme comprises all relevant funding activities in the area of transport research in the following Federal Ministries:

- Economics and Technology (BMWi) – programme coordination
- Transport, Building and Urban Affairs (BMVBS)
- Education and Research (BMBF)
- the Environment, Nature Conservation and Nuclear Safety (BMU)
- Food, Agriculture and Consumer Protection (BMELV)

This document therefore provides an extensive overview of current key issues relating to land-based transport. The research programme is intended to provide a guide to solving these issues. It is aimed primarily at industry, academia and research bodies. If you are considering taking part in this programme, for example, as part of a funded research project, comprehensive relevant information and addresses are provided in the Appendix.

This programme follows in the footsteps of its two predecessors. The Federal Government's first transport research programme, launched in December 1996, was entitled "Basic Parameters of a Forward-Looking Mobility Research Policy". This was a "research framework of the Federal Government", which had, as its mission statement, the preservation of mobility in the long term, while noticeably reducing unwanted effects of traffic. This programme was revised in March 2000. The aim of the second programme, "Mobility and Transport", was to create sustainability, safety and competitiveness through intelligent transport.

1.1 Background and Challenges

The mobility of people and goods is of central importance to the prosperity of society as a whole. A functioning and efficient transport system is a prerequisite for mobility, and ultimately forms the backbone of today's industrial, service-oriented, information society. It has a significant influence on competitiveness, innovation, growth and employment.

The Federal Government is committed to safeguarding and developing a sustainable system of transport and settlement in order to ensure the mobility of people and goods in a manner that is efficient, safe, socially acceptable and environmentally sound.

Research and technological innovation also help Germany to maintain its position as an attractive and competitive location for business and investment in terms of its transport system. However, we must find ways of overcoming the following challenges:

Safeguarding growth and employment

The automotive and logistics sectors are, together with retail, the three sectors currently recording the highest turnovers. The following key figures illustrate the importance of the mobility and transport sector to the German economy:

- Approximately one in seven jobs in Germany depends either directly or indirectly on the automotive industry.
- In 2006, German logistics companies recorded a total turnover of approximately 180 billion euros.
- Approximately 2.6 million people are employed in logistics (across all industries).
- The logistics sector is the largest employer of trainee apprentices in the German economy, and has an additional potential employment rate of approximately 20 %.
- 53 % of the rail industry's turnover of 9.1 billion euros comes from exports.[1]
- "Deutsche Bahn" (German National Railways) and other public transport providers carry 10.4 billion passengers each year.
- The tourist industry records 3.4 daily excursions and business trips each year, which generate a gross turnover of 156 billion euros. In 2006, 75 % of all holiday destinations were reached by car, and 23 % by bus and rail.[2]

The strong market position indicated by these figures can be preserved and reinforced in the face of international competition through ongoing technological improvements and innovations in particular.

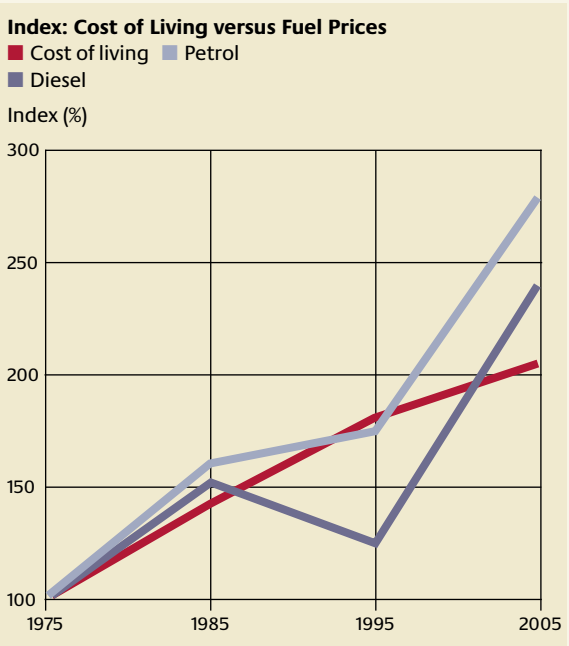
Climate protection and provisions for affordable mobility

In Germany, approximately 20 % of CO_2 emissions can be attributed to transport. If mobility is to remain unrestricted, while also taking account of the Federal Government's climate targets, the development of settlement and mobility must be more closely aligned with these. Relevant measures in this regard include:

- increased energy efficiency through new engine designs, the optimisation of components and subsystems, and improved energy conversion
- the substitution of fossil fuels with fuels that cause lower CO_2 emissions, and the commercial manufacture and supply of these
- optimised traffic flow through new traffic management strategies and technologies
- technologies to help increase use of energy-efficient means of transport in a cooperative, intermodal transport system
- measures to increase the quality, efficiency and attractiveness of public transport
- measures to change individual patterns of mobility

Note in particular that further increases in fuel prices are to be expected, given the increased global demand for energy. The measures listed above can help keep mobility affordable for all citizens, while also conserving limited resources.

Index: Cost of Living versus Fuel Prices



[1] Based on 2006. Source: Press release from the German Railway Industry Association (VDB), dated March 15, 2007

[2] Source: "Tourismus in Deutschland 2006" ("Tourism in Germany 2006"), published by the German Tourism Association

Shaping mobility in the face of demographic change

Population development and changing settlement patterns are causing shifts in mobility requirements. The population is declining and aging at the same time. According to the latest population forecasts, Germany's current population of 82.3 million (2006 figure) will drop to 74 million by 2050, while the population of those aged 65 and older will simultaneously rise from 15.9 million to 23.5 million, which represents an increase of 48 %.[3] A new trend in settlement behaviour is emerging, which will benefit high-density urban areas (conurbations) and some cities. However, most cities and regions will suffer a decline in population. If we examine demographic effects as a whole, the following assumptions can be made:

- Longer working lives will change mobility patterns.

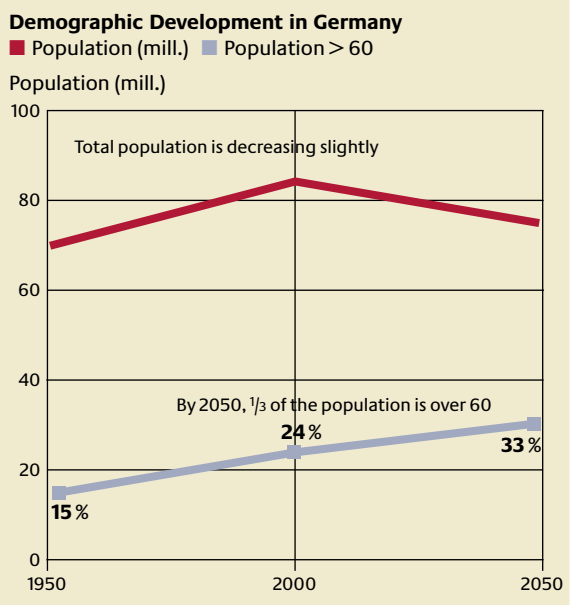
- The number of people who actively use transport into advanced years will increase, as will the number of transport users with reduced mobility. As a result, new structures will be required to provide attractive and affordable transport alternatives with low barriers to access and technologies and services tailored to meet the needs of senior citizens.

- The declining rural population will have a negative impact on the conditions for attractive and economically viable local public transport options. As a result, new services for mobility will be required in peripheral rural regions in particular (for example, demand-responsive buses, shared taxis etc.).

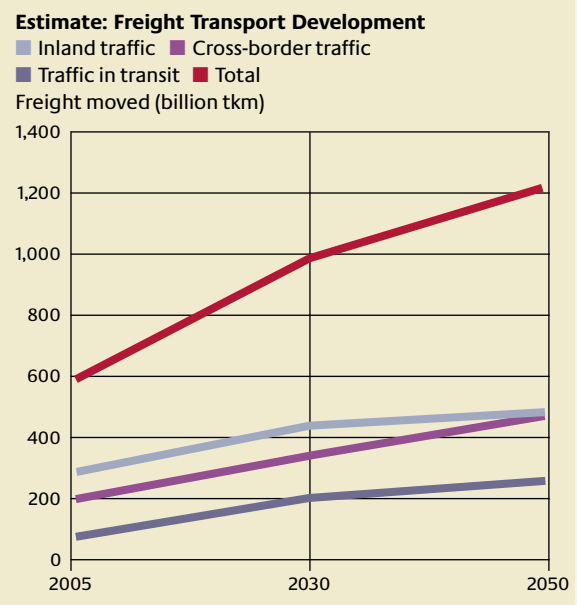
Managing the strong growth in freight transport

Due to the increased exchange of goods within the enlarged European Union and growing global trade, freight transport is expected to increase on a massive scale in the coming years. According to the latest forecasts and estimations, the amount of freight moved (i. e. tonnes carried multiplied by the distance travelled in tonne-kilometres) will increase by 69 % between 2005 and 2030, and by 110% by 2050. Traffic in transit is expected to see an increase of 130 % by 2030, and 214 % by 2050. The market share of the various modes of transport (modal split) will not exhibit a sustained change in the forecast period. Approximately 70 % of freight will be transported by HGV, and 27 % by rail and inland waterway.[4] It is therefore essential that we employ intelligent solutions to make efficient use of the available capacities and reserves of all modes of transport, with a view to

Demographic Development in Germany



Estimate: Freight Transport Development



[3] 11th Coordinated population forecast by the Federal Statistics Office, middle variant 1-W2

[4] Estimation of the long-term development of freight transport in Germany to 2050. Source: progtrans report commissioned by the BMVBS, 2007

enabling the free-flowing, reliable transport of people and goods.

Preservation and expansion of the transport infrastructure

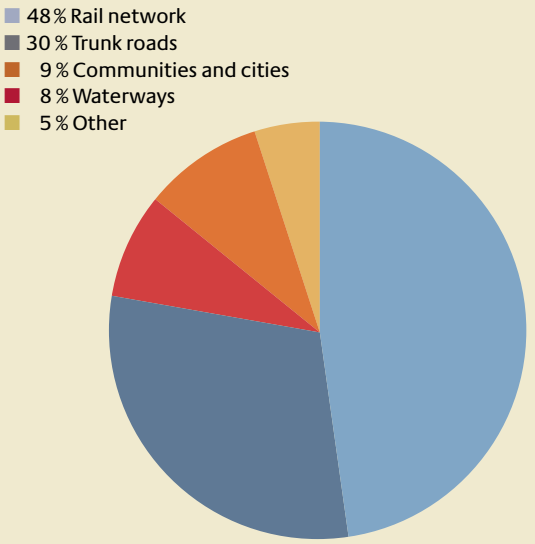
The Federal Republic of Germany has a densely developed transport network with approximately:

- 231,400 km of inter-urban road (including approximately 12,530 km of motorway)
- 413,000 km of local authority road
- 41,300 km of railway, and
- 7,300 km of federal waterway

Due to the scope and the age of the transport infrastructure, most of the funds available are spent on maintenance rather than new development and expansion.

Of the 150 billion euros allocated by the government for investment in the transport infrastructure between 2001 and 2015 under the Federal Transport Infrastructure Plan 2003, no less than 83 billion will be spent on maintaining the existing infrastructure. We are running an increasing risk of no longer being able to cover maintenance costs through public funding alone. Congestion, roads in a poor state of repair, road works and accidents all lead to tailbacks and traffic disruption. According to "Keep Europe Moving", the mid-term review of the EU Commission's White Paper on transport[5], European countries spend, on average, approximately 1% of gross domestic product (GDP) covering costs incurred by traffic congestion. In Germany, with our very dense infrastructure, this would correspond to more than 20 billion euros each year. In future, the expansion of existing infrastructures for private and public transport with intelligent systems based on communications technology will be one way to reduce the extent and duration of tailbacks and to make public transport more attractive and more efficient.

Federal Spending on Transport 2004
19,5 billion euro



Personal safety and environmental protection

Road safety: The number of people dying on Germany's roads has consistently decreased over recent years, and fell by 23 % between 2003 and 2006. The figure reached an all-time low in 2007 with 4,970 deaths (compared with 19,193 in 1970). However, the total number of traffic accidents has decreased by a much lesser extent – by just 1% in the same period (2003 to 2006). Despite the success of efforts to date, it is unacceptable that someone still dies every 100 minutes on our roads. Increased road safety therefore remains a key concern.

Traffic pollutants: The effects on health and on the environment of exhaust gas emissions from traffic have been significantly reduced in the case of the main pollutants like HC, CO or SO_2, thanks to the introduction of catalytic converters in petrol engines. Discussions now focus on reducing emissions of the climate gas CO_2 and of dust and particles, in part due to the rapid increase in the number of vehicles with diesel engines on our roads.

Noise can have a very intrusive effect on our lives, and can prevent us from sleeping, relaxing, communicating, and concentrating at work. Approximately 60 % of the population feels affected by traffic noise alone, with a significant portion being exposed to

[5] "Keep Europe moving – Sustainable mobility for our continent", Mid-term review of the European Commission's 2001 transport White Paper, Luxemburg, 2006

noise levels that are potentially harmful to one's health. A primary objective of future transport research is to reduce traffic noise from all modes of transport, primarily at source.

Land consumption and landscape fragmentation: In 2004, the total area of land used for settlement and transport in Germany amounted to 45,621 km². Between 2001 and 2004, an average of 115 hectares of land per day was developed for settlement and transport, with 22 hectares of this being designated for transport purposes. The consequences of this consumption are soil sealing and the fragmentation of integral natural and cultural landscapes, effects on the local climate and on the natural balance of flora and fauna. Research in this area should help identify new ways of reducing land consumption and landscape fragmentation for transport purposes.

Civil security and hazard prevention

After the terrorist attacks in the USA and Europe, security measures have been intensified, including those in the area of transport. Some of the new and emerging security standards for the transport of people and goods involve high costs and have a disruptive effect on goods clearance/turnaround times and transport, for example, due to longer waiting times at airports or safety certification procedures along the entire transport chain. On the other hand, innovative safety concepts and technologies can help reduce the risk of hazards, as well as the negative impact of security measures on operators and users of transport systems. The Federal Government's security research programme launched in 2007 addresses these issues directly. It aims to identify innovative solutions for hazard prevention and to improve security measures for dealing with terrorist and criminal activities.

1.2 Transport Research as Part of the High-Tech Strategy

The current research programme is part of the Federal Government's High-Tech Strategy.[6] This strategy is an overall concept that unites the Federal Government's various core objectives for research and technology. Transport research is listed as one of the priorities in the High-Tech Strategy.

One of the key aims of the High-Tech Strategy is to enhance the interface between science and industry to reduce the time it takes to implement the results of research. The transport research programme ties in neatly with this.

Research and development (R&D) in the area of transport usually takes the form of collaboration between science and industry. Public funding and support is also necessary in certain cases, for example, in order to cushion financial risks. This occurs, for example, when private enterprises are unable to pursue development and innovation within a viable time frame, without assistance or to the extent that is required. Possible reasons for this include:

- the relatively long time it takes for developments in the area of innovative transport technology to be implemented and achieve Market penetration

- the fact that strategic partnerships and collaborations are required between companies in different industries

Another goal of the High-Tech Strategy is to foster the basic conditions required for innovation above and beyond technological developments. This guiding principle is reflected in all aspects of the transport research programme.

In many cases, the High-Tech Strategy's problem-solving approach requires cross-departmental collaboration, which translates into the involvement of the BMWi, BMBF, BMVBS, BMELV and the BMU in the transport research programme. For example, the innovative "Safe, Intelligent Mobility" project is a partnership between the BMWi, BMBF and BMVBS.

[6] www.high-tech-strategie.de

Meanwhile, the "Hydrogen and Fuel Cells Technology" national programme for innovation unites the activities of the BMVBS, BMWi and BMBF.

The Federal Government will allocate an additional 6 billion euros to research and development for the period 2006 to 2009. This will contribute to increase public and private investment in R&D in Germany to 3 % of gross domestic product by 2010 (in line with the Lisbon Strategy).

The "Research Alliance of Industry and Science" will provide additional support for the implementation and further development of the High-Tech Strategy.

1.3 The Various Research Funding Instruments

The Federal Ministries involved in this research programme, namely

- Economics and Technology (BMWi)
- Transport, Building and Urban Affairs (BMVBS)
- Education and Research (BMBF)
- Environment, Nature Conservation and Nuclear Safety (BMU), and
- Food, Agriculture and Consumer Protection (BMELV)

plan to take a wide-ranging approach to driving and accelerating the required innovations in the area of mobility and transport by funding research and technological development.

The following funding instruments will be used:

- Funding of **departmental or contract research** that aims to find solutions to current policy issues and meets the (usually short-term) requirements of the individual department for scientifically substantiated results: Some of this research is carried out by agencies of the departments, such as the Federal Highway Research Institute (BASt), the Federal Maritime and Hydrographic Agency (BSH) or the Federal Environment Agency (UBA). These agencies form an essential component of the Federal Government's scientific and technical infrastructure.

- **Grant-based project funding:** This refers to the funding of short-term research projects with well-defined aims, based on a broad research programme (such as this) in private enterprises, research institutes and universities or partnerships between these, which are application-oriented and market-focused, and, where possible, whose results can be demonstrated. In most cases, public funding covers only part of the total project costs and spending. The remaining investment is to be covered by the grant recipients themselves.

- **Institutional research funding:** This refers to the funding of research that is not based on specific targets. Instead, funding is regarded as an investment in the institutions themselves, and serves to enhance the expertise of research institutes and underpin their long-term strategic approach to transport research. This type of research tends to be based on underlying principles, and typically addresses issues that, due to their magnitude, complexity and individual requirements, require the specific research tools that are usually only available in larger research centres. Institutional funding is currently provided for the transport research being carried out at the German Aerospace Center (DLR) in the Helmholtz Gemeinschaft (see also Section 2.1.4).

The instruments specified above complement one another, and can be used in combination if necessary. A parallel approach incorporating project funding and institutional funding, as well as the requisite coordination processes, has proven effective in practice.

Mobility and Transport Technologies

Basic structure of Federal Government's transport research programme

	Project/research funding	Departmental research
BMWi	• Transport technologies and systems in land-based transport (logistics, mobility of people in the 21st century, intelligent infrastructure)) • Institutional research funding at DLR	
BMVBS	• Projects from R&D innovation programme (hydrogen and fuel cells/fuel strategy, ecologically friendly engines for ships, master plan for freight transport and logistics, e-ticketing, transport information meta-platform) • Urban transport research programme, "Mobility 21" initiative, National Cycling Plan • Gen. departmental research (integr. transport policy, mode-specific research topics)	
BMBF	• Materials research • ICT2020 • Microsystems • Molecular plant research • Civil security research	
BMU	• Environmental research	
BMELV	• Biological fuels and materials	
Complementary research funding by EU as agreed by Member States		
EU	• Seventh Framework Programme for research	

1st example: "Alternative fuels and drive technologies":
The BMVBS drives the development of our energy strategy for tomorrow's transport systems. The BMELV supports and funds the development and supply of alternative fuels based on renewable raw materials. The BMBF funds the development of new materials for innovative drive units. As part of its funding activities, the BMWi integrates basic technologies to create new low-emission, energy-efficient drive systems.

2nd example: "Improved road safety through car-to-car communication":
The BMBF fosters the development of the necessary communications technology, while the BMWi is concerned with the applications for transport in terms of functionality, traffic flow and traffic safety. Meanwhile, the BMVBS has overall responsibility for transport policy, covers the area of intelligent infrastructure, and is also responsible for the necessary legal structures.

The Federal Government organises transport research as follows:

- The *BMWi* is responsible for technology-based and system-oriented project funding of transport research, including institutional funding for the DLR.

- As part of its departmental research, the *BMVBS* primarily funds research projects that seek to facilitate and underpin transport policy decisions. In future, research funding will also become a more far-reaching funding instrument of the BMVBS.

- The *BMBF* funds the research and development of basic technologies, some of which may ultimately be applied in the area of transport.

- The *BMU's* transport-specific research fosters innovations that are primarily directed at improving the environmental soundness of transport solutions.

- The *BMELV* promotes transport-relevant developments, in particular in the area of renewable fuels, and is concerned with the future of our rural landscape.

The coordination of research funding between the various departments is based on a standardised procedure (early coordination), as well as ad-hoc consultation. This allows the funding activities of the individual departments to complement one another in relation to cross-departmental issues, while potential funding overlaps are avoided. The Federal Government has defined general guidelines to facilitate agreement on which fields of research are to be assigned priority. These aim, first and foremost, to ensure a more efficient funding policy and to maximise the value added by research that is funded by euros from the public coffers. The following criteria underpin these guidelines:

- **Continuity:** The Federal Government's funding policy is based on a long-term vision, and offers science and industry predictability and planning reliability for their research and development projects.

- **Focus:** Funding is primarily aimed at particularly innovative and promising transport technologies that play an important role in the sustainable development of the transport system.

- **Flexibility:** Advancements in the research and development of innovative transport technologies can only be planned within certain limitations. The Federal Government therefore takes sufficient measures to ensure that funds are redirected towards new strategic objectives if this becomes necessary due to changing conditions or new developments.

- **Cooperation and coordination:** The interplay between science, industry and state funding is of particular importance to the successful development and rollout of new transport technologies. The Federal Government's funding policy in the transport sector is developed and enhanced in consultation with science, industry and the project management agencies that implement project funding on behalf of the Federal Government. The Federal Government strives to ensure that the relevant funding programmes of the EU are consistent with its own funding policy objectives, and that the funding activities of both complement one another in a useful manner.

- **Competition:** Transport research and the funding thereof must be competitively organised. This is a key requirement to ensure its effectiveness and to enhance the quality of results overall.

- **Quality control:** In order to preserve and enhance the high level of research and development in Germany's transport sector, structures, regulations and decision-making processes must be evaluated and optimised on an ongoing basis. The new transport research programme is subject to this evaluation process.

- **Standardisation:** Standards ensure that products can be sold successfully on a global scale. In future, aspects relating to standards will assume greater significance for research funding with a view to helping industry establish such standards within less time, thus making their innovations more competitive.

1.4 International Collaboration

Thanks to the global dismantling of barriers to trade and as a result of European integration, the international transport of people and goods is on course for further expansion. Since cross-border transport networks can only be efficient and effective if transport system-specific obstacles and incompatibilities are removed, the Federal Government attaches great important to the construction and expansion of a modern trans-European transport system.

Community research in the European Union

The objectives of national and Community research funding activities within the European Union should complement one another in a meaningful way. Distinctions between the two are based on the subsidiarity principle. Community research tackles specific issues of European concern, such as the interoperability of rail systems, where there is a clear benefit to be derived from this type of research or if a critical mass is to be generated. In accordance with the subsidiarity principle, European funding is intended to build on and enhance national research programmes.

The European Parliament and the Member States have assigned the EU Commission the task of implementing the Seventh Framework Programme for Community research funding. The programme will run from 2007 to 2013 with a budget of 54.2 billion euros. Transport forms one of the focal points of the programme.

The following five key concerns are addressed in relation to land-based transport (rail, road and waterway):

- Lessening the impact of land-based transport on the environment
- Promoting modal shifts and relieving the burden on the transport corridors
- Guaranteeing sustainable intercity mobility
- Increasing technical safety and improving hazard prevention
- Strengthening competitiveness

The goals and concerns of German and European research programmes are therefore closely aligned, which means that processes of mutual consultation between national and European research programmes and projects are becoming increasingly important. The more effectively projects communicate with one another, the greater the synergies that can be produced through funding. The Federal Government is now working with increased zeal to incorporate national R&D approaches into European research, while simultaneously emphasising the importance of more effective use and implementation of the results of EU research in Germany.

In this context, the Federal Government has a special interest in ensuring that German science and industry actively and successfully participate in European Community research. To promote this aim, the Federal Government has established national contact points for the various thematic areas that form part of the EU's Framework Programme for research. The BMWi has charged the TÜV Rheinland Group with the administration of the National Contact Point for transport research (for contact details, refer to Appendix III).

Bilateral and multilateral collaboration in transport research

In addition to national research activities and participation in European framework programmes, bilateral and multilateral collaboration between individual countries plays a key role in transport research. This is because many of the challenges faced in the transport area are similar for most countries.

For example, Deufrako[7], a bilateral Franco-German collaborative research programme in the area of transport research established in 1978, has stood the test of time and provided important momentum for European developments (see also Appendix IV).

The period from 2004 to the present day has seen an increase in multilateral research collaboration as part of the ERA-net TRANSPORT[8] and ERA-net Road networks, which each comprise more than 10 European Member States. Germany has played no small part in this collaboration, which has led to the establishment of the European Research Area (ERA).

Collaboration on EUREKA projects represents another important platform for cooperation at an application-oriented level. EUREKA LOGCHAIN[9], which the Federal Government helped to initiate, is a project dedicated to one of the key issues in transport research. It largely involves cross-border collaboration towards traffic avoidance and modal shifts in transport chains. In contrast to Community-funded EU research programmes, these bilateral and multilateral programmes are publicly financed by the nations involved, and are subject to national conditions of funding.

[7] www.deufrako.org
[8] www.transport-era.net
[9] http://logchain.eureka.be/background.do

2
Focal Points of the Research Programme

2.1 Funding of Research and Technology by the BMWi

The BMWi's transport research is part of the Federal Government's technology policy. It seeks to enhance the basic conditions required for innovation and technical progress in the long term. The following guiding principles of transport policy are of particular importance:

- Support technology-driven start-ups and innovative enterprises
- Intensify networking of industry and science
- Support the rollout of research results
- Create conditions that promote thriving investment and consumption, thereby substantially increasing demand for new technologies
- Foster greater competitiveness on a global scale through standardisation at an early stage
- Reinforce the innovative strength of small and medium-sized enterprises (SMEs)

Successes to date and financial parameters

As part of the second "Mobility and Transport" research programme, funds of approximately 380 million euros were made available from the Federal budget in the period 2000 to 2007. These funds to promote research and development in the transport area were allocated to the budget of the BMBF up to and including 2005, after which they were instead allocated to the budget of the BMWi due to a change in departmental responsibilities. These funds allowed new networks comprising enterprises and research institutes to develop new technologies and services, which have since found their way onto the market.

Examples include:

- the **INVENT** Initiative[10] with the German automotive industry and its component suppliers, which led to developments for innovative driver assistance systems in the areas of road safety, traffic flow and navigation
- the **"clean HGV diesel engine"** with "ADD blue technology", which complies with the EURO IV standard[11]
- **fire control systems** for tunnels, which will be used in future in Madrid's underground rail system and on the Brenner motorway in Austria
- the **"European Rail Freight Transport 2010"** ideas competition (SGV 2010), which encouraged enterprises to identify new ways to improve the quality and economic viability of freight transport by developing innovative solutions for technology, operations and organisation[12]
- the **"Mobility in Conurbations"** flagship project (Intermobil Dresden, Mobilist Stuttgart, Stadtinfo Cologne, WAYflow Frankfurt/Main, MOBINET Munich, CashCar Berlin), in which extensive mobility and transport concepts were designed, and which led to the establishment of large cross-regional transport management and control centres[13]
- **e ticketing** – the development of a standard, which will, in future, enable the implementation of an integrated, electronic ticketing system for public transport (core application[14]) throughout Germany
- the research project **"Regional Public Transport"**, in which ideas for efficient and high-quality local public transport in rural areas and in small and medium-sized towns were developed and tested[15]

[10] http://www.invent-online.de/
[11] www.tuvpt.de/abgeschlossene-projekte/minimalemission.html
[12] www.schiene2010.de/web/
[13] www.tuvpt.de/abgeschlossene-projekte/mobilitaet-in-ballungsraeumen.html
[14] www.eticket-deutschland.de
[15] www.tuvpt.de/abgeschlossene-projekte/pnvregion.html

- the **"Quiet Traffic"**[16] research network, which significantly advanced scientific knowledge of the effects of traffic noise pollution, and developed and tested technological solutions for noise reduction

An evaluation of the overall success of funding measures takes place at the end of the research and development process, which normally lasts several years. Over the course of this process, the milestones achieved or provisional results must be monitored on an ongoing basis using selected indicators. These indicators include:

- effect on transport
- economic and ecological effects
- social acceptability to transport users
- innovative value and intermodal transfer potential

The Federal Government's second "Mobility and Transport" research programme was evaluated on the basis of a range of criteria by external experts and by means of an internal review process. In the spring of 2001, the "Mobility in Conurbations" flagship initiative successfully passed a review by the Federal Audit Office in Koblenz, which included an on-site examination of the project management agency and selected funding recipients. The "Rail Freight 2010" project followed successfully in its footsteps in mid-2005.

The "Mobility in Conurbations" flagship initiative and the "Optimised Transport in Life-Cycle Management" and "Flexible Transport Chains" research projects were also evaluated externally.

Quantitative analyses of the success of the research programmes and individual projects were also performed to the greatest extent possible. These showed, for example, that approximately 150 million HGV-km per year were saved through "intelligent logistics" as part of the "Flexible Transport Chains" programme (the anticipated result was 100 million HGV-km per year). For other programmes, qualitative analyses were used instead, due to a lack of quantitative data.

[16] www.fv-leiserverkehr.de

It is also planned to evaluate research programmes that are currently still in progress. The results of evaluations performed so far have been incorporated into the overall concept and objectives of this third transport research programme. Accordingly, both prospective and retrospective evaluations of current programmes are planned (for example, reviews of objectives, status workshops, ongoing performance reviews and final appraisals).

The commitment of both industry and government is essential if research funding is to achieve lasting successes. The Federal Ministry of Economics and Technology plans to make more than 50 million euros available each year to finance the current "Mobility and Transport Technologies" research programme (i. e. approximately 220 million euros between 2008 and 2011). It can be assumed that the research projects will simultaneously receive a comparable level of funding from industry.

The following three pillars provide a thematic framework for the research projects that will be funded by the BMWi as part of this third transport research programme:

- Intelligent logistics
- Mobility of people in the 21st century
- Intelligent infrastructure

2.1.1 Intelligent Logistics

In an age of globalisation and of high demand for speed and precision in manufacturing processes ("just in time" or "just in sequence") logistics has assumed a pivotal role in economic activity. The future prospects of our economy are directly determined by the capacity of our transport system and the competitive capabilities of the logistics sector.

Germany's high reputation as a centre of production and an export nation is heavily dependent on end-to-end supply chain management to ensure highly efficient logistical processes along the entire value chain. In particular, our economy's ever-increasing focus on export has necessitated the development of highly efficient logistical structures, which play a key role in ensuring strong export figures.

Against this backdrop, the logistics industry itself has also evolved into one of our most important sectors, with significant potential for growth and innovation and for future job creation. For many years, logistics has been steadily coming up on the inside track to become our third-largest industry after retail and automotive in terms of both revenue and employment.

The logistics sector is currently the third-largest industry in Germany, employing almost 2.6 million people and bringing in an annual turnover of just under 180 billion euros.[17] Germany enjoys the largest share of the European logistics market at approximately 26 %.

Evidence of the health of the logistics sector is afforded, for example, by its steadily climbing growth rates, which have been averaging well above 2 % per annum (in real terms) for years, and consistently outstrip growth in GDP. Estimates therefore predict that employment in this sector will easily grow by 4 % per annum in the coming years.

Similar vitality is also demonstrated by the constant optimisation of process chains from the manufacturer to the consumer, which are determined to a large degree by the technological options available and, in particular by transport and communications technology.

In the past, logistics may have been largely embedded in company organisational operations. Today, however, it refers to the integrated, market-driven planning and control of all flows of material, goods and information within businesses, between businesses (suppliers to buyers), and from businesses to customers.

The dawn of the 21st century has been marked by rapid geopolitical, economic and technological change. Of particular significance is the current impact that EU expansion to the east is having on political and economic conditions, as is increasing trade with Asia, all of which enhances Germany's status as a logistical centre at the heart of global exchange. The country therefore has the potential to safeguard and expand its role as a logistical hub within Europe.

As a result, the German logistics industry is currently facing particular challenges, which are illustrated by the following key figures, forecasts and estimates:

Growth forecasts and estimates[18] based on 2005

- Freight traffic as a whole (measured in tonne-kilometres (tkm)) is set to increase in Germany by 69 % by 2030, and by 110 % by 2050.
- Traffic in transit (also measured in tkm) will more than double (136 %) by 2030, and will more than triple (214 %) by 2050.
- Container handling at Germany's maritime ports will almost triple by 2025.[19]

[17] Information Service of the Cologne Institute of Economic Research, Vol. 33, 2007

[18] progtrans: Abschätzung der langfristigen Entwicklung des Güterverkehrs in Deutschland bis 2050 ("Estimation of the long-term development of freight transport in Germany to 2050"), report commissioned by the BMVBS, Basel, 2007, pg. 118 ff

[19] PLANCO: Seeverkehrsprognose 2025 ("Marine Traffic Forecast"), report commissioned by the BMVBS, Essen, 2007

Strong growth in external trade and Germany's central position in the new Europe will produce a rapid increase in the exchange of goods and in freight traffic in the coming years. Even today, bottlenecks are emerging, in particular at maritime ports, along the main axes of the rail network and on roads at peak traffic times in high-density areas.

The Federal Ministry of Economics and Technology (BMWi) has taken up this challenge, and, through its new "Intelligent Logistics" research programme, aims to safeguard and enhance Germany's logistical competitiveness by providing innovative and intelligent solutions in this area.

In this way, the BMWi will also help implement the "Freight Transport and Logistics Masterplan" initiated by the Ministry of Transport, Building and Urban Affairs (BMVBS). Current developments and trends will be examined, as will quality standards in transport, economics and logistics, for the purpose of detecting where action is required and formulating appropriate responses. The objective is to strengthen Germany's position as a centre for both manufacturing and logistics, with a view to boosting competition, growth and employment.

Challenges

The Federal Government has identified specific challenges for industry and thus also for logistics based on these forecasts for growth. The key factors in these will be:

- **Globalisation** of commercial transport: Networks of companies, their suppliers and customers are becoming increasingly widespread. This produces a growing demand for services relating to the transport, storage and handling of goods, as well as for communication, planning and control.

- **Traffic in transit:** The eastern European expansion of the EU will undoubtedly lead to increased trade along East-West corridors (refer to the graphic). In addition, trade with the Asian countries currently experiencing a boom (in particular China and India) will continue to grow in importance.

- **Outsourcing:** The increasing tendency of enterprises to focus on core competencies means that the trend to outsource is set to continue in many industries. This results in a reduction of the vertical range of manufacture, accompanied by a geographical distribution of production sites. These new dynamics require perfect coordination between the flow of information and the flow of commodities. Logistical services are becoming ever more complex. The tendency to specialise in even more transparent processes will become more prevalent. As a result, Supply Chain Management will allow logistics companies to exert a greater influence over production processes.

- **Mass individualisation:** The global availability of a range of raw materials, prefabricated building components and transport capacities is leading many manufacturers to diversify their product range. Manufacturing is therefore becoming increasingly "individualised" or customised, in other words, pro-

Development of East-West HGV Traffic in Transit 2002/2020
Source: Acatech – Mobilität 2020.
Perspektiven für den Verkehr von morgen ("Mobility 2020. Perspectives on Tomorrow's Transport"), Stuttgart, 2006

ducts are accompanied by value-added services or have customer-specific features. For this to be an economically viable approach, manufacturing must be demand-driven and must have the support of intelligent logistical solutions.

The **"Intelligent Logistics"** programme of action aims to develop and prepare the rollout of technical innovations for the logistics and transport sectors.

Prerequisites for intelligent logistics

Intelligent logistical solutions have four distinguishing features:

- **Quality:** Increasing complexity means that the bar is set extremely high for the quality of logistical services. Transport is becoming an integral component of the supply chain and the entire production process. "Intelligent logistics" implies much more than making sure that parts make it onto the production line in good time. Logistics must also ensure that the parts are already pre-sorted into the sequence in which they are to be processed. Only concepts and technologies of the highest quality will last the pace in the face of stiff competition.

- **Profitability:** Competing on a global scale means having to deal with rising cost pressure. The German market is thronged with foreign logistics service providers, while German logistics companies operate at a global level and currently rank among the world's leaders in the field. Competition puts constant pressure on companies to become more efficient and introduce new, innovative solutions. These include, for example, bundling transport for greater efficiency and using existing loading spaces and storage areas to better effect.

- **Security:** Suppliers must be able to get their supplies to their customers, be they businesses or private individuals. Research and testing of entire transport chains, taking account of a wide variety of security-related aspects, plays an important role here in connection with efficient supply chain management. Innovation: Experience indicates that the logistics services sector adapts quickly to the demands of industry in terms of the ability to increase capacity and efficiency. There is room here for technical, operational or organisational innovation, at least for some elements of process chains.

R&D-Approaches for this Research Focus

Intelligent Logistics – Expanding Germany's Role as Europe's Logistical Hub

Efficiency/ Environ	Integration	Security of Supply
Vehicles	Processes	Tracking & tracing
Loading space	Enterprises	Security/theft protection
Hubs		Information chains

Policy field: Increasing efficiency and environmental protection for transport by rail, road and waterway

The entire transport system must be used more effectively in order to safeguard and strengthen Germany's position as the logistical hub of Europe. Faster implementation of new ideas for transport by rail, road and inland waterway, and of intermodal integration is required.

Vision

- Intelligent interlinking of HGV convoys (while taking account of driver autonomy)
- Increased load capacity with double-deck or extra-long freight trains
- Use of self-propelled individual freight cars for freight transport ("trucks on rails")
- Alternative drive technologies and/or fuels for transport vehicles

Key issues relating to safety, energy/fuel consumption, environmental protection, efficiency, and capacity utilisation are still arising for freight transport by road and rail. New drive and vehicle designs, aimed in particular at reducing energy consumption, as well as the accommodation of logistical requirements, provide key starting points for R&D activities. Information and communication technologies (ICT) will play an important role in improving efficiency, quality and reliability, and will provide support for planning.

Policy field: Reducing bottlenecks at logistical hubs

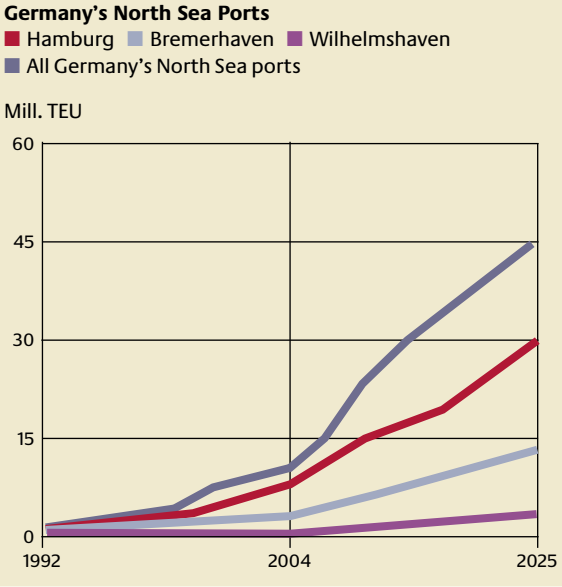
Logistical hubs (maritime ports, inland ports, combined transport terminals, marshalling yards and gateways, airports and freight transport centres) are the nerve centres of freight transport, and the locations where bottlenecks are most likely to occur. All experience similar problems, regardless of the mode of transport involved. The forecast growth in freight transport will exacerbate the problems of limited space for the handling and temporary storage of freight receptacles (such as containers), and of connecting up with hinterland transport. Maritime ports are currently experiencing growth rates in double digits in terms of container cargo volumes, and are nearing the limits of their capacity. German maritime ports alone will see the volume of cargo they handle more than double from 272 million tonnes in 2004 to 759 million tonnes in 2025. The established pattern of container volumes increasing at a faster pace than the total volume of cargo handled is set to continue in coming years. German ports handled 35 % of total container cargo in 2004, and this figure is set to rise to 59 % by 2025. This means that, within this period, the volume of container cargo handled will more than quadruple, from 10.8 million TEU to 45.3 million TEU. Hamburg will replace Rotterdam as the largest container-handling port in Europe.

Therefore, one future focal point for BMWi research funding will be innovative approaches in the following areas:

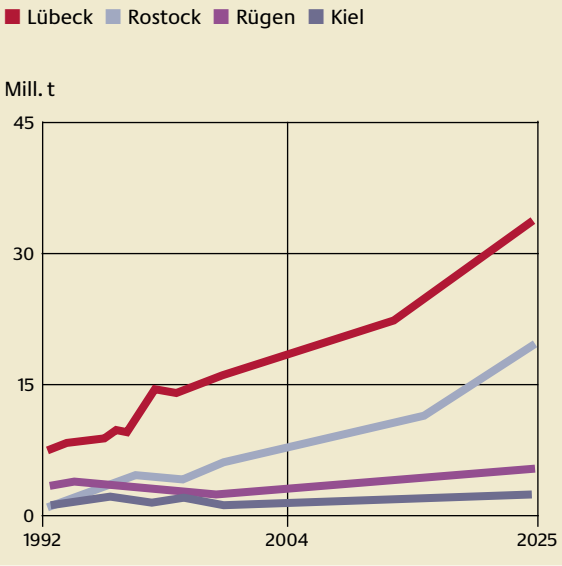
- Handling technology and automation
- ICT technologies and
- Process control

The objective in this case will be to bolster maritime port logistics as an economic factor. Approaches to accelerating the processing of incoming and outgoing commodity flows (for example, increased auto-

Growth in Container Volumes Handled by Germany's North Sea Ports



Growth in Ro/Ro Ferry Traffic at Baltic Sea Ports



Growth of Container Traffic and Roll-On/Roll-Off Ferry Traffic to 2025[20]

[20] Seeverkehrsprognose 2025 ("Marine Traffic Forecast"), report commissioned by the BMVBS, Essen, 2007

mation in the area of identification systems, the transfer of port functions to inland hubs with the assistance of highly efficient shuttle transport, and the use of standardised ICT technologies to encourage greater cooperation between maritime ports) provide possible starting points for ensuring efficient freight transport, relieving pressure on maritime ports and using resources in an environmentally sound manner.

However, a long-term solution for taking pressure off maritime ports is dependent on the support of a functioning hinterland transport system. Technological innovation in the handling systems for combined transport, at inland ports, airports and freight transport centres will make an important contribution in this regard, and research in this area will be fostered by the current research programme.

Policy field: Transport optimisation through cooperation and integration

In relation to transport optimisation, the question arises as to how additional partners can be incorporated into the transport chain in order to make it more efficient. To answer this question, research is required into the ways in which logistical hubs for freight transport can be interlinked, and how innovative and flexible networks can be developed for SMEs (freight handlers, private rail companies and private ship-owners). Cross-company forms of organisation could also contribute to optimisation in the area of intelligent scheduling and dispatching through:

- the avoidance of empty runs and improved utilisation of transport capacities
- a reduction in detours
- the acceleration of transport processes
- the use of intermodal transport chains, with increased use of rail and waterways

This is an area of considerable potential for highly innovative, service-oriented SMEs (small and medium-sized enterprises).

Policy field: Maintaining affordable logistical safety

Logistics is a sensitive, time-critical industry that is susceptible to errors. Therefore, the reliability of the transport infrastructure must be ensured, and complex transport processes kept transparent and free of disruption at every step. Innovative technologies can help logistics service providers in their efforts to control the increased costs of doing just this arising from international safety standards. End-to-end tracking and tracing systems for freight transport are of particular significance in this context.

The cost of complying with safety standards tends to be particularly high for transport hubs. Damage and theft constitute particular problems for valuable cargo. It is becoming apparent that “electronic seals” will become mandatory in the near future. R&D activities are required in this area to provide automatic detection systems and options for rapid response.

High expectations in relation to safety-relevant applications have also been vested in the Galileo global satellite navigation system. Galileo opens up new application possibilities not previously available to civilian users of the existing American GPS (global positioning system).

2.1.2 Mobility of People in the 21st Century

Highly developed transport systems have become an essential component of modern societies. Not only private transport by car and high-capacity local public transport systems, but also high-speed rail (where journey times are becoming ever shorter) have become an indispensable part of our daily lives. The ability to meet a range of commercial, professional and recreational mobility requirements is key to ensuring economic growth and prosperity, and for removing any barriers to participation in all areas of social life. Mobility is therefore an important prerequisite for independence, flexibility and autonomy in terms of both time and space.

Challenges:

Managing climate change
In the Kyoto Protocol, the EU has committed to reducing greenhouse gases by 8 % on average (based on 1990 figures) in the period 2008–2012. Germany plans to reduce its emissions by 21 % in the same period. Today, greenhouse gas emissions are approximately 19 % below the 1990 level.[21]

CO_2 emissions from transport have also dropped by more than 12 % since 1999, despite the increase in transport services provided. Nevertheless, the transport sector is still the second-largest contributor to CO_2 emissions after power plants. In fact, its share of total CO_2 emissions has jumped from 15 % in 1980 to approximately 21 % at the end of the 1990s, and is currently stagnating at around 20 %.

The main culprit within the transport sector is road traffic, firstly because of its large share of total traffic volumes, and, secondly, due to the particularly high levels of specific emissions per person-kilometres or tonne-kilometres travelled.

Mobility that is demand-driven but also complies with the Federal Government's targets for climate change and sustainability therefore needs to be supported by measures to further reduce CO_2 emissions from transport.

[21] www.bundesregierung.de/Content/DE/StatischeSeiten/Breg/ThemenAZ/klimaschutz-2006-07-27-die-nationale-strategie.html

Fuel prices
Petrol and diesel prices have soared by more than 50 % in real terms since 1993. This trend is continuing, regardless of short-term fluctuations in the price of crude oil. Transport is responsible for almost one third of total energy consumption (29 %). And road transport, in turn, accounts for 83 % of this share. However, rising fuel prices have had virtually no impact on the use of private transport to date, with people tending to economise in other areas instead. In order to ensure that mobility remains affordable for all into the future, while also minimising the environmental impact, we must change our individual patterns of behaviour, exhaust all of the technical possibilities for improving energy efficiency (for example, with lightweight construction) and use alternative drive technologies and fuels as long-term options. This will necessitate a delicate balancing of costs and benefits.

Demographic change
According to population forecasts, current demographic shifts will result in a declining, aging population. This will have some serious implications for future patterns of mobility and the associated level of demand for passenger transport. We can also expect longer working lives and longer life expectancy to shape mobility patterns. Private cars will continue to play as important a role as other solutions for personal mobility. Public transport services will undergo a significant structural transformation due to the increasing concentration of population in conurbations and the simultaneous decline in many other regions.

The BMWi's research funding programme therefore also targets research projects that focus on the following challenges:

Policy field: Development of sustainable mobility solutions

We can assume that demand for mobility services will, in future, depend on the criteria of individualisation, quality, value for money and environmental compatibility. Transport systems will need to be able to react as quickly as possible to customer requirements. Private cars provide an easy, comfortable solution to the complex requirement of "door to door" mobility, and therefore set the standard for public transport services.

New, integrated "door to door" solutions
We need new, integrated door-to-door transport solutions to guarantee accessibility, in particular for senior citizens or persons with reduced mobility. Tighter integration of different services and modes of transport is essential if this objective is to be achieved. Different modes of transport must be combined to produce solutions where the unavoidable interfaces and barriers are barely noticed by the end user. This model's only chance of success depends on a seamless technical, operational and organisational integration of public and private transport. The ultimate goal here is the creation of a financially viable, integrated, barrier-free transport system that will cover as much of the country as possible. This will also involve a cost-driven modification of the density of local public transport services in the face of falling demand, in particular in rural areas. Appropriate, flexible solutions involving small vehicles and new modes of utilisation and operation can potentially preserve the quality standards of the services provided at reduced costs. Research and development is required to formulate concepts and criteria that will allow for reliable planning of public transport services and their financially viable evolution. These concepts could be put to the test in pilot projects.

Using new technologies to improve access to public passenger transport
If public transport is to be made more attractive, it must become easier to use. Cash-free payment options and a dynamic information system to indicate location-specific and time-specific connections must become the norm. Technologies and standards that employ the same medium to achieve these objectives must be made available, and must be as user-friendly as possible. In this context, particular support will be provided for technological developments to enable a nationwide implementation of electronic fare management (based on the core application of the German Association of Transport Operators (VDV)[22]) and its transferability to other areas of use (as, for example, between local public transport and airlines).

Innovative, intermodal information accessibility and information services provide the necessary foundations for integrated, barrier-free mobility. Transport information (for example, information about vehicle types, entrance and exit points) and guidance systems at stops or points of transfer can help make local public transport more accessible to persons with reduced mobility. They also help other passengers find their way in unfamiliar surroundings, and enhance the security and overall accessibility of transport facilities.

All of this requires cost-effective methods of collecting and maintaining the necessary geo-data and the standardisation of innovative information services. The recording of the relevant data about locations and infrastructural facilities must be standardised to enable inter-regional integration of such services. Personal navigational devices provide another means of integrating information relating to various modes of transport, and contribute to increased intermodal utilisation of the transport system.

Mobile on foot – at work or at play
People make approximately one quarter of all journeys on foot, making this "mode of transport" a key component of mobility. Directional assistance in the area of personal mobility, in particular for persons with reduced mobility or to provide tourist information, is just one possible application of personal navigation systems. Achieving the desired level of accessibility in our transport systems to ensure a flexible and environmentally sound means of travel is unthinkable if information cannot be provided about the current transport services on offer. Personal navigation systems provide an ideal medium for this purpose. In future, interaction between these systems and Internet and mobile phone technology on end devices will open up new application possibilities. Technical enhancements to ensure precise positioning (as aspired to in the GALILEO satellite navigation system) are required before these systems can be used for navigation within buildings.

[22] www.eticket-deutschland.de

Policy field: Safe travel

Approximately 90 % of traffic accidents can be attributed to human error. In future, technical systems will provide greater support for drivers, without interfering with concentration and without diminishing driver responsibility.

Driver assistance
The "car of the future" will provide active assistance in hazardous situations. The development of safety technologies (for example, to provide assistance during congestion or at intersections, or automatic guidance systems) that build on existing principles constitutes an important objective of this research programme. The underlying aim is to develop systems that can lessen the consequences of accidents, or even avoid accidents altogether. Appropriate information and communication technologies, issues relating to liability and individual patterns of behaviour will all be of significance in this regard.

Innovative safety systems for rail transport
Generally speaking, high safety standards have already been attained in the area of rail transport. However, in Europe in particular, rail transport is experiencing a critical phase of development. New safety requirements arise when, for example, the operational control systems of different countries have to be linked up to ensure integrated, cross-border transport. High-speed transport solutions also entail specific safety requirements. The need to reach a consensus between countries with different national safety philosophies constitutes a particular challenge, given that the consensus may have serious economic implications for the countries involved. For example, it is estimated that an investment of over ten billion euros will be needed in order to align Germany's signalling and control systems with the new ETCS European standard.

Other possible areas of research include solutions for real-time, automatic detection of damage to vehicles and tracks, or lifecycle-oriented methods for improving the efficiency of control and signalling technology. The use of new materials (as in lightweight construction) or new design principles that also adhere to existing safety standards requires costly testing and approval procedures, the costs of which can be reduced by R&D.

Enhancing perceived safety
It is important that passengers feel safe, in particular when using unmanned modes of public transport. Perceived safety plays a crucial role in the acceptance of public transport systems and routes. The integration of organisational and technical approaches to identifying hazards or emergencies ensures that immediate assistance can be provided should the need arise. Meanwhile, modern lighting concepts and visible monitoring equipment can allay fears and prevent acts of violence.

Policy field: Environmental protection and noise control

The development of future modes and systems of transport will need to take greater account of the potential effects on the environment and noise pollution levels. In terms of vehicle-related technologies, the following measures and strategies are currently being pursued:

Alternative drive technologies and fuels
The future development of engine drives must strive to significantly reduce CO_2 emissions. In the short to medium term, CO_2 emissions will only fall if drive technologies are consistently enhanced and made more efficient.

In addition to the ongoing enhancement of combustion-engine technology, the launch of cars with hybrid drives marks a large step in the direction of alternative drive systems. Hybrid drives combine a combustion engine and an electric motor, and thus also the advantages of both drive types, such as high range, fast refuelling, recuperation of braking energy, and less noise and lower emissions, to a certain extent at least.

The ability of hybrid drives to achieve sustainable market penetration depends to a large degree on whether they manage to reduce fuel consumption in everyday use by close to 30 % compared with conventional drives. Future research in this area will therefore focus on the enhancement of the core components of the drive line, as well as the application-driven development and integration of new functional modules. The solutions developed must have results that can be demonstrated in practice so as to prove the potential savings in terms of fuel consumption.

The research and development of specific solutions for vehicles (passenger cars and commercial vehicles) is required in the following areas:

- electric propulsion engines
- transmission and drive variants
- electric energy stores for mobile applications
- control units and converters
- energy and drive management
- standardisation and modularisation of the complete drive system

New materials and processes in automotive and engine technology

The use of new materials and processes can significantly increase the efficiency of conventional drives. A study by EUCAR/CONCAVE[23] predicts that the efficiency of diesel engines could potentially improve by between 16 % and 34 % between 2002 and 2020. The increase could be between 13 % and 24 % for petrol engines. The new EU Directive on the environment envisages that, by 2012, the average CO_2 emission level of newly licensed private cars in the EU will not exceed 120 g/km. The Euro 5 standards, which are set to come into force as of 2009, will see the introduction of further restrictions of emissions from petrol and diesel cars. New manufacturing processes and combustion systems, fuel-injection technology, friction optimisation, and resilient materials to meet increased requirements for pressure and temperature resistance all offer additional potential for increasing fuel efficiency and reducing emissions of greenhouse gases.

[23] EUCAR, JRC, CONCAVE, 2005: Well-to-Wheels analysis of future automotive fuels and power trains in the European context. A joint Study by European Council for Automotive R&D, European Commission Directorate-General Joint Research Center and CONCAVE. Overview of Results

Reducing traffic noise

Noise from rail and road traffic affects a large portion of the population. Traffic noise can be particularly intrusive at night, and can even lead to health problems. Changes need to be made to both vehicles and infrastructures in order to reduce this noise. Research contributes directly to the development of low-noise modes of transport and routes. It is particularly important to control noise pollution at source to prevent widespread propagation.

In order to make significant progress in combating noise pollution, integrated studies are required in relation to both rail and road traffic, taking **all** sources of noise into account.

Rail traffic noise: The main source of rail traffic noise pollution is rolling noise. High-speed traffic also adds aerodynamic noise. Freight trains are louder than passenger trains due to the simpler technologies used and certain train-specific characteristics. Rolling noise is caused by the friction between the wheels and the tracks. The formula is a simple one: The smoother the surfaces of the wheel and the tracks, the less noise produced by the train. K-type composite brake blocks (the development of which was funded by the Federal Government) produce a lasting reduction in the grinding of wheels against tracks. The technical specifications for new freight wagons cannot be met without the use of these or of similar technology. As a result, all new freight wagons procured by Deutsche Bahn are now equipped with K-type brake blocks. Existing rolling stock constitutes a particular problem because a conversion to K-type brake blocks requires a costly restructuring of the braking system.
As part of its noise reduction programme launched in 1999, the Federal Government funds noise insulation measures on existing sections of track (to the value of 100 million euros in 2007). These funds cannot currently be used for vehicle adjustments. Against the backdrop of the EU Directive on Environmental Noise, Deutsche Bahn has set itself the goal of halving rail traffic noise levels (based on 2000 levels) by 2020, i. e. to reduce these by 10 dB(A). This cannot be achieved by the noise reduction programme and K-type brake blocks alone. Additional new technological approaches must be developed as part of the LZarG project (“Quiet train on real track”) funded by the BMWi.

2.1.3 Intelligent Infrastructure

A well developed, efficient transport infrastructure is a core prerequisite for demand-oriented mobility of people and goods. It is an important factor in attracting new business and investment, and has a significant influence on economic development. It is therefore important to improve the efficiency of our existing transport infrastructures and adapt them to meet new challenges. The possibilities for expanding these or developing new infrastructures are limited. Instead, our focus should be on employing intelligent technologies and organisational forms to make better use of existing infrastructures.

Infrastructural building measures tend to have a major impact on traffic flows. At the same time, the renovation of traffic routes and transport facilities offers opportunities for technological innovation. These include procedures for monitoring the need for repair, and new methods for effective time-saving and cost-efficient corrective maintenance. In addition, new forms of infrastructural financing are now available in Germany, i. e. public-private partnership models, where private investors maintain public transport infrastructures. Transport infrastructure is becoming a corporate asset, which means that we can expect new approaches to and possibly also benefits for infrastructural maintenance and expansion in relation to lifecycle costs.

In future, intelligent interaction between vehicles and infrastructures will unlock new potential for greater safety, increased capacity and improved traffic flows. This applies equally to all modes of transport. Information providing a detailed description of the current condition, capacity load and availability of transport infrastructures and vehicles will prove instrumental in this. The funding measures that form part of this pillar of the programme are therefore directed towards projects focussing on the following areas:

Policy field: Creating free flow with intelligent transport systems

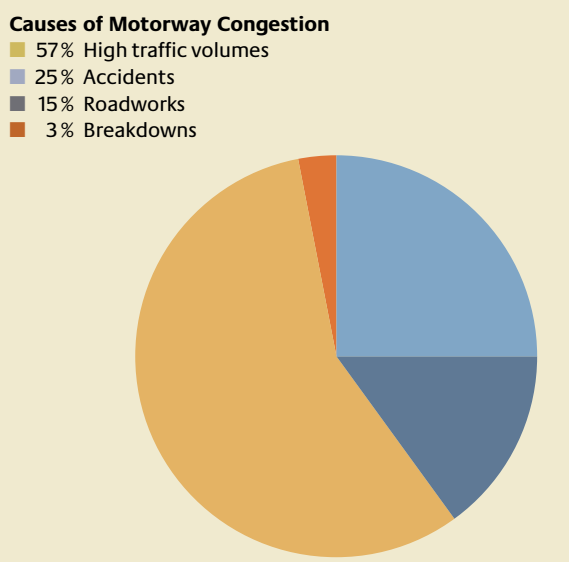
Statistics on the effects of traffic congestion are not available, and various studies have produced diverse findings.

According to the mid-term review of the European Commission's White Paper on EU transport policy, the economic costs of traffic congestion amount to 1% of the EU's GDP. In Germany, this figure is in excess of 20 billion euros per year.[24]

Congestion undoubtedly results in costs to the economy. Based on the findings of a research project commissioned by the BMVBS in 2004, the cost of delays due to congestion on Federal motorways can be estimated in the region of 3.5 billion euros annually.[25] The Federal Government aims to combat the reasons for this congestion as far as possible, not least in the hope of reducing the number of congestion-related traffic accidents.

High-quality traffic information

Navigation and traffic management require user-friendly end devices and reliable, comprehensive data generation. The traffic information currently obtained from a range of sources needs to be integrated and processed using models for reliable forecasting. Comprehensive approaches to the coordination of traffic management strategies are required, as is a



Source: Hessian State Office for Roads and Transport, 2005

[24] European Commission: "Keep Europe moving – Sustainable mobility for our continent". Mid-term review of the European Commission's 2001 transport White Paper, Luxemburg, 2006

[25] Printed paper of the Bundestag (German National Parliament) 16/5996, dated July 5, 2007

range of communication channels for transport users. Standardised interfaces, local communication technologies (such as W-LAN), broadcast channels (such as DAB) and bidirectional data transfer technologies (like UMTS) must be enhanced.

Traffic management currently pays little attention to information on environmental pollution, which would enable the counteraction of critical pollutants. Technological and organisational integration of the bodies involved in traffic management must be ensured, for example, through open interfaces to a shared system architecture.

Collaboration and communication on the roads
Collaboration and communication both among vehicles and between vehicles and an intelligent infrastructure are key requirements for innovation in traffic management. Driver assistance systems providing information about other vehicles and the current section of road should also be able to help drivers adapt their driving to the situation at hand, thereby increasing road capacity and reducing traffic disruption from accidents. Examples of situations where such technology could be used include the "zipper rule" used for merging traffic, lane-specific flexible speed harmonisation, and assisted passage through road works on motorways. In urban areas, we can work towards achieving the vision of a dynamic "green wave" by coordinating traffic lights in a way that is adapted to the traffic. The success of these approaches will be reflected in shorter journey times and lower emission levels.

Communication systems to support the operation of private and public vehicle fleets must also be developed, tested and standardised. Efficient operational control through collaboration and communication can, for example, act as a lever for cost reduction and for boosting the competitiveness of transport operators, while maintaining a good-quality public transport system.

Technologies for collaborative traffic management
Based on the principles applied to intermodal traffic management at a regional level, methods and instruments for collaborative, interregional traffic management will need to be developed in future. Capacity utilisation and traffic management can be improved across entire transport networks using sophisticated technologies to coordinate local traffic management resources.

This also requires new methods for coordinating and developing strategies for integrated traffic management. The conditions necessary for higher-quality transport will then be in place.

Legal and organisational issues are also of relevance in this context. Norms and standards can help safeguard competitiveness and shorten innovation cycles.

Policy field: Efficient and effective rail transport

Effective and efficient operational control
The introduction of the standardised signalling, control and train protection system (European Train Control System, or ETCS) represents a key prerequisite for creating an efficient cross-border European rail network. This involves the development of migration strategies that will allow the economic and operational benefits to be exploited as soon as possible, so that the technology, and thus the rail networks, will also be accessible to smaller rail operators.[26] R&D activities

ETCS: trans-European rail traffic is subject to many restrictions today because of established national electricity supply and signalling systems. The European Train Control System (ETCS) is the standard for European cross-border operational and control systems for rail transport developed by the EU Commission and the Member States in collaboration with the rail industry and rail operators. According to ETCS, trains should, in future, be able to travel throughout Europe without locomotive changes at each border, and with a standardised signalling system in place. ETCS will be implemented in phases. ETCS was introduced in Germany for the first time on the Jüterbog – Halle/Leipzig line (ETCS Level 2).

[26] In September 2007, the Federal Government set out a national implementation plan for early realisation of functional ETCS corridors. The plan is entitled "Nationaler Umsetzungsplan für die TSI Zugsteuerung, Zugsicherung und Signalgebung des konventionellen transeuropäischen Eisenbahnsystems gemäß Art 6, Abs 1 der Richtlinie 2001/16/EG" ("National Implementation Plan for TSI Train Control, Protection and Signalling in the Trans-European Conventional Rail System in Accordance with Art 6, Par. 1 of Directive 2001/16/EC").

are needed to enhance and test forecasting models for the railway operation, as well as tools for scheduling vehicles, personnel and routes and for incident management and, in addition, to develop optimised processes at a European level.

In terms of the physical infrastructure itself, signalling technologies now need to be updated. Even our relatively "modern" electronic signalling towers are already up to 20 years old. Redesign measures must therefore take account of the identifiable technological potential for an efficient rail system. In this context, European standards must ensure seamless integration of rail networks across borders and greater competition.

Longer and heavier: the potential for higher volumes of rail traffic
The longer a train is and/or the greater the permitted axle load, the more efficiently route capacity will be utilised because much larger goods quantities can be transported per stretch of track at peak times. In addition, specific transport costs are simultaneously reduced. In relation to relieving infrastructural pressure, these features are key to improving the profitability of both passenger and freight transport. The development of optimised train lengths and axle loads must take account of the particular requirements of the infrastructure and operating procedures. Basic investigations into economic efficiency, and the development of technical solutions for these kinds of innovations are important tasks that will help make rail transport more attractive to users.

Policy field: Building and maintaining routes for the future

The construction, operation, maintenance and optimisation of transport routes are all essential prerequisites for a smooth flow of traffic. In 2003/2004, over 40 % of Germany's 40,700 km of federal highway was slightly limited or limited in use. One in seven bridges on federal trunk roads is in a critical or unsatisfactory structural condition.[27] According to a statement by the German construction industry, almost one in five of the country's 32,000 rail bridges is over 100 years old, with almost half of these over 75 years old. Half of Deutsche Bahn's 600 tunnels are more than 127 years old, and two-thirds were built more than a century ago.[28][29]

According to the current Federal Transport Network Plan of 2003, the investment needed just to maintain the existing network is estimated to be in the region of 83 billion euros for the period 2001 to 2015, which equates to over half of the total investment.

LCC-oriented maintenance of road and rail
We currently lack both a comprehensive data base and a standardised methodology for calculating life-cycle costs (LCC) that take account of the current maintenance requirements for roads, rail routes and civil engineering structures. Research into a range of methods and technologies is therefore required (for example, for structural diagnostics and for estimating maintenance costs). In addition, specific technologies to maintain and expand transport infrastructures are required in order to achieve the objectives of LCC-oriented infrastructure management.

Intelligent road works management
Traffic obstructions and the associated ecological damage and safety hazards are to be significantly reduced by implementing technical and organisational measures for intelligent road works management. Road works planning could then estimate and make provision for the effects on traffic before work on a project even begins. This applies equally to road and rail.

Safety of transport infrastructures
Research and development towards an intelligent transport infrastructure must also ensure that appropriate safety and security technologies are made available.

The transport infrastructure is exposed to a wide range of threats (including natural phenomena, fire, accidents, criminal acts and acts of vandalism). Large transport hubs, bridges and tunnels are all areas of particularly high risk within the transport infrastructure.

[27] Road report 2007
[28] "Verkehrswege in Not" ("Routes in Crisis"). Letter to parliament from the German rail industry, 2004
[29] Detailed information about the condition of the rail network is also available in the report entitled "Infrastrukturzustands- und -entwicklungsbericht 2006" ("Report on the Condition and Development of Infrastructure") published by Deutsche Bahn AG in June 2007.

The risk of fire and smoke spread (for example, in tunnels) can be reduced through dedicated strategies and the implementation of safety measures. These include conducting simulation and risk analyses to ensure the operational reliability of safety equipment, as well as realistic fire tests and rescue exercises, which include checks of protection mechanisms and evacuation procedures.

Advancing electronics and sensor technology are opening up new possibilities for protecting transport users from or warning them about hazards (for example, black ice, snow, risk of aquaplaning, gusting etc.) or damage to roads (for example, measuring skid resistance on tarmac) or civil engineering structures.

In this context, innovative technology can make an important contribution to the improvement of transport safety, the protection and maintenance of the transport infrastructure, and to the improvement of subjective perceptions of safety levels for hazard prevention and prediction.

2.1.4 Synergies with Aerospace Technology – Transport Research at the DLR

The Helmholtz Association of German Research Centres (Helmholtz-Gemeinschaft, or HGF) has set itself the task of researching key and pressing issues relating to society, science and industry. To find solutions to these, the 15 German centres in the Association employ large-scale scientific infrastructures and equipment, and work in close collaboration with institutions of higher education and other research bodies on a national and international level. The Helmholtz-Gemeinschaft has both the framework and the capabilities required to carry out the type of in-depth and far-reaching research required when dealing with complex problems.

Institutional funding of the HGF adheres to the principles of programme-based funding in a total of six research areas. The "Transport" programme, which belongs to the "Space and Transport" research area, is currently being worked on exclusively by the German Aerospace Center (DLR). The content of this programme is closely aligned with the BMWi's funding programmes in this area, and focuses on medium to long-term research of relevant scientific issues and complex problems, which the DLR as a large research institute is particularly suited to tackle.

The objective is to help design a modern transport system that is sustainable in the long term from an economic, social and ecological perspective. Such a system is essential to the development and prosperity of our economy, and is a prerequisite for growth, employment, and for Germany's competitiveness in global trade and export.

It would appear, however, that the task of developing this kind of transport system is akin to trying to square the circle. This is because economic necessity and the desire for personal mobility are both in constant conflict with the chronic congestion of the transport system, the effects of traffic on health and the environment, and the large number of victims of traffic accidents.

With the involvement of the DLR, strategic objectives have been defined over the last number of years at both national and European levels. The pursuit of these objectives, some of which are listed below, will have a significant influence on transport research in the coming decade:

- Make more efficient use of existing transport infrastructures
- Effect modal shifts towards environmentally sound modes of transport
- Make intermodality a reality
- Expand the trans-European transport network, in particular the rail network
- Reduce the negative effects of traffic on human health and the environment
- Increase safety

The Transport programme has already been aligned with these overarching objectives during the set-up phase, and has taken them into account when defining the focus of the three new transport research institutes of the DLR and the programmatic design of the research objectives themselves. The programme's

constructive genesis largely originated from the recommendations of the Helmholtz senate, which were fully implemented and verified in an interim evaluation by independent experts in 2005. Since then, the programme has been developed further consistently with a stronger research focus towards industry. The success of this customer-oriented approach is already evidenced by increasing external funding from industry, as well as by the interest in strategic collaboration that has been expressed by various industry partners, which is undoubtedly based on reputation. However, the strengthening of existing contacts in industry is just one aspect of the programme's multi-faceted approach to cooperation and networking. This also extends to partners in academia and to institutions and associations in Germany, Europe and beyond.

The programme will continue to energetically pursue the same approach, with a focus on the following subject areas:

- Land-based vehicles
- Traffic management
- The transport system

Against the backdrop of Germany's increased focus on export, the demands of international as well as national transport markets will need to be considered. In particular, transport-specific expert knowledge is to be used to tap into expertise in the field of aerospace for traffic applications. This symbiosis, which is unique in Germany, will ensure that innovative high technologies produce solution-oriented results.

The programme's focus on **land-based vehicles** includes both road and rail vehicles. The *road vehicles* area encompasses the fields of "road user assistance", "vehicle energy systems" and "innovative vehicle structures", three more or less completely independent research topics with huge potential. Research to assess and develop vehicle assistance systems and automation incorporates work on sensor networks for position detection and analysis, the development of reliable mechatronic chassis and experiments with semi-automatic generation of realistic 3-D landscape models from remote sensing data for use in driving simulators. Additional focal points will be energy management and storage based on the overall optimisation of the fuel-consumption system, secondary energy use in vehicles, fuel cell systems suitable for application in vehicles, and other alternative drive forms and appropriate hydrogen stores. Also included in this area is research into the development of innovative vehicle designs and structures, taking account of multi-material design and airframe/space-frame structures. Many interdependencies will arise between this area and research relating to *rail vehicles*, dedicated to the development of innovative rail vehicle designs for both regional and high-speed transport. The research activities in this area aim to increase the efficiency and attractiveness of rolling stock by enhancing capacity, production and operation at lower costs and by ensuring greater levels of comfort for users. Meanwhile, greater safety and reliability is to be achieved through the development of more effective crash structures, coupled aerodynamic and structure dynamic optimisation and improved resistance to wear from wheel-track contact. In terms of improving energy efficiency and conserving resources, prominence will be given to research into reducing the aerodynamic friction coefficient, light-weight construction, increasing the efficiency of the energy conversion chain and intelligent energy management.

Traffic management is another priority research area. With regard to *road traffic management*, methodical principles are being formulated, which are being applied practically to the development of a *transport management strategy for major incidents and disasters*. These principles will be largely based on project experience to date in the area of traffic measurement using aerospace technology. This research seeks to integrate optical sensor technology and radar technology in a tool for assessing the situation and for forecast-based decision support to assist police and traffic management units, the Red Cross, the Federal Agency for Technical Relief (THW) or other relief agencies. The problems associated with cross-border transport and the collisions that occurred in the recent past are just two examples of the current evidence suggesting that rail transport can be made more efficient, and that some serious safety deficiencies need to be addressed. Consequently, research

and development in the area of *rail traffic management* focuses on operational safety, the optimisation of system and component testing, as well as lifecycle management for innovative rail transport systems. Efforts to develop a railway collision avoidance system are to make a significant contribution to improving safety, while simultaneously increasing capacity in rail transport. Meanwhile, *airport management* research focuses on the linking-up of ground and air transport. Here, the objective is to develop a total airport management system that integrates ground and air transport, taking account of capacity and safety and security issues. Activities in this area will be closely coordinated with the Helmholtz Aerospace programme.

Investigations into the interdependencies between **transport development and the environment** form the third pillar of the programme. For example, patterns of demand in freight and passenger transport both on the ground and in the air will be subjected to detailed analyses, evaluations and forecasts, taking into consideration technological as well as social development and trends. The key negative effects of mobility on people and the environment at the local, regional and global level will be placed under the microscope in research projects dealing with traffic noise and emissions. KOMPASS, the planned report on the status of mobility in Germany, also falls within this area. In addition to its own research and assessment of mobility indicators, the DLR also plays a coordinating and steering role in this project, which unites the expertise and research activities of prominent German research institutes and public partners.

2.2 Transport Research by the BMVBS

2.2.1 Research Dedicated to Creating a Modern Transport Policy

Modern transport policy, as an integrated transport policy, encompasses all modes of transport, namely road, rail, waterway and air transport. On the basis of a modern, high-capacity and efficient transport infrastructure, the modes of transport must be able to guarantee mobility today and in the future. Ensuring mobility as the foundation of Germany's economic success is therefore one of the central objectives of the Federal Government's transport policy. Mobility is also essential to facilitating participation in society, as well as being an expression of economic prosperity.

However, mobility must not lead to over-exploitation at the expense of humanity and of nature. The underlying concept of a modern transport policy is therefore that of an integrated transport, urban development and regional planning policy. This also includes easy access to destinations, short distances and a safe and environmentally compatible handling of traffic.

Our transport policy pursues the principle of sustainability. The aim is to ensure mobility, while at the same time overcoming and limiting its negative effects. This includes reducing resource consumption and pollutant emissions. This is achieved by optimising both the overall transport system and the innovation potential of the mobility industry itself. New transport telematics applications and traffic guidance systems can make traffic flow more smoothly, find the best routes and logistically track freight. Linking the various modes of transport is to facilitate transfers and combined usage.

The Federal Government's aim is for all modes of transport to form an efficient and modern overall transport system, thus providing relief to regions of high traffic density while at the same time creating development opportunities for structurally weak areas. Through innovative system solutions, such an overall transport system will also ensure greater safety – in road, rail, waterborne and air transport.

Therefore, to optimise the entire system, the Federal Government is focused on an integrated transport policy and, thus also a comprehensive policy approach. In addition to developing the conventional policy areas such as regulatory policy and investment policy (for example, in the construction and maintenance of transport infrastructure), other areas such as transport process optimisation, demographic change, urban development and settlement development, new technologies, energy supply, environment, climate change, financing systems and security are indispensable elements of an integrative, holistic policy approach that must be able to also cope with future issues. The research conducted by the BMVBS, also known as departmental research, serves to support this policy approach. It is essentially an innovation policy because transport policy must rely on the development of new future-oriented innovative solutions in order to handle issues associated with the sustainable protection of mobility.

Departmental Research as a Tool for Informing Policy-Makers

High-quality, knowledge-based external consulting services are drawn upon in order to respond to the many diverse issues raised by transport policy. This knowledge-based consulting, known as departmental research, is conducted at in-house, purpose-built departmental research institutes or is awarded to third parties in the form of research projects. The knowledge areas addressed in the context of departmental research nowadays no longer encompass only technology, economy and law, but also the areas of spatial research, psychology, sociology and organisational and political studies.

However, new knowledge areas, for example, logistics or transport informatics, must also be incorporated into departmental research in order to find viable answers to the questions posed by policy-makers. Spatial research must also be incorporated, and this is already happening as a result of the enhanced BMVBS portfolio. The transport sciences are not only interdisciplinary, but also cross-disciplinary, that is, completely new scientific areas are developing, for example, the cross-sectional areas of environment, energy and climate in connection with an integrated, intermodal transport system with all of its new and additional issues and facets.

The departmental research activities conducted by the BMVBS also include the support of the BMVBS during the further development of legislation and both technical and non-technical regulations, studies on transport and mobility development, the elaboration of forecasts and estimates, the development and support of policy programmes, as well as the development of aids to decision-making on important individual issues. Furthermore, certain individual aspects from the field of basic scientific research must also be examined if new issues are raised when putting a policy into practice or when setting up integrated programmes and such issues were never examined previously in this context (for example, mobility research) or if they require immediate clarification (for example, problems concerning fine-particle emissions or extra-long HGVs).

In terms of its departmental research, the BMVBS strongly advocates finding innovative solutions to problems. In this context, the BMVBS supports approaches that have already proven to be viable in isolated cases (for example, pilot projects or best-practice examples) until they are fully functional or ready to be brought to market (for example, electronic timetable information, electronic ticketing, the German Transrapid magnetic levitation system, applications for the Galileo satellite navigation system, the Transport Energy Strategy and the National Programme of Innovation for Hydrogen and Fuel Cell Technology). This appears to be necessary because, in many cases, the market is unable to help sound individual solutions make the necessary breakthrough in an increasingly complex, application-oriented environment. Under the auspices of public-private partnership processes, numerous possible solutions have already been successfully deployed.

In terms of the programme, the research priorities of the BMVBS are geared towards the policies prioritised by the Federal Government, in particular those stipulated in the coalition agreement.

2.2.2 The Integrated Overall Research Programme of the BMVBS – Structure and Target Fields

In addition to the departmental research institutes that fall within the area of responsibility covered by the BMVBS, namely the Federal Highway Research Institute (BASt), the Federal Office for Building and Regional Planning (BBR), the Federal Maritime and Hydrographic Agency (BSH), the Federal Institute of Hydrology (BfG), the Federal Waterways Engineering and Research Institute (BAW) and the German Meteorological Service (DWD), whose departmental research is not outlined below, the BMVBS has its own research programmes whereby specific research projects are awarded to third parties. Each year, the BMVBS outlines these programmes in one integrated overall research programme. To ensure better understanding and visualisation of the BMVBS approaches, the integrated overall programme is aligned with the following target fields:

I. Main Target Fields
   1. Infrastructure
   2. Urban/Regional Development, Agglomeration
   3. Participation, Regional Cohesion
   4. Safety, Security
   5. Environment
   6. Energy, Climate, Innovative Technologies
   7. Sustainability/Integrated Overall Concepts
   8. Improving the competitive position of the New Federal States
   9. European and International Cooperation

II. Data, Methods, Models, Procedures, Forecasts, Scenarios

III. Further Development of Ordinances, Guidelines, Technical and Non-Technical Regulations

IV. Strategic Communication, Conveying of Results

The aforementioned target fields comprise the general technical and thematic basic structure for the eight annually recurring and six fixed-term departmental research programmes operated by the BMVBS in the area of mobility and transport.

Main horizontal lines of research

The aforementioned target fields predefine the general structure that the individual research programmes operated by the BMVBS have in common. Depending on the budgetary and technical orientation of the individual programmes, different individual projects are defined for the individual target fields. The main "transport policy" lines of development determine the lines of research to be followed, whereby the difference between research funding and departmental research also becomes apparent. The main horizontal lines of research for the BMVBS are as follows:

- Future-proof, energy-saving, low-CO_2 and low-emission transport,
- Support for innovative technologies on their way into practical use,
- Low-noise transport,
- Protection of the transport system against climate change,
- Demographic change in transport, urban and regional development,
- Urban development at the interface of mobility and transport,
- Freight transport and logistics for enhancing German competitiveness in the global economy,
- Transport telematics for a more efficient use of infrastructure,
- Sustainability in future transport infrastructure financing,
- Safe transport.

Both the concept of integrated and intermodal transport and the concept of a European city provide direction for these main horizontal lines of research. Due to the various aspects involved in the aforementioned research lines, some of them are handled by several departments. The programme of innovation for

"Hydrogen and Fuel Cell Technology" is an example of a cross-departmental project funded jointly by the BMVBS, the BMBF and the BMWi within the framework of the 6 billion euro R&D innovation programme and the Federal Government's High-Tech Strategy.

The integrated overall research programme of the BMVBS comprises two main pillars, namely general BMVBS departmental research and research within the Federal Government's R&D innovation programme.

2.2.3 General BMVBS Departmental Research

Horizontal issues (general departmental research programme for transport)

The general BMVBS departmental research programme is the central starting point for departmental research by the BMVBS in the area of policy consulting. Here, in the form of analyses and studies based on departmental research, areas that may cause problems in future are identified, narrowed down and documented. In many cases, they are then later handled within their own programmes. This was the genesis of the BMVBS projects handled in Section 2.2.4 as part of the High-Tech Strategy. At present, the BMVBS is preparing to research two important new areas, namely electromobility and improvements to maritime safety.

With a programme budget of around four million euros per annum, this programme also finances all important work for infrastructure planning and its methodology, potential future infrastructure financing, and forecasts and scenarios for future development as a basis for general planning. Here, both demographic change and the possibilities associated with climate change are moving increasingly to the fore. Safety and security aspects are important issues, for example, in relation to the transport of dangerous goods or general emergency concepts in transport. Therefore, it can be assumed that, in future, technology leadership in the area of electronic system security for road vehicles (eSecurity), for example, will be equated with market leadership.

The issue of low-noise transport is increasingly significant against the backdrop of a desired shift of freight from road to rail. As part of departmental research in the area of policy consulting, the current research findings in relation to active and passive noise mitigation must be edited in a properly targeted manner, and strategies further developed.

The issues of climate change and the protection of infrastructure and operation against extreme climate phenomena are becoming increasingly important, especially in the area of maritime transport, inland navigation and aviation. As part of the BMVBS initiative „Shaping the Future to Address the Challenges of Climate Change", the BMVBS departmental research institutes of the German Meteorological Service (DWD), the Federal Maritime and Hydrographic Agency (BSH), the Federal Waterways Engineering and Research Institute (BAW) and the Federal Institute of Hydrology (BfG) bring their expertise together on behalf of the BMVBS in the area of shipping and waterways. Intermodal transport chains are considered to be part of the research area for optimising and increasing efficiency in the integrated overall transport system, which also includes aspects of trans-Alpine transport and the motorways of the sea.

In the area of shipping, the BMVBS funds studies on passenger ship safety and maritime safety. In passenger ship safety, a project that aims to develop holistic criteria for improved survivability of a (damaged) ship and modern criteria for the safety of everyone onboard is setting new standards worldwide, its starting point being that a ship is its own best lifeboat. The only way to fulfil this aim of continuously improving safety is to always use the most modern, innovative technology. Developing the requirements for a modular boat bridge concept with INS can also be regarded as another good example here. The requirements are being developed while taking account of all of the tasks that would be encountered in real-life use.

As part of its research information system[30], the BMVBS offers a a continuously updated online platform that provides information on the findings of important national, international and supranational projects from the area of transport and mobility, thus ensuring a broad knowledge transfer of such findings.

[30] www.forschungsinformationssystem.de

Departmental research into roads as a mode of transport (four individual programmes)

A budget of around 12.5 million euros has been allocated to four programmes that will fund more detailed research into finding ways to optimise the road network. This area concerns simplified infrastructure planning, increased safety through planning and organisational measures, noise reduction and noise prevention, improved traffic flow management and knowledge-based consulting when updating road guidelines and regulations. An important part of this departmental research is the implementation of road infrastructure planning where the issue of "simple construction" plays an important role in addition to scientific support for issues concerning nature conservation. Research on the functional evaluation of the road network is to provide new perspectives for future infrastructure planning. Under the auspices of a public-private partnership in the area of federal trunk road construction, the A and F models are to facilitate the involvement of a partner from the private sector in the planning, construction, financing and operation of German roads. This gives rise to numerous issues, from both a conceptual and a practical implementation perspective, that must be addressed. Road safety always forms part of the BMVBS transport policy. The safety of people on the move, especially older people, is also an issue, as are vehicle safety and infrastructural optimisation to improve the safety of the entire road network.

Departmental research in the area of aviation and aerospace

In the area of aviation and aerospace, the BMVBS operates a smaller programme with an annual budget of around one million euros. This programme funds research into safer air transport as well as local environmental aspects concerning airports. Its project for modelling measures to reduce noise and emissions aims to better identify the environmental effects of air transport, thus facilitating a targeted reduction of both forms of pollution. It also funds two other projects, one to develop strategies to reduce noise at source, and the other to develop new technologies for particulate emission measurements. When it comes to the further development of guidelines and regulations, this programme also serves the additional purpose of facilitating knowledge-based external support, for example in the following areas: the problem of biofuel blending for aviation fuel, passenger safety and protecting flight crews against cosmic radiation. The problem of the verification of the structural strength of aircraft and the question of integrating unmanned aircraft systems into the existing air transport system will also have to be addressed here.

German National Cycling Plan

Almost 100 million euros have been allocated towards the implementation of the German National Cycling Plan (NRVP) 2002–2012, along with an annual investment budget of around three million euros for supporting research projects, pilot projects and competitions. Numerous projects are currently underway, for example, to increase bicycle use in relation to the overall volume of traffic in Germany by 2012, to promote cycling as part of a sustainable, integrated transport policy, to further develop modern, socially acceptable and environmentally friendly short-distance mobility in accordance with the "Compact City" model and to improve road safety. Furthermore, pilot projects that include supporting research are funded with the aim of developing bicycle-friendly towns and cities.

Programme of Research into Urban Transport

As part of the reform of Germany's federal system, the old Local Authority Transport Infrastructure Financing Act (GVFG) and its associated state programmes have come to an end, but the federal schemes have continued and therefore also the Programme of Research into Urban Transport (FOPS). This programme enables the BMVBS to provide an annual financial budget of 4.2 million euros for research projects in the area of urban and rural local transport. FOPS is the only holistic, nationwide and practice-oriented research programme for handling urban transport problems. For this reason, it covers a wide range of issues. The purpose of this programme is to identify ways in which local authorities can deal with the current problems concerning particulate matter and nitrogen oxides as well as demographic change, the negative growth of many towns and cities as a result of heightened internal migration patterns and the effects on local and regional transport. Studies in the programme furthermore address issues concerning

local public transport (for example, against the backdrop of a future decline in the school-going population and, associated with this, the safeguarding of local public transport in rural areas) or issues concerning competition in local public transport. Another key issue is freight transport in cities, which also encompasses the subject of stationary traffic. Yet another focal point is to link different telematics applications (such as infrastructure data management) with computerised operational control systems and timetable information systems, and to develop these further.

The promotion of local public transport is therefore an important common element of transport policy at federal, state and municipality level. As part of an integrated transport policy, local public transport products and services that appeal to the public are essential to solving and avoiding mobility problems. Attractive public transport is a positive factor in attracting business and investment to our cities. Therefore, public transport has a key role to play in our transport system: Every day, 26 million passengers are transported by bus, tram or rail, which corresponds to around 18.5 million car trips. The Programme of Research into Urban Transport funds numerous promising research projects, all of which aim to improve our quality of life through the provision of better public transport. Managing personal motorised transport in a way that avoids harming towns and cities, and the general safeguarding of mobility both locally and regionally are other important issues in the Programme of Research into Urban Transport.

The Programme of Research into Urban Transport is a recurring two-year programme, whereby specific priorities are set for any given two-year period. For the period 2008/9, these are as follows: Safeguarding mobility through new forms of organisation/financing in local public transport (ÖPNV), mobile services (including information services) for users of public and private transport, making provision for public services in rural areas by linking transport policy, settlement policy, social policy and health policy as well as climate-efficient and energy-efficient urban and transport structures.

Mobility 21 initiative

Based on a wish from the parliamentary arena, the BMVBS is holding a competition for innovative transport solutions under the framework of "Mobility 21" in the following categories: Cities and conurbations, rural areas, infrastructure and mobility, freight transport and logistics, society and the environment, and innovative technology. The purpose of this initiative is to identify and pursue sound existing solutions and approaches that could not be developed further for various different reasons. A total of 3.8 million euros have been awarded for this competition.

With the funding initiative "Mobility 21 – Examples of Innovative Transport Solutions", the BMVBS seeks to promote innovative concepts, system solutions, technologies, procedures and services in the area of transport and mobility:

- that systematically build on existing findings from research and development,
- that are geared towards introduction, further development, establishment and distribution of these findings,
- where there is great public and economic interest in their implementation.

As part of this initiative, the BMVBS examines concepts that have already been developed, determines how relevant they are in terms of providing a solution to problems concerning transport policy and planning, and tries, with a view to the economy as a whole, to "generalise" the solutions to the problems. The programme's specific focal point is the promotion of solutions in the following areas: cities and urban areas (conurbations), rural transport, freight transport and logistics, innovative technology, society and the environment, and infrastructure and mobility.

The Internet portal www.m21-portal.de will document the projects and any success achieved in their further application. It also provides a general platform for other innovative transport solutions of general interest.

2.2.4 Transport-Related Research as Part of the Federal Government's R&D Innovation Programme

In association with the six billion euro R&D innovation programme and the Federal Government's High-Tech Strategy, the BMVBS uses a total budget of 200 million euros to fund different projects/project clusters that deal with the implementation and practical application of innovations.

Hydrogen and fuel cell/fuel strategy

The Federal Government is pursuing the goal of advancing the changeover to a sustainable energy supply in Germany. This is to have a balanced approach that fulfils the following criteria: safety, cost effectiveness, climate friendliness and environmental compatibility. The Federal Government is pursuing a balanced energy mix that does not have any one-sided dependencies.

For the transport area this means that the Federal Government's fuel strategy needs to be further developed.

Industry and Science are working on long-term fuel cell scenarios, strategies and research projects. The "National Programme of Innovation for Hydrogen and Fuel Cell Technology", announced in May 2006, is focused on continuing the work done in the past and setting new focal points. The aim of the programme is to accelerate the development of both technology and – and this is important for German competitiveness in the global economy – the market for this technology through targeted research funding and support for emerging hydrogen and fuel cell industries for mobile, stationary and portable applications.

The cross-departmental collaboration entitled the "National Programme of Innovation for Hydrogen and Fuel Cell Technology", which involves the BMVBS, the BMWi and the BMBF, bundles together all activities in this area. Funding for this programme will total 500 million euros up to 2015. Targeted research funding and the promotion of the emerging hydrogen and fuel cell industries are the best way to positively influence this process as another element of the Federal Government's fuel strategy and to reduce the transport sector's dependency on crude oil. In this regard, the BMVBS, as the department responsible for the practical implementation of these new technologies, is interested in participating in the development of sample applications at an early stage. This also affords the BMVBS a good opportunity to further develop its technical and non-technical regulations (for example, those concerning safety) at an early stage.

Ecologically friendly engines for ships

Increasingly, issues concerning energy and fuel also play a role in the area of maritime shipping and inland waterway transport. Backed by appropriate research, the BMVBS seeks to further reduce the emissions from engines for ships and promote more ecologically friendly drive systems.

The BMVBS has recently incorporated the issue of more ecologically friendly engines for ships into the High-Tech Strategy. Transport by sea and inland waterway is regarded as being environmentally friendly modes of transport. However, as a result of a ship's longevity, its drive system often becomes outdated. The BMVBS is currently tackling this issue through research and funding in the hope of also achieving faster improvements with regard to existing ships. This involves studies into the technical alternatives for reducing emissions in existing engines for ships as well as the suitability of modern, more environmentally friendly fuels for such engines.

As part of a further reduction in the emission thresholds for barge engines, the threshold for sulphur content and the introduction of biogenic components into fuels within the EU, there are also studies to determine whether older barge engines can tolerate such fuel and, if so, under which conditions. This kind of research is being carried out because if such a fuel were to become compulsory, a large number of old engines would have to be replaced at a considerable cost that could not be borne by the inland waterway industry.

It will have to be examined whether the results can also be applied to he maritime shipping and rail modes.

Freight Transport and Logistics Masterplan

A sound and efficient transport system cannot be achieved without excellent logistics. In terms of logistics, Germany is already a leading location in Europe. The aim of the BMVBS Freight Transport and Logistics Masterplan is to improve the basic conditions for Germany as a location for business and investment. Germany is to be made stronger and more competitive as a location for manufacturing and logistics, which will, at the same time, make a contribution to growth and employment. In this respect, the Masterplan is to be considered as an action plan aimed at achieving a more efficient overall transport system as well as better use of all modes of transport. Integration is key. In particular, greater efficiency means greater demand orientation, greater profitability and a clear forward-looking approach.

The Masterplan is to be developed within the framework of a wider communication process. The federal departments, professional associations, companies and trade unions, federal states, the coalition government, the Bundestag (the lower house of the German parliament) and science are all involved in the different stages of creating this Masterplan.

e-ticketing

For a long time now, research has been conducted into the provision of nationwide e-ticketing in local public transport (electronic payment, electronic fare determination and electronic tickets) and numerous variations have been tested. Through its development of a core application, the BMBF has developed a uniform system architecture that can be used as the basis for the long-envisaged nationwide implementation of e-ticketing. However, the envisaged efficiency potential can only be achieved through the coordination and nationwide implementation of a common interoperable standard in Germany. This is only possible with the backing of the Federal Government.

The so-called core application promoted by the BMBF is to provide a basis for the practical implementation of e-ticketing. The introduction of interoperable electronic fare management is to break down the barriers to using the local public transport system and give customers an enhanced travel experience, in addition to providing a new marketing platform and more appealing fare options for public transport operators and integrated transport associations. A sustainable, collective migration to the new technology would fulfil all of the requirements for achieving profitability and freedom of choice for the operators. The core application of the Association of German Transport Operators (VDV) enables a local migration to EFM systems, and allows for the coexistence of the following variants: cashless payments, electronic tickets and automated fare determination with an active or passive logon and logoff. Each of these stages will have a standardised customer interface, and customers will be able to travel anywhere at any time using the payment and processing methods that best suit them. This is an ambitious goal, even for German industry and the integrated transport associations/ transport operators.

Each of the individual transport operators and integrated transport associations will implement electronic fare management autonomously, in its individual migration steps, both locally and regionally.

e-ticketing systems with cashless payments, electronic tickets and automated fare determination contribute to breaking down the barriers to the local public transport system. This is evidenced by international experience. Smartcards (chip cards), in particular, have proven themselves worldwide as both an effective customer retention tool and an efficient technology in local public transport. They have also been instrumental in lowering marketing/operating costs, encouraging supplementary sales, acquiring new customers and optimising fares. An added bonus is the fact that they result in fewer fare dodgers and forged tickets, which greatly reduces the loss of earnings incurred by businesses involved in the transport industry.

Independent advisers have estimated that it will take around 570 million euros to implement nationwide e-ticketing for all companies involved in local public transport in Germany. The BMVBS hopes that its contribution of 10 million euros (for implementation research) will help make this innovative project a reality.

The VDV core application facilitates standardised electronic fare management with the possibility of European interoperability. It safeguards the economic freedom of choice for transport operators and the standing of most of these as medium-sized enterprises, while improving marketing opportunities with regard to customers.

The Travel Information Meta-Platform initiative

It is hoped that a budget of 4 million euros from the 6 billion euro programme will considerably improve the quality and availability of travel information for both private transport (roads) and local public transport. The goal is to create a situation where transport users are enabled to retrieve information while on the move in the transport system by using GPS/Galileo-enabled smart phones, for example, to stay informed at all times "on trip" about their location, mobility options, tailbacks and delays in both public and private transport. The intention, at a later date, would be to couple this with the e-ticketing project to ultimately produce the best travel solution in the form of a Personal Travel Assistant (PTA). A supporting goal of such a development would be to design the planned applications for senior citizens.

In the area of local public transport, the meta-platform is to build on the BMVBS project DELFI (integrated electronic timetable information) and develop it further in accordance with the requirements of local public transport. Better travel information will significantly increase efficiency in these of the transport infrastructure.

The preparatory work for the Travel Information Meta-Platform initiative was undertaken in six orientation studies that examined the following subareas:

- current and possible future detection procedures,
- current data quality and possible levels of quality in the future,
- current geo-referencing procedures and possibilities for inter-communication,
- basic conditions and interfaces for an overall travel information system
- as well as current travel information platforms in public and private transport.

The six orientation studies were to identify those areas that require attention in order to produce a suitable travel information system for all public and private transport in Germany.

Reliable travel data forms the basis for travel information that is accepted by users, and for efficient transport management. This is particularly the case when exchanging data from different sources. The meta-platform is to consolidate the data provided from different sources, which is currently scattered and uncoordinated, and prepare it for use in an integrated network. Special tools are required to facilitate this consolidation of data. To ensure comparability as well as reliable further processing of the data by the transport manager/service provider, it is also necessary to evaluate the quality of the data provided and to inform the user of its quality. Furthermore, travel information always has a spatial reference that is geo-referenced differently in the various systems. A geo-referencing system must be developed in order to facilitate the exchange of data between systems.

Through the use of standardised interfaces/protocols and other essential tools, the meta-platform is to act as a coordinating link between service providers, content providers and existing (sub)platforms in both public and private transport, as well as establish the necessary communication between data and systems. It is to provide consolidated raw data for public and private transport as well as breakdown information for service providers, for the public authorities responsible for collective traffic management and for the traffic alert services provided by radio stations. Some (sub)platforms already exist in conurbations as well as at regional, state and national level. Euregional platforms are also already in operation. All of these platforms are to be coordinated with the meta-platform.

2.3 Biofuel Research by the BMELV

2.3.1 Background

Almost a third of the end-point energy consumed in Germany is used in the fuel sector. The fuels used are based almost exclusively on petroleum, more than 97 % of which is imported. However, the availability of petroleum and other fossil resources is finite and the world's output of petroleum will have peaked in just a few decades. At the same time, energy consumption is on the rise as a result of the advancing economic development of many regions in the world, especially China, and a shortage of petroleum and rising prices are inevitable. Furthermore, the consumption of fossil resources places an immense and inevitable burden on climate, water, landscape etc.

Increased use of biofuels presents an alternative to the use of finite petroleum-based fuels, and can make an important contribution to sustainable mobility in a modern industrial society. This is particularly the case with regard to climate protection and the security of energy supply. In 2007, biofuels covered 7,3 % of Germany's fuel requirements (in relation to energy content).

Germany is therefore paving the way within Europe. Many countries are currently encouraging biofuel production as part of efforts to reduce CO_2 emissions.

In 2003, the European Union introduced the Biofuels Directive, which set defined goals and objectives to support the introduction of alternative fuels to the market. The Directive stipulated that biogenic fuels were to account for 2 % of fuel consumption by 2005, while a target of 5.75 % was set for 2010. Germany has already surpassed this target. Earlier this year, the EU Commission announced that it is to propose a binding target of 10% of renewable energy in the mobility sector, which means that biofuels will also have a growing market share.

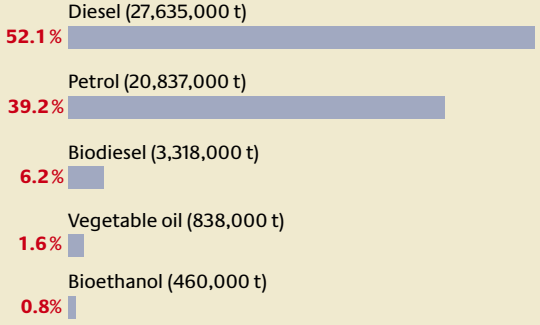
Measures undertaken by the Federal Government to promote biofuels

On January 1, 2004, the existing fuel duty rebate was extended to all biofuels and to biogenic shares in mixtures with fossil fuels. The Federal Government thereby promptly completed the framework set in place by the EU Energy Tax Directive in October 2003.

After detecting an over-compensation of biofuels in 2004, a partial taxation on biofuels was introduced in August 2006 when the Energy Tax Act came into effect. Furthermore, since January 2007, the Biofuel Quota Act also obliges the petroleum industry to gradually increase the share of biofuels blended into fossil fuel to 8% by 2015.

Under the framework of the "Renewable Resources" research programme run by the Agency of Renewable Resources (FNR), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) also funds R&D projects and demonstration projects in the area of biofuels. The BMELV's Market Introduction Programme for Renewable Resources supports, among other things, the installation and retrofitting of filling stations for private use in agriculture and forestry and also in environmentally sensitive areas of the local economy and the construction industry. As part of the package of measures entitled "Biofuels in Agriculture", the FNR has established 13 information and advisory offices nationwide on behalf of the BMELV.

Primary Fuel Consumption in Germany in 2006
Fuel consumption in 2006: 54 million tonnes
Biofuel percentage: 6.3 % (based on energy content)



Source: BAFA/BMU 2008

Current situation and potential within the biofuels area

In 2007, fuel consumption in Germany was distributed as follows: around 52% diesel fuel, 40% petrol and 7.3% biogenic fuels (an increase from 1.4% in 2003, 1.8% in 2004 and 3.8% in 2005). This share of biogenic fuels was largely covered by biodiesel (around 72%). In 2007, the share of bioethanol and pure vegetable oil within biofuel consumption was around 10% and 18% respectively.

Fuel consumption in Germany is expected to decline in future. In 2007, a total of 53 million tonnes were consumed, but experts predict that this will fall to just 44 million tonnes by 2020. At the same time, greater acreage is becoming increasingly available for the cultivation of energy crops. In 2020, this could amount to 3.5 million hectares.[31] If this acreage were used exclusively to produce synthetic biomass-to-liquid (BTL) fuels, it would cover just under 11 million tonnes or around 25% of the country's fuel requirements, which will have fallen to 44 million tonnes per year by that time.

In addition to conserving fossil resources, the ecological aspect also plays an important role. Biofuels can make a significant contribution towards achieving the aforementioned goals associated with reducing CO_2 emissions.

Biodiesel has already been widely introduced to the German market. According to industry sources, production capacity was around 5 million tonnes per year by the end of 2007. In 2007, a total of 3.3 million tonnes of biodiesel were sold. With a quota commitment of 4.4% for biofuels (based on energy content) in the area of diesel fuel, around 1.5 million tonnes of biodiesel alone can be sold as a biogenic component in 2007. Domestic and imported Rapeseed is the main raw material used in the production of biodiesel in Germany. However, in view of the existing and planned production capacities, the limited potential for rapeseed cultivation in Germany will be exhausted in the short run due to crop rotation, among other things.

In 2007, the use of **vegetable oil** as a fuel was around 0,8 million tonnes, the majority of which was used in commercial vehicle fleets.

The European fuel market's demand for **bioethanol** can be covered by production based on European raw materials, as well as imports from third countries. In order to develop the future market potential of bioethanol produced from European raw materials (in the face of the forecasted improvement in opportunities for bioethanol from third countries to access the European market, for example, through the WTO and bilateral/multilateral agreements), bioethanol production must become considerably more profitable in both Germany and the EU. At present, the production capacity for bioethanol in Germany is around 600,000 m^3 per annum. In 2007, 460,000 tonnes of ethanol, mainly in the form of ethyl tertiary butyl ether (ETBE), were blended directly into petrol. Since 2008, a 2% admixture of ethanol to petrol (based on energy content) has been mandatory. This share will increase to 3.6% by 2010 and remain constant until 2015.

However, while we may, for example, reach the domestic limits of rapeseed cultivation for biodiesel production, there are still considerable opportunities for increasing capacities, especially in relation to bioethanol.

It is estimated that, in the long term, Germany has 2.5 to 5 million hectares available for the cultivation of renewable resources.[32] Technological advance, in particular, will generally continue to free up acreage that can then be used to cultivate renewable resources.

In terms of ethanol in particular, there is still considerable potential for expansion in the area of biofuel production (including first generation biofuels) in Germany.

[31] FNR 2006

[32] BMELV and BMU (national biomass action plan, currently unpublished)

2.3.2 Focal Points of Biofuel Research by the BMELV

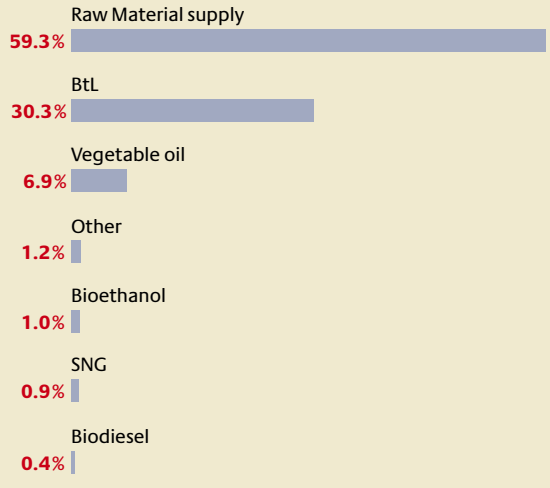
The funding of R&D projects and demonstration projects in the area of bioenergy has been part of the BMELV's "Renewable Resources" research programme since 2003.

Biofuel technologies can help strengthen Germany's profile as a location for business and investment and a location that offers cutting-edge technology, as well as open up new export markets. Furthermore, they generate alternative incomes in German agriculture, which strengthen Germany's ability to compete in this sector, while considerably strengthening upstream and downstream sectors also.

As part of its "Renewable Resources" research programme, the BMELV funds R&D projects in the area of first- and second-generation liquid bioenergy fuel sources. In terms of first-generation biofuels, these projects focus on supply, fuel quality, technical feasibility, environmental compatibility and exhaust emissions.

For R&D in the area of BTL, the BMELV support strategy "From the Field to the Tank" currently supports 20 projects (as at October 2008) with a total investment in funding of around 22 million euros.

R&D Measures for Biofuels (FNR)
Budget for recently concluded and ongoing projects: approx. € 14 million



Source: FNR 2006

To accommodate climate protection and resource conservation, while at the same time establishing sustainable alternative incomes in domestic agriculture and forestry, fuels and fuel components that are suitable for the mass market must be increasingly considered when formulating R&D projects.

If we are to close existing gaps and be in a position to use bioenergy for fuel purposes in a manner that is energy-efficient, cost-effective and ensures a high level of environmental protection, we must clearly intensify all our research efforts. Taking account of those issues that concern the energy sector, environmental policy and agricultural policy, the BMELV detects a particular need to conduct research in relation to the opening up of potential that is still largely untapped, as well the development of new, efficient, environmentally friendly and cost-effective processes for the supply and use of bioenergy sources for fuel production. Any future research conducted within the framework of the BMELV's "Renewable Resources" support programme will focus on the following areas:

Raw material supply (incl. cultivation)
In terms of R&D, we need to take action to achieve an environmentally compatible and economically viable cultivation of energy crops that also supports biodiversity. Furthermore, we must develop sustainable concepts for biomass logistics.

Biofuel production
It is imperative that we advance the development, testing and optimisation of production routes for sustainable biogenic fuels (for example, biomethane, BTL fuels or lignocellulosic ethanol) through to the first demonstration sites on an industrial scale.

Use of biofuels
Vehicle drive trains need to be developed further. Furthermore, R&D needs to be conducted in the area of biofuels and biofuel blends, especially in terms of the compatibility of materials used in the entire system (vehicles and filling stations).

There is also a need to conduct R&D in the innovative area of heat and power generation (for example, CHP technology).

Supporting ecological research (incl. emission studies)
In the case of biofuels used in Germany in the past, already in use or planned for use in the future, the relevant national and European standards authorities need to develop fuel standards that can be borne by industry, if they have not already done so.

Furthermore, these biofuels must be considered as part of existing regulations (e.g. the Tenth Ordinance for the Implementation of the Federal Immission Control Act). Biogenic fuel certification has also become necessary in view of the growing international trade in biofuels. The Biofuel Quota Act gives the Federal Government the power to link the tax-based and quota-based funding of biofuels to compliance with an obligation to ensure sustainability. The Federal Government is currently working intensively on a pursuant ordinance.

We also need to take action in terms of R&D with regard to emission behaviour and the optimisation of exhaust emission values for biogenic fuels and biofuel blends. Studies into the mutagenicity of engine exhaust emissions as a result of burning rapeseed oil and diesel fuel are expected to report their findings in 2009.

Supporting economic research
In R&D, we must continue to evaluate the economic, ecological, legal and technical aspects of promising routes for the production of biogenic fuels.

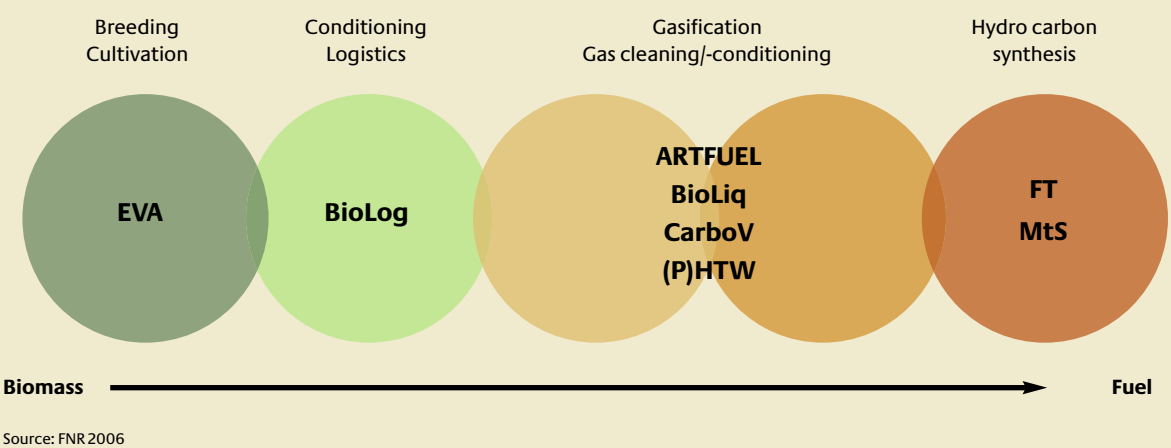
2.3.3 Focal Points of Materials Research by the BMELV

In addition to current research funding in the area of biogenic fuels, the "Renewable Resources" research programme funds numerous projects in the area of materials research relating explicitly to the automotive industry. The aim of these funded projects is to foster lightweight construction through the use of renewable resources.

In the automotive industry, especially in German mid-range and luxury cars, natural fibres are used as standard to reinforce door linings, rear window shelves, and boot linings, to name but a few. In 2005, around 19,000 tonnes of natural fibres (excluding wood and cotton) were used in Germany.

According to a study by the "nova-Institut", around 3.6 kg of natural fibres is used on average in every passenger car. However, it is difficult to predict the automotive industry in its choice of materials in the future. With each model series, there are reasons for and against the use of natural fibre-reinforced composite materials. In economic terms, natural fibre-reinforced and wood fibre-reinforced materials deliver sound price stability because they are less dependent on the price of oil than other materials, especially if a high proportion of natural fibre or wood fibre can be used. If there are greater penalties for CO_2 emissions

BMELV support strategy "From the Field to the Tank"



Source: FNR 2006

in future, additional economic benefits will be derived. Apart from a considerable reduction in weight, some of the other technical considerations that speak in favour of the use of natural fibre-reinforced and wood fibre-reinforced materials include intrinsic rigidity that matches glass fibre polypropylene materials, impressive crash test results with a high crash resistance, as well as good energy and sound absorption.

The automotive industry plays a key role in the development of natural fibre-reinforced and wood fibre-reinforced materials. For many years, the BMELV has supported the development of both lining and structural components as well as the modification of associated technologies. For some time, particular emphasis has been placed on biocomposites whereby natural fibres are to be integrated into matrix materials from renewable resources. Here, there are challenges concerning the further development and optimisation of production engineering and its adaptation to the processing properties of new matrix materials and vice versa. Developments to date involving biocomposite materials (natural fibres and vegetable oil-based matrices) concern areas in which processing procedures such as hand lay-up, the moulding technique or profile drawing have been applied to date, and for which the requirement profiles of target products have gradually increased. Following the initial developments made in terms of door linings, a car's exterior will be next to come under the spotlight, one example being the BMELV's support for the construction of BioConcept cars.

The BMELV takes account of the development of new materials from renewable resources in its current publications and in its funding priorities.

2.4 Environment-Related Transport Research by the BMU

2.4.1 Background

Mobility is an important fundamental concept for modern economies. However, transport is a considerable burden to the environment and endangers human health. Therefore, an overarching, priority goal is to fulfil the mobility needs of both the economy and society with as low a transport intensity as possible, and to further reduce the burden that transport places on the environment, nature and human health.

In Germany, transport has increased considerably in the past 15 years. Freight transport, in particular, has risen significantly during this time (see the graph provided below).

Increased passenger transport does not necessarily improve the mobility of people. Similarly, a rise in freight transport does not necessarily mean a better and more efficient supply of goods. Germany's mobility needs must be satisfied in such a way that they can be reconciled with the requirements for sustainable development. From an ecological perspective, this is the case when the quality and action targets are met in terms of climate protection, air pollution control, noise protection, nature conservation and rural preservation, quality of the residential environment and resource conservation. Targets and initial steps towards sustainable mobility are identified in both the climate protection programme and the Federal Government's national sustainability strategy.

The environmental and health implications associated with these developments can be divided into the following areas:

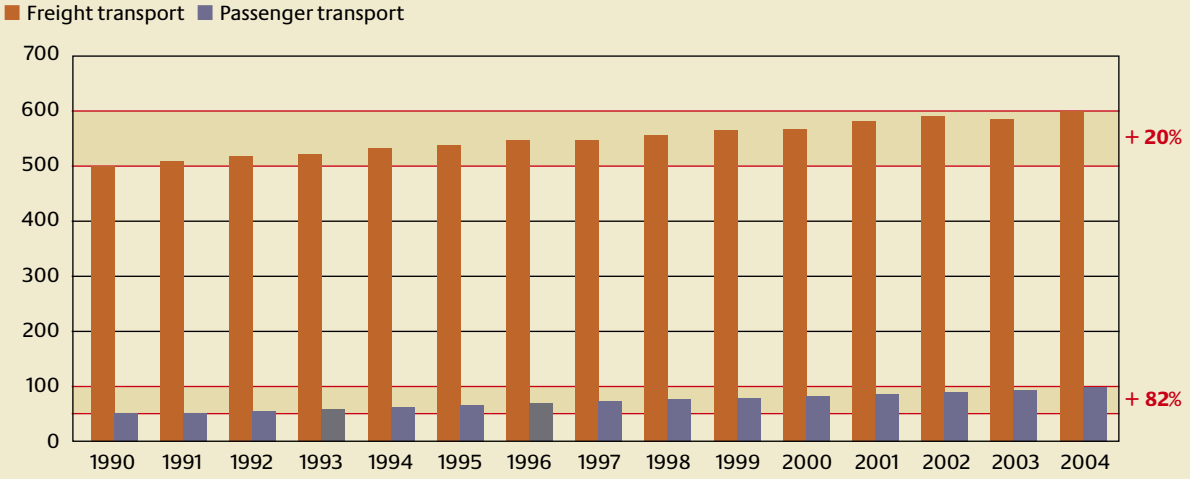
Climate protection

CO_2 emissions from transport are a significant contributor to anthropogenic climate change. In addition to the targets laid down in the Kyoto Protocol, which are binding under international law, other considerably more ambitious reduction targets must be achieved in the period 2020–2030 so that the effects of climate change can be reduced. The transport sector, in particular, will have to take major steps to significantly reduce emissions. The only way to overcome this challenge is to introduce a broad package of measures comprising several very different approaches.

Air pollutants

Despite growth in traffic volumes, considerable progress has been made in recent years in terms of the transport emissions produced by nitrogen oxides, volatile organic compounds (VOCs) and carcinogens (e. g. diesel particulates, polycyclic aromatic hydrocarbons (PAHs) and benzene). However, we still need to achieve more drastic reductions in this area in future.

Rise in Kilometers Travelled in Freight and Passenger Transport in Billions of Kilometers



Source: TREMOD 4.0 (Transport Emission Estimation Model), IFEU Heidelberg 2005

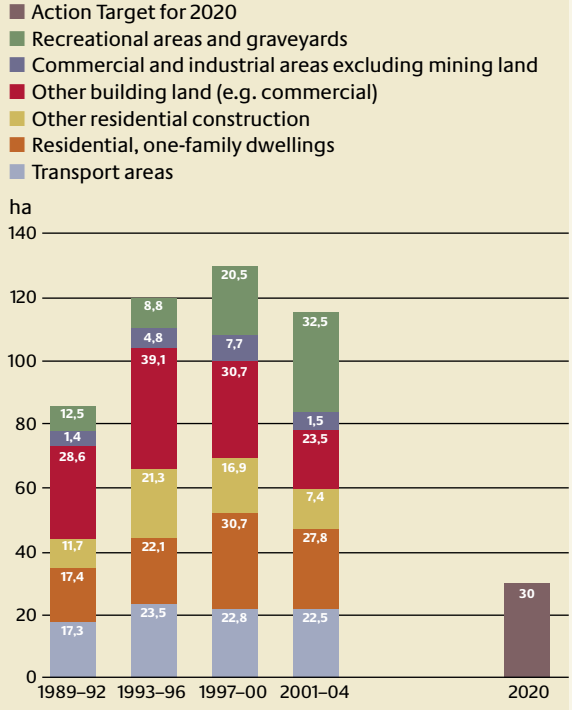
Noise

For many years, noise exposure in Germany has remained at a consistently high level. Approximately 60 % of the population feels affected by road traffic noise alone, with a significant portion being exposed to noise levels that are potentially harmful to health. The main problem areas are in conurbations (with traffic noise being the main source), along the main freight rail network at night and residential areas close to airports. As a result of the EU Directive on Environmental Noise, which requires each Member State to draw up noise maps, a survey of the current impact of this pollution is being drawn up for 2007.

Nature conservation and rural preservation

In 2004, the settlement and traffic area in Germany was 45,621 km² and land consumption continues to grow, especially at the expense of agricultural land. In the period 2001–2004, the area encroachment from settlement and traffic was, on average, 115 hectares per day. Initial measures to reduce area encroachment were introduced and implemented under the last Federal Government and will continue to be implemented by this Federal Government. The amendments to the Federal Building Code, the Federal Nature Conservation Act and the Federal Soil Protection Act serve as examples of the progress made in planning law. The abolition of the home ownership grant for new owners as of 2006 also contributes to a reduction in area encroachment.

Daily Rise in Settlement and Transport Areas
Causes and Causers (eastern Germany Estimated 1989–1992)



Source: FEA Calculations Based on the Federal Statistics Office

Safeguarding and improving the urban quality of life

Transport and mobility are among the most controversial action areas in urban planning. Unlike almost any other area in local government policy, they concern ecological as well as economic and social issues. Frequently, the many endeavours and problems associated with improving transport conditions at local level cannot be measured in concrete terms as regards their scope or their effects.

2.4.2 Research Priorities

The research activities of the BMU strive to help reduce traffic-related pollution. The research tasks seek to determine traffic-related CO_2, pollutant and noise emissions as well as examine relevant ways to benefit the environment through traffic planning measures, reduced traffic or modal shift and the use of new or improved technologies. Pilot projects test these research findings to ensure that they can be applied in practice.

The research activities support the four areas in which traffic-related pollution can be reduced:

- Lower transport intensity by decoupling economic performance from transport,
- Modal shift to more environmentally sound means of transport,
- Greater utilisation of existing transport capacities and
- Reduced vehicle-specific environmental pollution.

If the transport sector is to make an adequate contribution to the reduction of CO_2 emissions, it is necessary to examine and implement not only technical measures in relation to vehicles and improved fuel quality, but also measures that relate to an overall concept for environmentally friendly transport and ensure high mobility with less traffic. The goal here is to adopt a number of different approaches in an effort to considerably improve the efficiency of the overall transport system.

To optimise the use of various instruments, it is necessary to first undertake a comprehensive analysis of mobility behaviour and the transport market. Therefore, one research priority is the development of instruments that can evaluate the measures for an overall concept for sustainable mobility. In particular, the possible contribution that renewable energies can make in the mobility sector is to be examined more closely. In this regard, we commissioned a research project entitled RENEWBILITY, which commenced in August 2005 and is expected to run until mid-2009.

Another goal is to fully decouple growth in transport performance from growth in economic performance, in particular by increasing efficiency. The research priority in this case is to influence the relationship between trade, logistics and traffic volumes in the area of freight transport, and the relationship between regional settlement patterns, travelling distances and mobility in the case of passenger transport. It is necessary, in this regard, to identify innovative developments that will increase the efficiency of freight carriers (both infrastructure and transport-related) and logistics processes, evaluate these from efficiency perspectives, and then deduce the resulting consequences and opportunities for more environmentally friendly mobility. Furthermore, it is hoped that the practical optimisation of logistics processes will mean lower transport intensity and therefore a further reduction in resource consumption and climate-relevant emissions. Therefore, sustainable mobility not only reduces pollution and results in a better quality of life, but also has long-term economic and employment benefits.

At present, this research activity is part of the R&D project entitled “Sustainable Mobility through Innovations in Freight Transport”, which was awarded in August 2006 and accompanies the “Freight Transport and Logistics Masterplan”.

With regard to the population’s current exposure to noise (especially in relation to traffic noise), we must seek to reverse current trends. Therefore, any noise exposure that can have serious health effects and cause considerable nuisance should be avoided in residential areas as soon as possible. In the long term, this level of protection should be raised to prevent, as far as possible, disruptions to communication and concentration as well as interference with recreation and sleep. To further reduce noise in rail transport operations, technological challenges include finding solutions for enhanced rail monitoring and maintenance. Studies into noise reduction in air travel and in vehicles, as well as topics such as low-noise tyres and noise-absorbing road surfaces, will continue to be pursued. Additional innovative measures are also required alongside technological measures to mitigate noise exposure in conurbations.

The research priority in air pollution control technologies for transport and fuels is a reduction in pollutant emissions outside compulsory type approval cycles for light and heavy-duty commercial vehicles as well as the more general development of ways to reduce pollutant emissions in ocean-going vessels and aircraft. Furthermore, research projects are to be used to devise concepts for developing and evaluating alternative drive systems and fuels. Criteria will also be defined for the further development of instruments that measure fuel consumption and CO_2 emissions from vehicles. These criteria are to better inform car buyers about energy consumption in auxiliary systems such as air conditioning, thus enabling buyers to lean towards purchasing more efficient vehicles. Furthermore, these are to act as an incentive for vehicle manufacturers to dispense with such extras or to use low-energy consumption devices.

A key goal of sustainable transport policy is to improve the modal split in favour of more environmentally friendly modes of transport. In this regard, use of both rail transport and the environmentally friendly inland waterways transport system must be intensified for freight transport, in particular. At the same time, however, additional efforts are necessary to safeguard and extend the environmental benefits

associated with these modes of transport. With regard to inland waterways transport, implementation of the FUTURA concept is to promote the construction and operation of particularly environmentally friendly inland-waterway vessels that have been modified for use on rivers. Promotion of intermodal freight transport requires a quality initiative in terms of interfaces.

In the area of passenger transport, it is necessary to encourage cycling and promote customer-friendly local public transport. To retain existing customers and attract new customers, local public transport must be both efficient and appealing. In this regard, individual projects have already produced many positive results. The findings from such projects are to be intensified in future for stakeholders in other cities and municipalities.

For comprehensive sustainable mobility at local level, it makes sense to develop and update guidelines with concrete objectives to be met by stakeholders on the ground in order to support a sustainable transport system. These guidelines must cover all important transport issues, ranging from settlement development through to preventive health care.

However, the objectives concerning climate policy and energy policy for the transport sector cannot be achieved unless we intensify our use of renewable energies. Since renewable energies in other sectors are to also contribute significantly to lower CO_2 emissions and reduced energy imports, it is imperative that they are used efficiently in transport. When considering the energy chain as a whole, the drive systems in battery electric vehicles are the most efficient. They do not cause any local pollutant emissions. Furthermore, sound emissions are limited to rolling and wind noise. In conurbations, in particular, they can make a significant contribution towards a better environment and quality of life.

By combining an electric motor with a combustion engine, a plug-in hybrid drive can use electricity from renewable energies to cover a large proportion of the kilometres travelled each year, without the user having to tolerate any limitations (when compared with a conventional vehicle). To support the strategic further development of this engine type, the BMU is currently road testing plug-in hybrid vehicles.

2.5 Transport-Related Research by the BMBF

Sustainable, safe and efficient mobility is one of the key pillars for a functioning economic system and modern society. Research in the most diverse of areas is necessary to achieve innovation in the area of mobility. Greater vehicle reliability and safety through the use of a systematic approach is a common vision shared by several research programmes funded by the BMBF.

The BMBF funds transport-related research as part of various specialist programmes, especially "ICT 2020: Information and Communication Technologies 2020", "Materials Innovations for Industry and Society" and "Microsystems" as well as molecular plant research and systems biology.

2.5.1 ICT 2020

In the specialist programme „ICT 2020", transport-related research is promoted through innovation alliances. Innovation alliances are technology-spanning collaborations between science and industry that relate to a specific field of application.

Innovation Alliance: "Initiative for Automotive Electronics"

Electronics and electronic systems are today the main driving forces behind around 80 % of all automotive innovations. In order to preserve competitiveness over a period of 10 years and more, it would appear appropriate to support the German automotive industry with a national initiative on a pre-competition level. Leading German car manufacturers and components suppliers therefore suggest launching such an initiative called "Initiative for Automotive Electronics" in order to take a holistic approach to dealing specifically and sustainably with current research topics in precisely this area.

The challenges lie in the following areas: safety, reliability and the environmental compatibility of systems.

Safety: Driver assistance systems offer great potential for protecting the lives of passengers and other road users. It is possible to envisage driver assistance systems that can support the driver in critical situations by detecting the surroundings, for example, using networked sensors and by controlling the vehicle (for example, with the drive train).

Reliability: The reliability of automotive electronic systems is one of the key considerations when purchasing a vehicle and has a major impact on the warranty costs. And yet, growing system complexity and progressive miniaturisation pose completely new challenges in terms of reliability.

Environmental compatibility: Environmental compatibility implies energy efficiency and reduced pollution. Energy efficiency can be increased by comprehensive energy management. Electronic systems also play a major role in controlling the drive train. The tasks for future engine electronic systems include increasing engine efficiency, reducing pollutant emissions and integrating electric drive systems (hybrid solutions). This requires extensive development of power electronics and mechatronic systems.

The *Initiative for Automotive Electronics* aims to ensure that cars made in Germany will still be among the best in the word in another 10 years' time, and will be able to assert themselves on the world market. This will be achieved through research into electronic components and systems for the car of tomorrow, which is taking place before exposure to competition with the involvement of many different companies, together with universities and other research institutes.

The vision is for a zero-fatalities, zero-faults and zero-emissions car, i. e.:

- Reduced emissions and increased fuel efficiency
- Increased safety through driver assistance systems with complete detection of the car's surroundings, aiming to achieve "accident-free driving" in the long term
- Individual and intuitive comfort systems for simple, safe handling and control, including the communication infrastructures

- Manageable system complexity and cost reductions, with a simultaneous increase in the share of electronic systems in the car

- Increased system and function reliability with growing system complexity accompanied at the same time by progressive miniaturisation

The research topics and technological prerequisites for achieving these objectives are as follows:

- *Technologies*

Advanced CMOS, software technology, intelligent power electronics, sensor systems, secure data communication, system integration technologies, unconventional actuators, pattern detection and sensor fusion, adaptive and multi-modal driver dialogue systems

- *Systems & architectures*

Modular architectures, fault tolerance and fail-safe characteristics, consistent simulation/design, system and function reliability, robust design, zero-fault concepts

- *Standardisation*

Standardisation of interfaces & modules, creation of open systems for high modularity

Innovation Alliance: "Communication Technology for Safe Mobility"

One achievement in recent decades has been that far fewer people die in traffic accidents than in the past. However, as long as people are still being killed and injured in road traffic, traffic safety will always remain an important research policy issue. Furthermore, efficient mobility is one of the key pillars for a functioning economic system and modern society. Given the forecasts for future growth in traffic volumes, traffic flows will have to be organised along intelligent lines, also taking account of the differing requirements of individual groups such as senior citizens.

Information and communication technologies offer great future potential in this context. They open up a new dimension of foresighted driving. The exchange of information between intelligent systems from car to car or between cars and the traffic infrastructure could help to save lives in future. For example, warnings of traffic jam tail ends could be sent to following cars, cars that are further away can be informed of accidents, and so on. Furthermore, the data transmitted by cars to a traffic management centre could also help improve the traffic flow.

The challenge from the perspective of communication technologies is that current standards for wireless data transmission are not yet suitable for safety-relevant applications. In this case, the communications networks must be particularly fail-safe and permit swift reactions with low delay times. A number of projects funded by the BMBF and the BMWi have already laid the foundations, so that further research and testing in realistic environments is now necessary. This will require a cross-departmental approach.

The overriding objective of the innovation alliance is to halve the number of road fatalities in Germany in the medium term and to drastically reduce the number of accidents. Furthermore, traffic congestion is to be avoided and accurate traffic information made available promptly to road users. The technological and economic objective is to establish a uniform standard in car-to-car communication, initially on a European level.

Research needs to be conducted in the following areas: further development of the WLAN standard (IEEE 802.11p) to achieve a viable standard for car-to-car communication with high bit rates; further development of the standard in cellular mobile phone telecommunication for traffic use; investigating the viability of a reserved frequency band in the 5.9 GHz band for safety functions; new forms of mobility management at local or moving danger points (for example, road works or an accident), multi-modal driver assistance systems and standardised semantic technologies for communication between cars and the traffic infrastructure.

Innovation Alliance: "Networked Intelligent Objects in Logistics"

The globalisation of production and commercial transport, together with acceleration in the cycle rates of commercial activity, are currently seen as the major driving forces behind modern logistics development.

New demands in terms of speed, fault tolerance and flexibility require maximum transparency and automated handling of physical flows.

From a technical perspective, the challenge is to implement intelligent self-organisation of (possibly remote) application components, while at the same time permitting a reduction in the complexity of previously centralised ICT systems and enhancing system reliability. Security aspects refer to the reliable protection of communication between all system components as well as ongoing detection of manipulation or intruders.

The overall aim is for prototype implementation of an innovative integration platform for logistics information systems based on sensor networks. This includes developing a service-oriented software architecture, hardware infrastructure, system integration, validation and demonstration in practical application cases.

As far as application is concerned, scientific clarification is needed in terms of how to achieve technical and economic improvements in logistics processes with intelligent objects based on sensor networks or other automatic ID or tracking technologies; how to integrate decentralised information systems based on sensor networks into in-company and cross-company ICT infrastructures; and how to use these aspects to develop new business process models.

The following research topics need to be addressed and the appropriate technological prerequisites put in place: sensor networks, microsystems, safety and security, energy (storage, generation/supply), miniaturisation, service engineering, ICT networks and systems, protocols and standards, service-oriented software architectures and data integration.

2.5.2 Materials Innovations for Industry and Society

Within the framework of materials research funding by the BMBF, a large proportion of funding is allocated to new materials technologies including their manufacturing and coating processes for transport technologies. The main beneficiary of this funding is the automotive industry and its supplier structures.

The following programmatic objectives are currently being pursued:

- Weight reduction through the use of lightweight materials: light metals, high-strength steels, polymers, fibre-reinforced composites, hybrid materials; newer approaches to reducing component complexity by integrating functional properties into structural components (mechatronic and adaptive materials, smart materials)

- Greater efficiency (higher power density, higher thermo-mechanical load spectrum, less friction loss, less consumption) in engine technology and in the construction of aircraft turbines through the development of high load-bearing materials (nickel-base superalloys, new steels, intermetallic alloys, hybrid materials) as well as the use of nano technology (for example, tribological nanolayers)

- Reduction in exhaust emissions through improved catalytic converter technology (catalytic layers, metallic and ceramic carrier systems) and sensor technology as well as higher load-bearing materials in the drive train

- Safer and more comfortable transport technology components as a result of the use of functional materials (for example, tyres, a functional outer shell and interior fabrics)

Future research topics will focus increasingly on materials technologies for greater resource efficiency (using fewer materials and less energy), for lightweight structures in the construction of vehicles and aircraft, for lower emission thresholds (especially for CO_2) and for energy storage. New developments in nanotechnology and simulation technologies will give materials technology new impetus.

Innovation Alliance: "Lithium Ion Battery LIB 2015"

Against the backdrop of a growing need for electrical energy storage in order to safeguard power supply and mobility in the future, the BMBF has, with strong financial backing from industry, launched a sponsoring programme entitled "Lithium Ion Battery LIB 2015". This programme is supplemented by or linked to initiatives in the area of pure research by the

German Research Association (DFG), institutional research, for example, by the Helmholtz Association of German Research Centres (HGF) and support from other federal government departments.

The high technical requirements in terms of the necessary energy and power densities (factor 5–10), as well as the life span and the temperature windows, can only be achieved through lithium ion technology. However, it is not possible to upscale the existing lithium ion technology (in laptops or mobile phones). Instead, we require new approaches to materials and technologies, which must also satisfy the high security requirements, in particular.

The innovation alliance LIB 2015 is geared towards mobile (further development of hybrid technology/ development of technology for an electric vehicle) and stationary (storage of renewable energy generated for standalone solutions/cushioning of peak loads) end use. In terms of content, BMBF funding concentrates on research in the following areas: materials and components, production engineering for the manufacture of battery cells, microsystems technology (for example, the system integration of cells into a battery system and the integration of a battery into the relevant area of application).

Its goal in terms of industrial policy is to pool together and strengthen the top competencies in German industry for important sub-components and forge successful partnerships with the world of science. This involves strengthening and expanding the entire value chain, including German battery manufacturers, and ensuring competitiveness in this future market, which is particularly important for the automotive and (renewable) energy sectors.

2.5.3 Microsystems

As a result of new solutions in the area of microsystems technology, sensor technology development has reached a feverish pace, resulting in significantly improved driver assistance and increased vehicle safety. Driver assistance systems are partially established in the market but, for a long time now, they have remained far behind the technical possibilities. Consequently, initiatives within the framework of the Microsystems research programme focus on improving sensor technology for detecting a car's surroundings as well as research with the aim of improving the human-machine interface, that is, optimised interaction between driver and vehicle.

In addition to enhancing vehicle intelligence, advanced sensor technology and actuator technology are used to control and regulate complex tasks within the vehicle. This is particularly true of engine management and the drive train. To achieve the climate goals of reducing fuel consumption and pollutant emissions, we require new concepts and optimised rules. These, in turn, require adapted sensor technology. Planned research projects are to lay the technological foundations for more environmentally friendly vehicles and for environmentally friendly transport (for example, within the framework of the innovation alliance for lithium ion batteries).

Vehicles are becoming increasingly complex. Today, a vehicle comprises several million lines of software code, several kilometres of cable and more than 15,000 components. The most important purpose of a vehicle is to transport people and/or goods. In our networked society, predictability and reliability are essential. As a result of the growing complexity not only of vehicles but also of value chains, an increasing number of system failures is currently being observed. Our national standard of excellence, "Quality Made in Germany", is increasingly being put to the test. The traditional approach of increasing the reliability of individual components no longer has the desired effect at a reasonable expenditure. Here, it is also necessary to develop new concepts, in particular, integration of the overall system concept and better connectivity for individual components. Microsystems technology, in conjunction with electronics and software, plays a key role in condition sensors and can significantly improve continuous monitoring of critical components.

2.5.4 Molecular Plant Research and Systems Biology for Optimising Biofuels for Future Drive Concepts

Regional availability, positive effects on the environment and climate, opportunities for sustainable production and a positive impetus for socio-economic

developments in rural areas are all aspects that promote intensified use of biogenic fuels. In addition to utilising biogenic residues or using micro-organisms such as algae, plants represent the main production basis for second-generation biofuels. Thanks to the perfected finishing steps for synthetic fuels, second generation biofuels have the potential to achieve a higher purity level. Synthetic fuels are a prerequisite for the next generation of combustion engines.

The BMBF aims to support the establishment of renewable bioenergy production in Germany, so that it can compete internationally, that is, without grant aid. Renewable bioenergy will make a substantial contribution towards Germany's mix of energy in the future. Germany's technology leadership in the different value chains of bioenergy production and use must be conserved or established. The required synergy effects between green and white biotechnology is to be promoted with the aim of optimising the market relevant output traits of biogenic fuels.

In past centuries, plants were primarily selected and bred for their nutritional properties. To cover the growing demand for biogenic fuels and to facilitate the development of specific new traits for such diversified usage concepts, plants must be bred with specific new traits in the shortest time possible. Biotechnology, genome research and systems biology lay the foundations for optimisation. Ongoing R&D programmes funded by the BMBF (for example, GABI-FUTURE, FORSYS or GenoMik) provide the basis for explaining complex molecular relationships and facilitating their innovative use. "Public-private partnerships" are prerequisites for the pooling of resources and competencies, as well as promptly implementing these findings in innovative products and production processes. This enables molecularly assisted or rational plant breeding ("Breeding by Design") methods, which are already providing the foundations for breeding progress, as well as strengthening Germany's global competitiveness.

There are plans to design a cross-departmental R&D concept that is geared towards complex innovation chains, thus setting the necessary impetus for all industries concerned.

In the area of "biofuels", R&D funding is concentrated on the fields of plant genome research/biotechnology and plant systems biology in order to explain molecular relationships and cellular networks to:

- Optimise net yield per unit
- Develop concepts for rational plant breeding ("Breeding by Design") to optimise raw materials
- Enhance agrarian biodiversity through the utilisation of natural and induced genetic diversity.

Furthermore, support is provided for:

- Research activities towards a technical use for photosynthesis and
- Pure research for optimising conversion processes.

2.5.5 Research for Civil Security

It is by no means an overstatement to say that the transport routes of modern society, namely road, rail, air and water, are its lifelines. Their use has now become so finely balanced that minor disruptions could have far-reaching adverse effects and cause considerable damage. If these routes are blocked, the consequences can be catastrophic and could destabilise society and industry. On January 24, 2007, the Federal Government adopted the programme "Research for Civil Security". This programme focuses on greater citizen protection against the threat of terrorism, organised crime, natural disasters and technical incidents. Critical security situations and new threats require highly developed technologies as well as innovative security systems and their associated action strategies.

The security research programme is part of Germany's High-Tech Strategy. This funded research project is expected to provide solutions that will contribute to civil security and open up the international market for Germany security products and procedures.

The security research programme is aimed at companies that develop innovative security solutions as well as operators of security-relevant infrastructures. These include operators of transport infrastructures as well as their cooperation partners in research facilities, authorities and industry.

Funding for this security research programme is organised along two programme lines:

The first programme line "Scenario-Oriented Security Research" follows a comprehensive approach that considers all relevant aspects of a potentially very complex primary security solution. This programme line calls for proposals in the following areas: "Protection of Transport Infrastructures", "Safety and Rescue Solutions", "Protection of Critical Supply Infrastructures" as well as "Securing Commodity Chains".

The second programme line 2 "Mixed-Technology Networks" focuses on research and the use of new security technologies for clearly defined areas of application. This programme line calls for proposals in the following areas: "CBRNE Sensor Technology", "Integrated Protection Systems for Security and Emergency Forces", "Pattern Recognition" and "Biometrics". In all areas, research topics have applications for transport will be eligible for funding.

Appendices

I. Guide to Project Funding

Project funding is intended for companies, research institutes and universities. It takes the form of grants for research projects that are assigned different R&D levels (research categories), depending on the objective in each case. These levels include pure research, industrial development and experimental development. Also included are projects that seek to demonstrate the initial practical application of improved or new transport technologies and system approaches. Project funding is a means of supporting high-risk projects that are of national interest and limited to a certain topic or timescale. Funding is only awarded in cases where the market itself is unable to provide the new technical developments in the foreseeable future. To distinguish between project funding, institutional funding and contract research, please refer to the information provided under Section 1.3.

Project funding frequently takes the form of collaborative research, whereby institutions of higher education and research institutes work together with companies to improve technologies by comprehensively tackling (on a work-sharing basis) complex problems that can only be solved over a longer period of time, or to develop completely new technologies.

Prerequisites

This guide is intended to provide an initial overview of the framework conditions for funding. More detailed information about the funding modalities are published in departmental-specific regulations governing funding or calls for proposals, which ensure that the funding is used for the public benefit and in accordance with the legal requirements.

The topics eligible for funding are outlined in Section 2 of this programme. However, due to the limiting framework conditions (for example, the budget available), it is necessary to prioritise the topics in sequence. Nevertheless, the programme provides the framework, formulates the main features of the funding policy and provides the basis for making funding-related decisions. There is no legal claim to a grant. The grant-awarding agency will decide freely after due assessment of the circumstances within the framework of the budget funds available.

The decision to fund the underlying topic of a project idea can only be made by the relevant ministries and, if required, by the project management agency commissioned by the ministries to manage the research project under certain conditions. The authorities and/or project management agency assess each project submission on the basis of its innovative content, as well as the expertise and creditworthiness of the applicant. Furthermore, they evaluate the potential contribution that the project can make to the "funding policy" objectives of the transport research programme. Funding is then provided if all aspects of these criteria are adequately fulfilled.

Companies (especially small and medium-sized enterprises), institutions of higher education and non-university research establishments and other institutions or corporate bodies resident in Germany are all eligible to apply. The project must be conducted and utilised in Germany.

Financial modalities of project funding

Funding is awarded in the form of grants. The Federal Budget Code (BHO) together with the Administrative Regulations relating to the Federal Budget Code (VV-BHO), in which the prerequisites and procedures are regulated, form the legal basis for project funding. Furthermore, the EU Community Framework on State Aid for Research, Development and Innovation applies, particularly when calculating the rate of funding. On the basis of the principle of subsidiarity, grants can be awarded in different forms and methods of financing, each in accordance with the Administrative Regulations relating to the Federal Budget Code. Allowing for the interests of the federation and the grant recipients, the grants are awarded as partial financing (pro rata, part funding or fixed-sum financing) or, in exceptional cases, full financing of a project.

In view of the applicants' different accounting systems, it is necessary to distinguish between grants on an expenditure basis and grants on a cost basis when calculating funding.

For applicants who do not operate commercial (double-entry) book-keeping, but rather receipts and expenditures (single-entry book-keeping) (which is frequently the case in public institutions with public

service budget management and corporate governance), the project's expenditure is the calculation basis for the level of funding awarded.

Universities generally receive full funding.

Commercial companies generally receive funding on a cost basis because the project costs being assigned, including the overhead costs, are determined according to the rules of commercial (double-entry) book-keeping.

The rates of funding are subject to the regulated upper limits of the aforementioned EU community framework. Therefore, in the case of the application-oriented projects usually conducted by industrial enterprises, up to 50 % of the costs can be funded. However, the Community Framework permits a differentiated regulation for individual applicants (especially SMEs), which may result in a higher rate of funding, where appropriate.

The most important factors in determining the rate of funding are the technical and scientific risk and the federal interest attached to the project. In line with the principle of subsidiarity, the rate of funding is calculated according to the principle of economic and economical use of public funds.

Project execution

A matter of special importance to the Federal Government is the provision of competent and detailed advice to applicants on the funding options within the transport research programme. The first port of call for such advice is the project management agencies used by the ministries, which most ministries commission on their behalf to implement and execute this research programme (the Appendix contains a list of project management agencies as well as information about other information centres).

The project management agencies oversee and support the project, both in a professional and administrative capacity, from the moment the applicant establishes contact through to submitting the application, checking the application, deciding whether the applicant is eligible for funding, disbursing the funds, reviewing the results, determining the final settlement and utilising the findings.

Utilising the findings

An essential prerequisite for a successful project is to ensure the best possible utilisation of the findings. Therefore, even at the application stage, the regulations governing funding make provisions for an accurate statement concerning the subsequent utilisation of the findings in the form of a utilisation plan. The organisation executing the project is required to state how they will implement this utilisation plan, and then aspire to this goal. In return, they are granted the right to exclusive use of their findings.

However, in the case of research projects that expect to be of commercial value, the organisation must ensure that the results obtained are legally protected, since it is of particular interest in the case of project funding that an application for a patent is filed for new patentable knowledge, where possible. In the case of small and medium-sized enterprises and public research institutes, these associated costs are eligible for funding. Furthermore, there is a general requirement to publish such findings in the form of conference papers and articles in technical journals.

II. Main Contacts for the Federal Government's Funding Activities in Transport Research:

Federal Ministry of Economics and Technology (BMWi)
Villemombler Straße 76
D-53123 Bonn

Division VII B 5 (Transport Technologies)
Tel: + 49 228 – 99 615 – 2881
Fax: +49 228 – 99 615 – 4371
Internet: www.bmwi.de

Project Management "Mobility and Transport, Building and Housing"
TÜV Rheinland Consulting GmbH
Central Area: Research Management
Am Grauen Stein 33
D-51105 Cologne
Tel: +49 221 – 806 – 4141
Fax: +49 221 – 806 – 3496
Internet: www.tuvpt.de

Federal Ministry of Transport, Building and Urban Affairs (BMVBS)
Robert-Schuman-Platz 1
D-53175 Bonn

Division A 30 (Policy Issues Concerning Research, Development and Research Funding)
Tel: +49 228 – 300 – 2610 / 2710
Fax: +49 228 – 300 – 3428
Internet: www.bmvbs.de

Federal Office for Building and Regional Planning
Deichmanns Aue 31–37
D-53179 Bonn

Division I 5 (Transport and Environment)
Tel: +49 228 – 99401 – 2302
Fax: +49 228 – 99401 – 2260
Internet: www.bbr.bund.de

Federal Highway Research Institute (BASt)
Brüderstraße 53
D-51427 Bergisch-Gladbach

Division Z5 (National and International Research Support and Cooperation)
Tel: +49 2204 – 43 – 250
Fax: +49 2204 – 43 – 148
Internet: www.bast.de

Federal Ministry of Education and Research (BMBF)
Heinemannstraße 2
D–53170 Bonn

Division 525 (Communication Technologies)
Tel: +49 228 – 99 57 – 3180
Fax: +49 228 – 99 57 – 83180
Internet: www.bmbf.de

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Alexanderstraße 3
D-10178 Berlin

Division IG I 5 (Environment and Transport)
Tel: +49 30 – 18305 – 2330
Fax: +49 30 – 18305 – 3335
Internet: www.bmu.de

Division IG I 6 (Air Pollution Control Technologies for Transport and Fuels; General Affairs Concerning Immission Control and Climate Protection in Aviation)
Robert-Schuman-Platz 3
D-51375 Bonn
Tel: +49 228 – 99305 – 2470
Fax: +49 228 – 99305 – 3225
Internet: www.bmu.de

Federal Environment Agency
Bismarckplatz 1
D-14193 Berlin

Division I (Environmental Planning and Sustainability Strategies), Location: Dessau
Tel: +49 340 – 2103 – 2909
Fax: +49 340 – 2103 – 2649
Internet: www.uba.de

Federal Ministry of Food, Agriculture and Consumer Protection (BMELV)
Rochusstr. 1
D-53123 Bonn

Division L 5: Energy Recovery from Renewable Resources and Energy Issues
Tel: +49 228 – 529 – 3155
Fax: +49 228 – 529 – 3184
Internet: www.bmelv.de

Agency of Renewable Resources
Hofplatz 1
D-18276 Gülzow
Tel: +49 3843 – 6930 – 100
Fax: +49 3843 – 6930 – 102
Internet: www.fnr.de

III. Main Contacts for EU Funding Activities in Transport Research

Thematic Programme "Transport (incl. Aviation)"

Inland and Maritime Transport (Sustainable Surface Transport)

Federal Ministry of Economics and Technology (BMWi)

Villemombler Straße 76
D-53107 Bonn

Division VII B 5 (Transport Technologies)
Tel: +49 228 – 99615 – 4711
Fax: +49 228 – 99615 – 4371
Internet: www.bmwi.de

Federal Ministry of Transport, Building and Urban Affairs (BMVBS)

Robert-Schuman-Platz 1
D-53175 Bonn

Division A 30 (Policy Issues Concerning Research, Development and Research Funding)
Tel: +49 228 – 300 – 26 11
Fax: +49 228 – 300 – 34 28
Internet: www.bmvbs.de

National Points of Contact:

Inland and Maritime Transport (Sustainable Surface Transport)

TÜV Rheinland Consulting GmbH
Central Area: Research Management
Am Grauen Stein 33
51105 Cologne
Tel: +49 221 – 806 – 4156
Fax: +49 221 – 806 – 3496
Internet: www.nks-verkehr.eu

IV. Franco-German Cooperation (Deufrako)

Appendix to the national "Mobility and Transport Technologies" research programme and "Predit 4" (Programme of Research, Experimentation and Innovation in Land Transport)

History and Context

Within Europe, Germany and France play important roles in the area of mobility and transport technologies, while their industries have a significant presence on the global market. The standard of construction for the rail and trunk road networks in both countries is outstanding. To also guarantee that this high standard is maintained in future, it is of mutual interest to both countries, despite competing with each other, to pool their strengths, especially in the area of pre-competition research and the definition of standards.

Franco-German cooperation in the area of transport research (Deufrako) was launched in 1978 by the French State President Valéry Giscard d'Estaing and the German Federal Chancellor Helmut Schmidt. For the first 20 years, Deufrako concentrated solely on rail transport. Over time, the cooperation has expanded to include other fields of research such as urban transport, telematics, freight transport, traffic noise and road safety. Since 2002, the fields of cooperation between both countries are also agreed in the Franco-German research forums. Since 2002, there has also been an intensive exchange of information between both national transport research programmes. Once a year, a steering committee informs and advises on the status of current research projects, chooses new projects from those proposed and implements any recommendations made by the research forums.

The EU's Seventh Research Framework Programme (FP7), which commenced in 2007, and the updated transport research programmes of both countries provide an opportunity to further develop the objectives and guidelines for bilateral cooperation, as well as define their principles and position within the European Research Area.

Objectives

In comparison to the European research programmes, the specific role of the national programmes is founded on three pillars:

- Consideration of specific matters or topics that require close cooperation with national institutions,
- Support for projects that only involve a limited number of partners and require a certain amount of confidentiality,
- Strengthening of research communities and consortia for multinational cooperation.

Furthermore, a bilateral cooperation such as Deufrako is characterised by four specific goals:

- Development of common positions with regard to and in the run-up to European standardisation,
- Support for strategic projects that require the presence of partners from both countries,
- Research and science as a means of bringing together the strategic positions of both countries.
- Active participation in creating and structuring a common European Research Area (ERA)

Development of Common Standards

The development of common proposals for standards is actually one of the main reasons for cooperation. Several Deufrako projects in the area of rail transport have already proven the added value of this bilateral cooperation. This is evident, for example, in the development of a standard for train protection technology. Originally, this topic was covered in national research projects. A Franco-German community project (Artemis) then took it on board and developed it further to form the basis for the cross-border European Train Control System (ETCS). Other common evaluation methods in the area of high-speed rail transport are also worthy of mention here, for example, common measurement standards when evaluating the dangers of crosswinds.

Support for Suitable Project Consortia

Another reason for the cooperation is the complementarity of stakeholders in science and research. Deufrako is a suitable platform for any specific advantages that come to light as a result of cooperating with partners from Germany and France on various research topics (for example, the “Noise Effects” project).

Harmonisation of Research Strategies

A third point concerns areas in which both countries previously conducted their own research but where collaborative research would now harmonise their research strategies as well as facilitate reciprocal learning. This has proven to be successful in the past, for example, when defining common measuring methods and procedures for evaluating crosswinds from high-speed trains (the “Crosswind” project), developing methodical and practical approaches for urban, regional and settlement planning along railway lines (project “Bahnville”) or security-relevant features in digital cards (the “Safemap” project).

Shaping the European Research Area

The EU Members States have the declared aim of pooling their national research strengths without forsaking national sovereignty (by creating a European Research Area – ERA). The goal of ERA is to strengthen Europe’s position when competing on a global scale. Deufrako seeks to actively contribute towards the realisation of this goal.