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THE FUTURE OF THE GERMAN AUTOMOTIVE INDUSTRY

Structural Change in the Automotive Industry: Challenges and Perspectives

FRIEDRICH EBERT STIFTUNG

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1

INDUSTRY IN TRANSFORMATION

The automotive industry is one of the most important industrial sectors in Germany, and in some regions it is a crucial element of the economic structure. This branch of industry not only drives innovation, growth and employment, but for several decades has also determined the development of transport and people's mobility habits.

Against the backdrop of globalisation German car manufacturers and suppliers implemented radical changes: production processes and chains were reorganised, which involved relocating manufacturing locations abroad and often went hand in hand with a reduction in employment. As a result of falling tax revenues and job losses, the affected regions are facing economic and social consequences. The difficult financial situation of many states, and above all local authorities, limit their scope to pro-actively influence policy in the regions with impacted plants.

This has been compounded by more recent developments, such as the question of the long-term availability of crude oil and years of steadily rising oil prices. They impose a financial burden on both producer and consumer. As road traffic is powered almost exclusively by fossil fuels, motorised transport is a major contributor to anthropogenically induced climate change and, consequently, must contribute to a reduction in greenhouse gas emissions within the framework of a climate policy. The resultant legal requirements have put pressure on the automotive industry to bring more fuel-efficient cars on the market and consider longer-term strategies of modernisation.

Another compelling reason are the rapid global developments, in particular in Asian countries such as China and India as well as in Brazil, Russia and South Africa. Economic growth in these emerging markets is driving urbanisation, and thus also driving an enormously dynamic development of motorised individual transport (MIT). Today, a large proportion of the cars produced by German car manufacturers is sold in these countries. Hence, exports account for a substantial part of these companies' sales. Meanwhile, highly efficient automotive industries are established in these so-called emerging markets themselves. As a result, they can no longer be regarded as long-term export markets. However, not only the international market is changing, but also the domestic market. Demographic trends will generate changes in demand in the medium term. Recent studies show that in particular young adults attach less importance to car ownership.

Moreover, for many years there has been an on-going debate in Germany about rebalancing the sharing of responsibilities and burdens and improving the interlinkage between different modes of transportation. In this context a shift to rail and public transport plays an important role.

Besides this, the economic crisis in recent years has demonstrated how sensitively the industry reacts to economic volatility. German policy used state aid primarily to cushion falling sales in the car industry, which in turn underscored the overall importance attached to the industry.

These many developments raise numerous questions: What are the challenges facing the industry and the regions with automotive industry? What are the potential consequences of this structural transformation for companies, suppliers, locations and employees? And how can they be met? How radical will the measures and proactive changes have to be in order to enable the industry to maintain its competitiveness – which innovations and strategies can help the industry to achieve its objective? How can the automotive industry react to changed mobility requirements and people's needs while complying with the goals of energy, climate, environment and transport policy goals.

The Working Groups on Innovative Transport Policy and Sustainable Structural Policy of the Friedrich Ebert Stiftung explore these issues. Their main focus is on the problems and strategies, but also the opportunities and threats for the automotive industry, suppliers and production locations due to structural change. In addition, the authors consider the requirements this important German industry must take to ensure employment in the future. Ultimately, the question for the car industry is whether it can successfully shape its future solely through market forces or whether it is a rather predestined field for modern industrial policy involving a round table with actors from company managements, works committees, trade unions, environmental associations, science and politics. To this end, representatives of political bodies, the automotive industry, the trade unions and sciences have gathered to discuss common thoughts and ideas. This position paper presents the analyses, positions and strategies of these actors.

The paper gives priority to passenger cars and, hence, motorised individual transport – also referred to here as car or automobility. The interfaces with other modes of transport will only be touched upon in presentations on alternative car use concepts. Apart from this, attention is focused on car manufacturers and their suppliers as well as those political, economic and commercial factors that heavily impact car production and demand. Although the commercial vehicle segment is important for individual manufacturers both economically and, on account of its rapid growth, environmentally, it will be mentioned only in passing as it is a specific transport subsystem with distinctive conditions, determinants and actors. As the automotive industry is a global industry, this presentation must take into account the global dimension of structural change in the industry. Geographically, it will focus on countries in a powerful growth phase, i.e. countries that are rapidly motorising and, hence, are important markets for German car manufacturers. Basically, these are the so-called emerging markets, in particular the BRIC states.[1]

As the aim of this position paper is to formulate recommendations for action for the locations in Germany impacted by structural change, the focus is on the regions in which cars are currently manufactured. Important economic and climate policy developments in the industry include innovations in power-train concepts. The position paper does advocate support for individual promising technologies, but recognises the need for systemic innovations to achieve ecological, economic and social goals. Hence, it is technologically neutral. One future development is explicitly emphasised, in particular with regard to its effect on employment, namely the electric drive train, as this is currently a conceivable development path. The following exposition is divided into four parts.

Part 2 starts by describing the conditions for structural transformation in the context of the development of car mobility. One focus in this context lies on the possibilities of automobility both worldwide and in Germany (Chapter 2.1) and the changes in the perspectives of road users (Chapter 2.2). Another important determinant for the industry and a trigger of transformation processes are the challenges posed by the need for environmental and climate protection. Chapter 2.3 deals with the significance of the transport sector for climate protection and national and European strategies to make cars more climate friendly. In addition, the possibility of climate-friendly car mobility is considered in the context of other car use concepts.

Part 3 is concerned with both the characteristics of the German automotive industry (Chapter 3.1) and the transformation processes in products, locations and employment (Chapter 3.2). These processes have been triggered by changing mobility needs on the one hand and the need for climate protection and resource efficiency on the other. The upheaval in the industry and the automotive-dependent regions generated by these factors is tantamount to a structural transformation. In this respect one fundamental change is the trend towards new drive concepts in research and development (R&D). At the same time, there is greater focus on the development of innovative concepts of automobility that assign a new role to the car. These approaches and the current discussions about them are highlighted in Chapter 3.3 (Chapter 3.4 for electromobility).

Part 4 deals with the effect of structural transformation on employment policy. In Chapter 4.1 the emphasis is on the general determinants of employment trends and in Chapter 4.2 on the transition towards electric drive trains and the associated changes in value chains, the impact on employment and required job skills.

The position paper concludes with recommendations for the actors concerned about how to promote sustainable development of the automotive industry. To ensure a sustainable (auto) mobility industry and strengthen its competitive position, Germany needs a location policy that facilitates, accompanies and cushions change (Chapter 5.1) and new vehicles, new drive technologies and new use concepts (Chapter 5.2).

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1 The abbreviation stands for the initial letters of the four countries: Brazil, Russia, India and China. Sometimes the abbreviation BRIICS is used, where the additional I stands for Indonesia and the S for South Africa.

2

THE CHANGING ENVIRONMENT OF AUTO-MOBILITY IN GERMANY AND WORLDWIDE

Motorised individual transport (MIT), i.e. passenger car traffic, is crucially important for our mobility, as demonstrated by figures for the development of motorisation and car use in Germany and around the world. German carmakers have benefited enormously from these developments.

However, the conditions for manufacturers and their suppliers are changing: In view of the consumption of resources and the emissions associated with car use there are growing demands to make MIT substantially more climate friendly. Political actors have responded by, for example, issuing maximum limits for CO_2 emissions. Despite this, the global energy consumption by transport is expected to continue to rise, while at the same time total reserves of raw materials will decline. To date, concepts for mobility, including motorised individual transport (MIT), that are on the whole environment and climate friendly have failed to find widespread acceptance. At the same time, demand for automobility is also changing, so that in the future people may want other vehicle and use concepts. So far, alternative concepts for MIT have not made a significant impact. Thus, the challenge for transport policy is to proactively shape mobility, instead of, as in the past, just keeping up with "natural" trends.

2.1 TRANSPORT DEVELOPMENT AND MOBILITY BEHAVIOUR

2.1.1 DEVELOPMENTS IN GLOBAL AUTOMOBILITY

The current global population of around 6.8 billion people uses about 500 million passenger vehicles worldwide[2] – and the number is increasing. According to forecasts of the International Energy Agency (IEA), the number of cars will treble by 2030, whereby most of this growth will not occur in the industrialised countries: the BRIC states will soon overtake Europe and the USA as the largest car markets (IEA 2009: 58). This will confirm the development of 2009, when, owing to the economic crisis in the USA, China became the largest market for commercial and passenger vehicles (Reuters, 8.1.2010).

Regarding global oil reserves, such a motorisation scenario would rapidly accelerate the consumption of currently known reserves and, thus, greenhouse gas emissions. Similarly, building new roads would increase the amount of paved land. Once a household has access to a car, it will usually take advantage of it. Crucial factors for the number of vehicle kilometres travelled include for example the degree of urbanisation in a country, the population density, the level of energy prices and GDP per capita. Today, people in the non-OECD countries travel three to four times less than people in the OECD member states. Given the current growth rates in the emerging markets, this is likely to change fundamentally.

Moreover, it is clear that as motorisation increases, cities and living and mobility habits change fundamentally. Nowhere can this be observed better than in the emerging markets, which are currently experiencing strong economic growth. Correspondingly, as incomes rise more and more people can afford to own a car. Already, China has seven megacities and it is only a matter of time before there are many more. Within a very short space of time they have developed transport systems based on US and European cities. This development is dominated by road building to accommodate the growing flow of traffic and number of parked cars.

While for most Chinese owning a car is still a dream, for many it is already reality: At the end of 2009, 76.19 million cars were registered in China, an increase of 17.8 percent compared to the previous year. Growth is particularly strong in the passenger vehicle sector: an increase of 25 percent to 48.4 million vehicles. More than 94 million motorised two-wheelers must be added to this (Beijing Transport Management Bureau 2010). Thus, the prerequisites for further urban growth are fulfilled: larger distances can be covered by car, which makes it more attractive to live in the newly built suburbs.

To promote the sale of cars and, hence, economic growth, petrol prices are kept artificially low in some emerg-

2 The 32 OECD member states, the rich countries of the world, which make up 18 percent of the world's population, have more than 60 percent of the global fleet of vehicles (OECD 2010).

ing markets. This generates further motorisation. High-performance cars sporting special features are particularly popular, a circumstance further supported by the growing upper class.

The overall structure of transport is also changing: Both the use of bicycles, the former main means of transport, and the use of public transport have fallen sharply. In China, public transport's share of the total volume of traffic has fallen by six percent in recent years (Hu et al. 2009). As traffic has grown the other side of the coin has become apparent in the form of undesirable side effects such as accidents, air pollution and traffic jams. In many conurbations rising traffic volumes and the lack of infrastructure have brought motorised traffic to the brink of collapse.

2.1.2 AUTOMOBILITY IN GERMANY

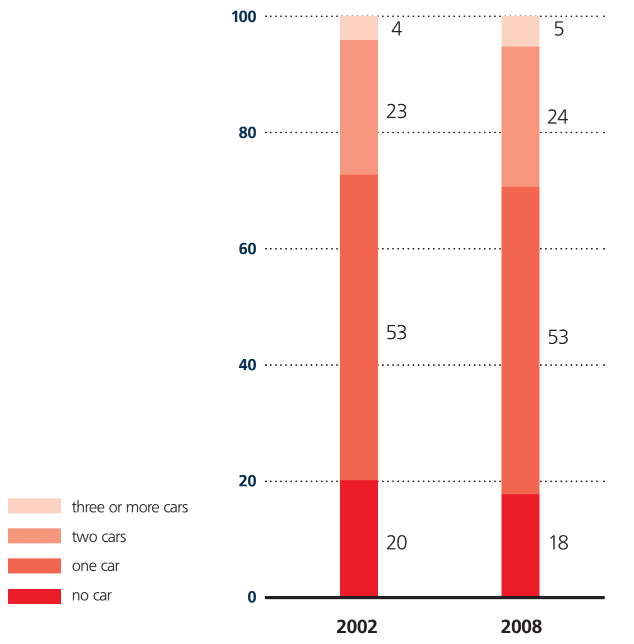
In January 2010, there were 50.2 million registered vehicles in Germany. Given a population of 82.1 million in Germany, the average level of motorisation was 508 vehicles per 1,000 inhabitants. Figure 1 shows car ownership per household, the decline in the proportion of car-free households since the 2002 surveys and the increase in the proportion of households with two or more vehicles.

All in all, the car is the most important means of transport in Germany: 58 percent of all trips and 79 percent of all passenger-kilometres are made by car. Figure 2 illustrates the increase in the importance of the car for everyday mobility in recent decades, whereas e.g. trips on foot have fallen sharply. That said, it must be stated that in terms of traffic volume and traffic performance, growth in motorised individual transport has slowed sharply compared to previous decades.[3]

2.2 CHANGING DEMAND FOR CAR MOBILITY

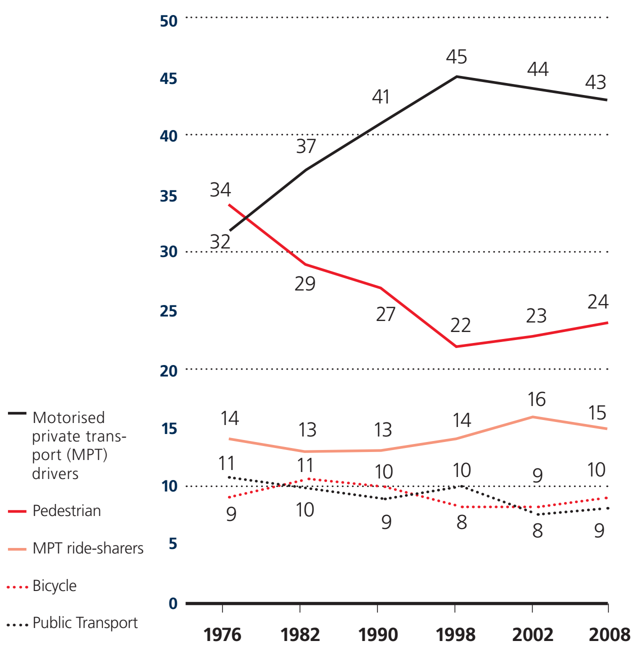
Over time there have been slight changes by age in the number of people with a driver's licence. Whereas the number has fallen slightly in the lowest age group of 18 to 29 years, possession of a driver's licence among older people is rising. Current studies interpret this as a profound trend that indicates that the importance of the car is declining among young people. They state that the emotional significance of the car is decreasing and that precedence is clearly given to the functionality of a car as a means of transport. This could influence both general interest in owning a car and the choice of a specific car. Large, high-performance cars are losing their function as a status symbol, in particular among young people in metropolitan areas, while at the same time the importance of intermodal use of means of transport is growing (Canzler/Kniw 2009).

Figure 1
Number of cars per household, in percent



Source: infas 2010

Figure 2
Modal split in Germany, in percent



Source: infas 2010

3 In 2008 a person travelled as many kilometres with motorised individual transport as in 2002, namely about 30 kilometres per day (Infas/DLR 2010).

According to a 2009 study by Arthur D. Little, a consulting company, already by 2020 a mobility mode chosen primarily on the basis of environmental awareness and quality of life could dominate in Europe, North America and Japan. A car's status is secondary for these "greenovators"; rather, it is one of several means of satisfying the need for mobility. This is reflected as much in the decision for alternatively powered energy-saving vehicles as in the traffic-reducing choice of residence in urban centres, the intermodal design of streets and the use of car pools and car sharing.

In the long term, demographic change in Germany will also transform automobility and, thus, demand for cars. The population as a whole will decline until 2030, while at the same time the proportion of people over the age of 65 will rise and the proportion of people under the age of 20 will fall (Adolf/Huibers 2009: 55).

A trend already apparent today and very relevant for carmakers, is the shift in disposable income within the German population: as a rule a new car is the second largest investment people make after home ownership. Population statistics describe the shrinking of the middle class as a long-term, relatively constant trend. The number of people on low incomes is growing, while at the same time this group's share of total income is falling in absolute terms.

Consequently, demographic and social change at the national level poses a serious challenge for carmakers. First, as the population shrinks, total demand will, too. With rising age the demands made of a car in respect of driving comfort and safety change. This is reinforced by the growth of the group that cannot (any longer) afford a car for financial reasons. Concerning the younger generations, it appears that cars are no longer valued in the way they were in earlier generations. Taken together, these trends indicate that in the future demand will call for fewer cars on the one hand and different cars on the other.

2.3 TRANSPORT AND CLIMATE POLICY

Meanwhile, there is a broad consensus that, in addition to natural causes, human activity is also a cause of climate change.

In the Kyoto Protocol the industrialised countries committed themselves to binding emission reduction targets averaging five percent (over the five-year commitment period 2008 to 2012), while the developing countries were called on to reduce emissions without commitment. In 1998, the EU member states agreed to internal EU burden sharing of their overall reduction commitment of eight percent (EEA 2006). As its share of the burden, Germany agreed to reduce its greenhouse gas emissions by 21 percent by 2012 (compared to 1990).

How countries achieve their targets is not part of the agreements. It is up to each state to decide the contribution to emission reduction of the different sectors responsible for the emissions, e.g. transport, industry or energy producers. Most CO_2 emissions are produced by the energy sector, in particular by power stations, but also by oil refineries. Whereas in recent years in the EU emissions have been reduced above all in the industrial sector, emissions in the transport sector have increased. Germany is one of the few EU member states that has been able to reduce greenhouse gas emissions produced by transport. It intends to use targeted political measures to promote and accelerate this development.

2.3.1 MOTORISED TRANSPORT AS A SOURCE OF GREENHOUSE GASES

Transport causes 22 percent of global greenhouse gas emissions and almost a fifth of those in the European Union (IEA 2010). In both cases road traffic accounts for the major share. With regard to transport-related per capita emissions in the industrialised countries, 89 percent are produced by cars or trucks. Contrary to the trend in other sectors, transport-related emissions increased between 1990 and 2004, particularly because of the sharp rise in freight traffic (Zimmer/Fritsche 2008).

The biggest single emitter in the transport sector is the USA. The share of the BRIC states has risen rapidly in recent years and is accelerating. Accordingly, the IEA forecasts that energy consumption in the transport sector will rise by 50 percent by 2030 and by as much as 80 percent by 2050 (IEA 2009) – despite all efforts to produce more energy-efficient vehicles that are expected to improve consumption by up to 30 percent. This goes hand in hand with a disproportionately high increase in CO_2 emissions in the transport sector worldwide of 7,500 Mt of CO_2 to 14,000 Mt in 2050, assuming transport policy does not change (IEA 2009: 67).

In 2004, 182 Mt of CO_2[4] – equal to 18 percent of all greenhouse gas emissions in Germany – were emitted by the transport sector, of which road transport accounted for 87 percent (McKinsey 2007). Of this share, 107 Mt of CO_2 were produced by passenger cars. For some years now road CO_2 emissions in Germany have stagnated at a high level, though most recently they have fallen slightly. Up to now, the growth in freight traffic has more or less balanced the gains in efficiency[5] achieved through advances in automotive technology.

The oil price plays a critical role in traffic trends. According to a 2008 World Energy Outlook study, it could reach an inflation-adjusted price of USD 120 per barrel in 2030, i.e. an increase of only about 20 percent (IEA 2009: 56).

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4 This value is in CO_2 equivalents (CO e), a unit used to measure the climate impact of greenhouse gases. Besides CO_2 itself, road traffic produces nitrogen oxide and various fluorinated greenhouse gases from air conditioners, whose climate impact in respect of CO_2 is 1300 times greater. Up to ten million tonnes of CO_2 a year are released by air conditioners in Germany, i.e. equal to seven percent of the total emissions in the field of transport (Luhmann/Reh 2004). In the discussion here only the term CO_2 is used.

5 The defined CO_2 emission limit for new passenger cars registered in the EU 27 were reduced from 188g/km in 1990 to 154g/km in 2008 (EEA 2009).

2.3.2 TRANSPORT POLICIES TO REDUCE GREENHOUSE GAS EMISSIONS

With regard to the requirements to reduce traffic-related CO_2 emissions, emission reduction targets have been formulated and specific measures and programmes introduced at both the EU level and the national level in Germany. Only a few EU member states – among them Germany – managed to reduce traffic-related greenhouse gas emissions in the period between 1990 and 2006. Whereas some Eastern European countries achieved this as a result of economic collapse, Germany was the only country to reduce transport-related greenhouse gas emissions through specific policy measures (EEA 2009, Friedrich/Petersen 2009). These measures are discussed below.

Whereas industry and energy producers participate in the European emissions trading system, transport is almost completely exempt.[6] Both Germany and the European Union have adopted a range of other policy measures to reduce greenhouse gas emissions by motor vehicles.

In Germany this includes the environmental tax reform on the one hand, which was increased gradually between 1999 and 2003 and adds a surcharge of 15 cents a litre to petrol and diesel in addition to the existing mineral oil tax. On the other hand, a CO_2 component was added to the motor vehicle tax, which up until then was assessed solely on the basis of engine capacity. Two euros are levied for each gram of CO_2 emitted per kilometre above the limit of 120 g/km. As at the same time, the rates levied on the engine capacity component were decreased to ensure that the impact of the tax on revenues was more or less neutral, the incentive effect is estimated to be negligible.

After the automotive industry failed dismally to fulfil a voluntary commitment to decrease the fleet consumption limit to 140 g CO_2 /km by 2008, in 2009 the EU passed binding limits for the fleet consumption of newly registered passenger cars. All carmakers have until 2015 to reduce the emissions of their fleets of new cars registered in the EU to an average of 130 g CO_2 /km. If this value is exceeded, amounts of up to 95 euros per additionally emitted gram of CO_2 will be payable. The EU directive provides for the limit to be reduced to 95 g CO_2/km by 2020 (Regulation [EC] No 443/2009). This means that carmakers and their suppliers will continue to be strongly challenged in the coming years to take measures to improve the efficiency of the internal combustion engine.

The Integrated Energy and Climate Programme (IECP) of the Federal Government of Germany of 2007 also contains provisions to encourage transport to contribute to climate protection in Germany. Specifically, it promotes energy-saving passenger cars and the increased use of biofuels. According to calculations of the Federal Environment Agency (UBA), this can reduce CO_2 emissions by 33.6 million tonnes. According to this, the transport sector would be responsible for 12.4 percent of the entire envisaged reduction in greenhouse gases in Germany by 2020. That said, this can succeed only if the necessary specifications for car efficiency and biofuel use are defined at EU level – which once again documents the significance of the EU in shaping efficiency policies for the automotive sector.

2.3.3 CLIMATE-FRIENDLY CAR USE CONCEPTS

Besides the technical, vehicle-related measures, other strategies to reduce traffic-related greenhouse gases focus on transportation use. For several decades, and at the latest since the oil crises in the 1970s, society, politics and mobility research in Germany have been discussing innovative, environmentally friendly mobility concepts. Apart from promoting specific modes of transport, one goal is to improve the intermodality between cars and other means of transport, such as bus, rail, bicycles and pedestrian traffic, thereby providing a more needs-oriented response to individual mobility requirements. Integrated concepts should facilitate the use of different modes of transport, which can be used either as alternatives or intermodally. Concepts that explicitly include cars are forms of joint car use, such as car sharing, traditional car hire systems, Park & Ride and traffic management systems, which are concerned primarily with interlinking cars and public transport.

The discussion about the potential of new car use concepts has been revived by the growing penetration of everyday life by new media and communications technologies and by the development of new drive technologies. The latter involve not only new engine technologies, but also new vehicle and use concepts. The discussion about electric bicycles and cars has played a crucial role in this development.[7]

However, the range of current expectations regarding the reach of electromobility over time and the associated uncertainty about future developments is very broad. Whereas some studies assume that electric and hybrid cars will gain a significant share (see Shell car scenarios up to 2030 or the study by Deutsche Bank Securities Inc.), other sources forecast that growth in demand for electric power in transportation will be weak (see International Energy Outlook 2010 of the US Department of Energy/Energy Information Administration).

That said, there is considerable uncertainty not only with regard to the expected market penetration by electromobility, but also concerning the environmental effects associated with electromobility. This holds both for anticipated specific environmental impacts and for the available raw materials needed to implement an electromobility strategy. The arguments include both the problems of providing adequate energy and the operational capacity of cars owing to the limited range, which predestines electric vehicles to be second or third cars. Moreover, electric vehicles are said to lose their

6 From 2012 air traffic will also be subject to the EU's emissions trading system. This will affect in principle all operators whose aircraft take off or land in the EU. Electric rail traffic is already included in the emissions trading system.

7 A distinction is drawn between hybrid vehicles that have a conventional internal combustion engine and in addition a small (mild hybrid) or larger (full hybrid) electric engine and all-electric cars that run on batteries. At the end of 2009 there were 1,588 electric vehicles on Germany's roads. Another 54 were added in the first half of 2010 (Fischer 2010).

advantage compared to traditional internal combustion engines if the entire life cycle of the vehicle is taken into account. Hence, apart from the question of the availability of raw materials for a high-performance energy storage system, in the future electric cars can only be an environmentally friendlier alternative if they use a regenerative electricity mix (Friedrich/Petersen 2009).

The studies point out that the transition to a pure electric car will probably be a longer-term development. However, already today it is necessary to reduce traffic-related greenhouse gases; accordingly, measures have to start by focusing on the existing transport system and the available technologies. Part Three below presents the strategies of both the carmakers and their suppliers who make it possible to meet the challenges posed by existing political and social conditions. In addition, the impacts on production locations and employment will be presented in detail.

3

CONSEQUENCES FOR THE AUTOMOTIVE INDUSTRY

How will the conditions described above affect the German automotive industry, i.e. the automakers and their suppliers in the medium to the long term? A central driver of change is the demand for climate protection. Policy standards on consumption and emissions are accelerating the processes of change in the industry. These developments have direct consequences for the automotive and automotive supply industries, which are a major, if not the key, component of the manufacturing sectors of developed economies.

This industrial sector is regulated e.g. at the European level through directives to reduce CO_2 emissions by setting emission limits for new vehicle fleets that car manufacturers have to meet by 2015 and 2020. These limits are almost impossible to meet with current technologies, a point on which all actors in the sector agree. On the one hand, massive R&D expenditures will be needed to optimise drive systems based on fossil fuels (internal combustion engine) and, on the other, it will be necessary to develop and apply alternative drive concepts:[8] the expected impact of the associated changes will involve a massive structural change, if not a structural break, for the entire industry and the regional centres of the automotive industry alike. A potential trend away from combustion engine-powered to electric-powered drive systems signifies a systemic change.

This chapter is organised as follows: It starts by outlining the basic structures of the German automotive industry, its importance for the overall economy, its regional distribution and its globalisation. It then examines responses to challenges in the form of innovative conceptual developments in the field of drive systems, vehicles and mobility. Finally, it discusses the political objective of promoting electromobility and the associated politically motivated "systemic change".

The next chapter deals with the opportunities and risks as they affect employment.

8 The spectrum of alternative power trains ranges from different hybrid concepts that combine an internal combustion engine with an electric engine, to pure electric drive systems and vehicles with fuel-cell drives. Development paths in the field of alternative fuels such as synthetic and biofuels (so-called synfuels and sunfuels) further complicate the challenges faced by power train R&D.

3.1 STRUCTURES OF THE AUTOMOTIVE INDUSTRY IN GERMANY

3.1.1 THE STRUCTURE OF THE ACTORS

Car production is a highly complex, technology-intensive process involving numerous types of players.[9] Viewing the industry as a pyramid, at the apex are the carmakers (original equipment manufacturers: OEMs), which are responsible for vehicle architecture, system integration, production of components, final assembly and distribution and which manage the entire car manufacturing process. As a rule, these are large enterprises that sell their products on world markets and have located their production facilities accordingly. In Germany these companies include BMW, Mercedes-Benz Cars (Daimler Group) and Volkswagen.[10]

Table 1 below compares German carmakers and German suppliers by size (sales and employees).[11] These large suppliers are tier 1 suppliers.

A second type of actor are the large supplier companies that have evolved into megasuppliers and system integrators for vehicle modules such as braking and steering systems, transmissions and seat systems (also tier 1 suppliers).[12] Five of the world's 20 largest suppliers are German: Bosch, Continental, ThyssenKrupp, ZF and BASF. Like the automakers they also operate in globalised locations and production structures. During the last decade carmakers have shifted more and more R&D, and the management of their respective supplier networks, to these companies.

9 In 2010 the average car had 10,000 components; at the top of the range it takes 12,500 components to build and equip a vehicle. By comparison, in 1988 a VW Golf consisted of 6,850 components.

10 Audi and Porsche are part of the Volkswagen Group, Opel and Ford-Werke are subsidiaries of the US companies GM and Ford.

11 Note about method: for suppliers only automotive revenues and the automotive sector's share of total company revenues are reported. As only some companies report employment figures for the automotive sector, Table 1 shows only total company employment.

12 Tier position designates the position in the value-added or process chain: Tier = rank, status.

A third type of actor are the suppliers of specific components and technologies that require specialised know-how and specific competencies, which make them indispensable for car production, even though they are small and medium-sized companies (Tier 2). Suppliers of products ranging from standard components to raw materials are categorised as tier 3 to tier n.

The fourth type of actor, the service providers, encompasses all service companies that provide services for other actors in the value-added or process chain. Particularly important for the automotive industry are engineering services providers.

A special role is played by suppliers of production equipment, in particular machinery and plant engineering as well as toolmaking. They do not provide components for serial production, but the production facilities for the plants of carmakers and suppliers.

The following figures are only rough estimates of the quantitative structure of the German automotive supply industry, based on Vollrath (2002):

– approx. 40 tier 1 suppliers, mostly system and module suppliers, each with more than 5,000 employees;
– approx. 250 tier 2 suppliers with a specialised product range, each with more than 500 employees;
– approx. 1,400 tier 3 to tier n suppliers, each with fewer than 500 employees.[13]

Table 1
Sales and employment of selected manufacturers and suppliers of the German automotive industry

Manufacturer	Automotive revenues in millions	Revenue share	Total employment
VW-Group	105,187		366,769
Daimler	78,924		258,628
BMW	50,681		96,207
Audi	29,840		58,011
Supplier			
Robert Bosch	30,261	57%	270,687
Continental	26,483	95%	134,434
ThyssenKrupp	11,305	20%	187,495
ZF	11,230	86%	60,480
BASF	6,968	10%	104,779
Schaeffler	6,104	60%	61,000
Mahle	5,277	98%	43,489

Source: Annual reports of the respective companies, as of 2009

3.1.2 THE MACROECONOMIC IMPORTANCE OF THE AUTOMOTIVE INDUSTRY IN GERMANY

The economic importance of car production in Germany can be briefly outlined in terms of innovative ability, foreign trade and employment:

– The automotive industry accounts for more than one third of all industrial R&D spending in Germany and for 30 percent of R&D employees (Stifterverband 2010). From 2006 to 2008 the innovation rate[14] was between 7.9 and 8.4 percent (ZEW 2010: 2). Thus, the automotive industry plays an outstanding role in German innovation and is an important source of stimuli for other sectors of the economy.
– The automotive industry is responsible for about one third (2006 = 32.8 percent) of the German trade surplus (Legler et al. 2009: 50).
– With 723,190 (2008 = 749,098) employees in the crisis year of 2009, this economic sector achieved sales of more than EUR 263 billion (2008 = EUR 331 billion) (German Federal Statistical Office 2010). Deliveries from other sectors of the economy increase the actual job market significance of the automotive industry by a factor of 2.4 (see Jürgens/Meißner 2005: 56). In other words, between 1.7 and 1.8 million jobs depend on German car production.[15]

3.1.3 PASSENGER CAR PRODUCTION

In the crisis year of 2009 4.9 million passenger cars (previous year 5.5 million) were produced in Germany. The global production by German carmakers was 9.8 million units (previous year 10.8 million), of which 2.2 million were sold locally and 7.6 million were sold abroad (IG Metall 2010: 2). Given the global production of 54 million cars, German manufacturers accounted for just under one fifth.

The following figure presents the output and distribution by units of cars produced by German carmakers in 2008 and their global links. As can be seen, most German production is exported, while the 532,000 units imported from abroad account for about one third of German carmakers' sales in Germany (see Figure 3).

Suppliers in Germany and abroad are responsible for almost 75 percent of value creation, i.e. by far the major part. Vice versa, this means that the carmakers have reduced their depth in manufacturing to 25 percent on average.

3.1.4 COMMERCIAL VEHICLE PRODUCTION

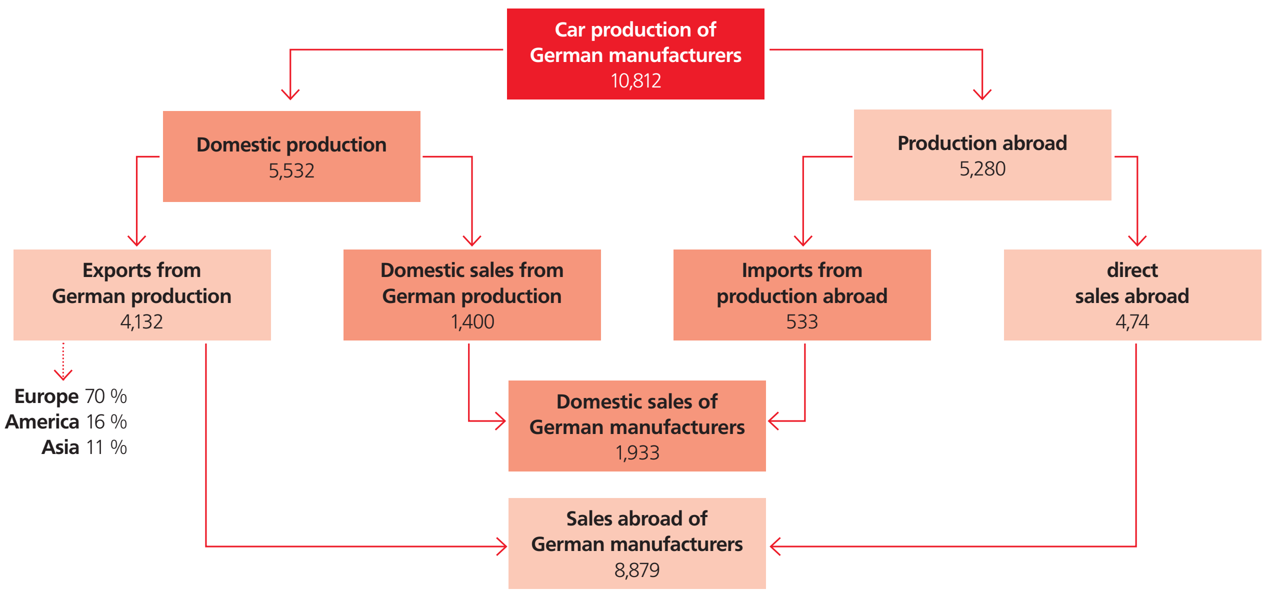
In both Europe and Germany the commercial vehicle segment was in a crisis from the third quarter of 2008 until the beginning of 2010, in which time it experienced a dramatic collapse in demand. Germany is one of the ten leading com-

13 In a 2007 study (VDA/IKB 2007: 12) the VDA assumes that there are 2,000 supplier companies in Germany, of which 208 have sales of more than EUR 100 million and 700 sales of more than EUR 10 million.

14 The innovation ratio is the ratio of R&D spending to sales.

15 To quantify the indirect employment impact for 2004 Legler et al. (2009: 65) use an employment multiplier of 2.2. Both figures for the employment multiplier are based on input-output calculations.

Figure 3
Passenger car production of German manufacturers in 2008, in thousand



Source: IG Metall 2010 based on Data of VBA and KBA.

mercial vehicle producers in the world. The segment provides employment for about 180,000 people. Taking a broader view, i.e. including operation, maintenance and use, about 2.5 million jobs in Germany depend on this segment (VDA 2010c: 6).

3.1.5 THE PREMIUM SEGMENT: A SPECIFIC FEATURE OF GERMAN CAR PRODUCTION

A specific feature of German car production is the pronounced focus on the so-called premium segment. Demand in this segment is characterised by relatively low price elasticity. Premium is the term used for vehicles that are high-value in terms of both technology and comfort. Many new developments and innovations are first introduced in this segment, before spreading into the mass market over time.[16] The Centre Automotive Research at the University of Duisburg estimates that out of the total world car production of 57.14 million units in 2010, the premium category accounted for 5.35 million units (9.4 percent), of which 3.91 million units were produced by German carmakers, i.e. 73.1 percent of global sales of premium automobiles (Frese 2010).

3.2 CHANGES IN PRODUCTION AND LOCATION

3.2.1 THE PRODUCTION MODEL OF THE GERMAN AUTOMOTIVE INDUSTRY: PREMIUM PRODUCTS AND SOCIAL COMPROMISE

German automotive production is best defined in the context of the social science debate on models of production. The concept of the production model usually includes:

- a specific link between product market strategies and labour relations in the companies;
- a specific link between labour regulation institutions at the corporate microlevel and the social macrolevel.

The "German production model" in general – and the automotive industry in particular – is a high-road production model defined as a competitive, quality-oriented strategy of specialising in premium products on the one hand (for details see Jürgens/Naschold 1994: 241) and a specific social compromise that combines productivity with employment on the other.[17]

16 Premium is not the same as large luxury limousines. Small cars such as the BMW Mini and the Audi A1 are included in this segment.

17 This includes employment guarantees, flexibility and participation of the workforce as well as a high level of skills in the workforce, strong representation of workers' interests in the company and the industry and a focus on negotiations and cooperation to adapt and further develop labour regulations

Social compromise between the actors goes hand in hand with an economic strategy of specialisation and growth (see Jürgens/Krzywdzinski 2006: 205).

The high-road production model of the German automotive industry has three main criteria:

First, the employees of German automotive companies are highly qualified: the proportion of skilled workers (= 62.3 percent; all industry = 58.6 percent) and academics (= 13.6 percent; all industry = 10.5%) is very high compared to other sectors (Federal Office of Statistics, employees subject to mandatory social security contributions as of 30 September 2009). In keeping with the spirit of social compromise, the representative trade union in this sector, the Industrial Union of Metalworkers (IG Metall) has used wage negotiations in the past to establish working hours and conditions that enable the companies to react flexibly to fluctuations in production. Even during the most recent crisis companies for the most part held onto their core workforce thanks to agreements on new regulations for short-time work and the trade union's proposal for a car scrappage incentive. Just how far-sighted this was is demonstrated by the current situation (summer/autumn 2010) in which demand, in particular from abroad, has picked up strongly and most of the German plants are operating at full capacity and planning to introduce extra shifts and reduce time off.

Second, the manufacturing facilities are designed to be flexible so that the model mix produced in a plant can be adjusted to orders without much retooling or cost. Most carmakers have two final assembly facilities that produce a specific car model.

Third, the main R&D facilities of carmakers and suppliers are located at company headquarters and, thus, close to the main production plants, which keeps the paths between research, development and production as short as possible. This means that German production plants also fulfil the function of global competence centres or "leading sites".[18] These are the plants in which prototypes are produced, the series runs of new products prepared and tested and production technology proved. Only when serial production runs smoothly and steadily can and will product assembly, including know-how transfer, be assigned to a site abroad.

3.2.2 REGIONAL DISTRIBUTION AND CONCENTRATION OF THE AUTOMOTIVE INDUSTRY IN GERMANY

All over the world so-called production clusters, and hence a high regional concentration, are characteristics of the regional distribution of corporate headquarters, R&D facilities and production plants in the automotive industry. Among the 16 largest automotive clusters in the EU in 2006, the European Cluster Observatory identified seven regions in Germany, which are listed in Table 2.[19]

Table 2
Employment in automotive clusters in Germany

Automobile cluster	No. of employees
Stuttgart	136,353
Upper Bavaria	82,339
Braunschweig	79,997
Karlsruhe	40,694
Lower Bavaria	37,960
Hanover	25,980
Saarland	25,123

Source: Blöcker et al. 2009: 57

Apart from this spatial concentration, certain regions are further specialised, for instance the Stuttgart region. Here the automotive supply industry is exceptionally focused on the internal combustion engine, its aggregates and components (Dispan/Meißner 2010; Dispan et al. 2009: 190ff.).

Statistics for employees subject to mandatory social security contributions provide data only for the individual federal states and overall vehicle manufacturing, which in addition to the automotive industry also includes, among other things, the production of rolling stock. As Table 3 highlights, almost half of all jobs in vehicle manufacturing in Germany and, thus also value creation, is concentrated in Baden Württemberg and Bavaria, followed at some distance by Lower Saxony and North Rhine-Westphalia.

Table 3
Regional distribution of employees subject to mandatory social security contributions in vehicle manufacturing by federal state

Federal states	No.	in percent
Baden-Württemberg	198,591	22.5
Bavaria	200,727	22.7
Berlin	7,615	0.9
Brandenburg	10,230	1.2
Bremen	22,800	2.6
Hamburg	27,259	3.1
Hesse	63,143	7.1
Mecklenburg-Western Pomerania	8,188	0.9
Lower Saxony	135,018	15.3
North Rhine-Westphalia	96,048	10.9
Rheinland-Palatinate	28,588	3.2
Saarland	23,552	2.7
Saxony-Anhalt	5,754	0.7
Saxony	29,398	3.3
Schleswig-Holstein	12,432	1.4
Thuringia	14,605	1.7
Total	**883,948**	**100**

Note: Data as of 31 December 2007 (last available figures) Source: Federal Statistics Office 2010

18 Robert Bosch GmbH in particular favours the concept of leading sites (for details see Jürgens/Meißner 2005: 91).

19 As a rule, automotive clusters are considered at the level of smaller geographic units (cities or rural districts), rather than at the level of the federal states.

3.2.3 GLOBALISATION, RELOCATION AND INTERNATIONAL MANUFACTURING NETWORKS

The aforementioned distribution of German automotive production between sites in Germany and abroad shows that almost as many vehicles are produced abroad as in Germany. Apart from German exports, foreign markets are supplied primarily by production in these markets or market regions. This holds not only for carmakers, but also for suppliers. The latter have also gone international and followed their clients to their locations abroad.

Whereas in the 1980s they focused for the most part on "simple" fabrication established in foreign markets or cheap locations abroad, since the mid-1990s hardly any distinction has been drawn between foreign and domestic technological content, manufacturing technology and product. The differences are mostly a function of the locations within a carmaker's global manufacturing network system (see competence centres/leading sites). As of 2004, the German automotive industry had 1,758 locations abroad, of which 609 were in Western Europe and 309 in Eastern Europe (Automobil Produktion 2006: 10).

Besides production sites, in recent years R&D departments have also been established abroad. Whereas initially these development services had the exclusive function of adapting products (vehicles or components) to their respective markets, recently they have started developing their own specific products, e.g. so-called low-cost cars, which the companies have, where promising, adapted to the German market.

Globalisation is usually mentioned in connection with the argument of global overcapacity. This supposedly available excess capacity is based on the technically defined production capacity in carmakers' final assembly plants and their respective annual capacity utilisation, which lies between 70 and 90 percent. The worldwide automotive industry has lived with this situation for at least half a century. Capacity adjustments are achieved less by closing sites than by adjusting personnel capacity (job cuts and shift work). From the corporate viewpoint, overcapacity looks very different. For example, the Volkswagen Group has identified an opportunity in the important Chinese market and subsequently wants to increase market share there and therefore needs production capacity in this market. Hence, three new plants will be built in the next two years to satisfy the expected demand. The same reasoning holds for the North American market and the new VW plant in Chattanooga/Tennessee.

3.3 INNOVATION DYNAMIC AND THE GERMAN AUTOMOTIVE INDUSTRY

The importance of the automotive industry for German innovation was touched on in Chapter 3.1.2. Since the mid-1990s the innovation dynamic in the German automotive industry has been characterised first by the growing use of electronics in cars and the evolution of mechanics and electronics into mechatronics. Electronically supported braking and steering systems, driver assistance systems and engine control solutions through to car infotainment have been integrated into cars to enhance safety and comfort.

Second, in recent years reducing emissions has become a focal point of innovation solutions to meet EU limits. Innovative solutions include applications to lower fuel consumption, such as fuel-injection technology, lightweight designs and new materials on the one hand and the use of soot particulate filters for diesel engines and catalyst technology on the other. This has also focused attention on drive concepts, in particular the further development of diesel and internal combustion engines. Starting points for further optimisation include additional measures to reduce emissions, including the so-called downsizing of engines in conjunction with turbocharging, variable valve timing and further weight reduction without, in the final analysis, significantly impacting performance.

Homogeneous combustion of a combination of diesel and petrol fuels, fuel cell drives and gas and hydrogen drives were also viewed as potential alternative drive systems, although initially the Japanese model of a hybridised power train was not pursued. However, the growing market acceptance of hybrid technology in the US market triggered a change in attitude, and recently German carmakers have started to offer vehicles with hybrid drives. Another innovation topic of crucial interest in the industry is advances in the electrification of the power train up to full electromobility.

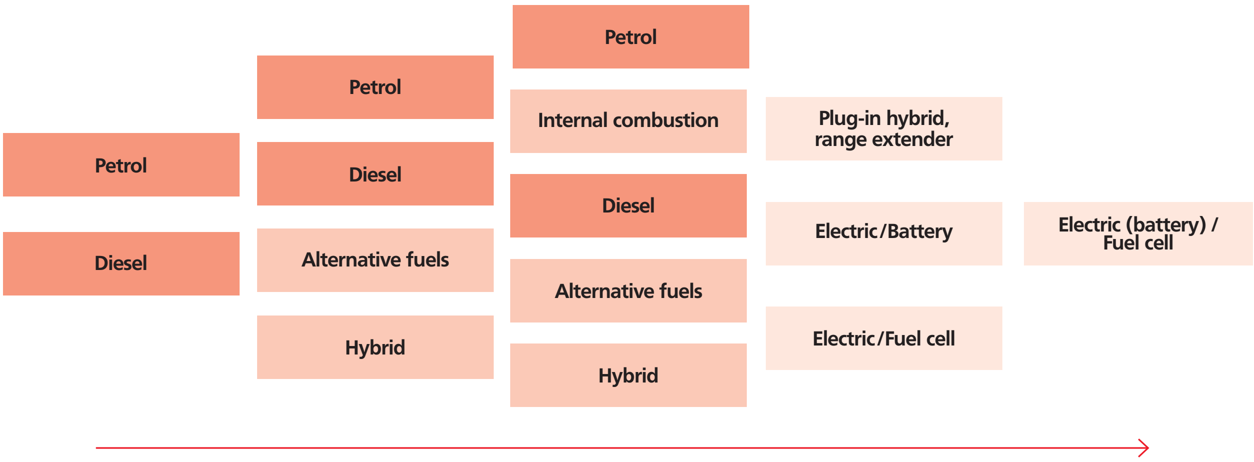
3.3.1 NEW DRIVE AND VEHICLE CONCEPTS

As the conditions impacting the automotive industry outlined above make clear, the industry is on the brink of a dramatic transformation in drive technology. The dominance of the internal combustion engine is increasingly being questioned on account of the scarcity of fossil fuels, climate issues and, in the final instance, the political discussion and strategy surrounding electromobility (see Chapter 3.4). The adoption of the National Development Plan for Electric Mobility initiated a public debate that in the meantime threatens to become hype, suggesting that in coming years the electric car will replace the internal combustion engine. On the other hand, questions about the timing of the electric car's market breakthrough elicit very different forecasts. Its success depends ultimately on a breakthrough in battery development that will at least partially solve the problem of range facing electric vehicles and the question of what portion of the car's power will come from renewable energies so as to realise the potential emission-related advantages of electric cars.

This process of electrifying the power train began with the so-called hybridisation of the drive system, which in particular Toyota and Honda have been pursuing since the mid-1990s. The Toyota Prius, the first hybrid vehicle to go into serial production, was launched in the Japanese market in 1997 and in the US and European markets in 2000 (Jürgens/Meißner 2005: 142).

Although European and above all German carmakers took note of this first step towards electrification of the drive train, they did not pursue it, emphasising the superiority of diesel engines in respect of emission levels. Around the turn of the millennium in particular Daimler placed its hopes in the fuel cell as an alternative drive system, and went on to start serial production of cars with fuel cells in 2004. Currently (2010), Daimler plans to launch with the B-Cass F-Cell electric car in 2015 (wind 2009: 11).

Figure 4
Overview of alternative drive train concepts



Source: Schmidt-Sandte 2010: 5

Figure 4 provides an overview of the various alternative drive train concepts. It illustrates the diversity of possibilities and variants that almost all German carmakers are pursuing with varying degrees of enthusiasm.

Given the great uncertainty about which development path will ultimately dominate, carmakers face the challenge of keeping up on all technological fronts and development paths. This will require extremely high capital investment and the corresponding human resources in R&D. As virtually no manufacturer can afford this on its own, in recent years a number of collaborations and strategic alliances have emerged, in particular in the field of lithium-ion battery technology[20] and in the small car segment.[21]

In the light of these different forms of alternative drive systems and fuels, carmakers face the new challenge of examining their current vehicle concepts and architectures. For example exclusively electric drive trains only develop their full potential when the vehicles are conceived with this drive concept in mind – what is known as purpose design. Swapping an electric engine for an internal combustion engine within an existing vehicle architecture (a so-called conversion design) cannot effectively utilise the design potential and degree of freedom offered by the vehicle architecture.

3.3.2 AUTO-RELATED MOBILITY CONCEPTS

The transformation processes outlined permanently impact the possibility of individual automobility. Taken in conjunction with the parallel changes in attitudes to mobility, this opportunity of realising new concepts opens up a new development path towards ecologically more sustainable mobility.

Global megacities have great significance for the development of car-related mobility concepts. They require new concepts to deal with mobility needs that arise on the one hand from the inability to afford a car and on the other from the lack of parking and street space to accommodate the rapid growth in car traffic in high-density metropolises. Motivated by critical air-quality limits, Chinese megacities are already toying with the idea of allowing only zero-emission vehicles in inner-city zones in the future.

One of the technological challenges facing electric cars is their range, which is currently limited by battery technology.[22] As a result, electric vehicles can be used only for relatively short distances, for instance for commuting or inner-city mobility. That said, for most road users these shorter distances account for about 90 percent of all travel.

This restriction is simultaneously an opportunity, namely to include electric cars as a component in a comprehensive network mobility offering in large metropolitan areas. However, this will require a paradigm change from individual car ownership to the concept of service-based mobility. Against the background of increasingly individualised and intermodal traffic behaviour this transformation promises a reduction in investment and operating costs and facilitates the needs-based use of mobility options: for the work commute light rail may be the best means of transport, for a trip to the lake a two-seater electric car, for holiday travel a hybrid limousine and for a major shopping spree a diesel van.

This would not only satisfy user requirements for needs-oriented mobility: in view of potential restrictions on internal combustion engines in metropolitan areas, the development

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20 Almost all carmakers and the major supplier companies have entered into cooperations and strategic alliances with South-East Asian companies in the electrical industry to ensure access to battery know-how (for an overview, see Handelsblatt, 30 September 2009).

21 E.g. Daimler-Renault-Nissan and BMW-Peugeot-Citroën.

22 After the manuscript has been edited, DBM Energy, a Berlin company established a „world distance record" for a lithium metal battery of 600 kilometres in an Audi A2 (on the stretch from Munich to Berlin in the night of 25/26 October 2010). This test run of a „revolutionary" battery concept received EUR 275,000 in funding from the Convergent Information and Communication Technology Unit at the Federal Ministry of Economics and Technology.

of electric cars as a building block of further mobility systems appears to be a sensible step.

This paradigm shift affects not only public transport providers and political and administrative actors, but also carmakers: as they travel a development path from a role as suppliers solely of vehicles to that of integrated mobility service providers. Instead of buying a car, clients could build on the current concepts of leasing and carsharing and purchase a "mobility package" that allows them to use the appropriate mobility option for a situation – be it an electric city car, a minivan, a rental bike or a long-distance train. This needs-oriented mobility is indicative of a trend to reduce the vehicle fleet, which implies lower sales potential for carmakers and their suppliers. It is clear that such developments go hand in hand with considerable corporate reorganisation that will involve new cooperation networks.

The following examples highlight the initial attempts of business models to integrate cars into rental systems. Findings to date show that this form of car mobility encourages road users to plan car use better and increasingly as a means of complementing public and non-motorised means of transport. This multimodal transport behaviour is not associated with significant constraints on mobility, but is associated with ecological advantages:

– Daimler car2go: The carsharing programme operated by Daimler in Ulm lends Smart cars under easy conditions; the programme now has 20,000 registered users. In contrast to conventional carsharing there is no basic charge. Users are charged by the minute. After use the vehicle can be parked in any public parking lot within the municipal boundaries. GPS and electronic data transmission makes it possible to monitor the Smart fleet in real time and track availability. In Ulm Daimler is currently also testing an extension of the car2gether concept. Users enter passenger requests and offers on a website and Daimler arranges the appropriate contacts. Payment by smartphone is planned, and if there are no offers customers can fall back on the car2go programme.
– Autolib: After the tremendous success of the Paris bike-sharing system, the French metropolis is planning the sharing of electric cars. The plan is for about 4,000 electric cars at 1,400 stations in Paris and vicinity. The monthly membership fee will be between EUR 15 and 20 with a use charge of about EUR 4 to 5 for 30 minutes. The first cars are supposed to be available as early as 2011.
– Peugeot: The Mu[23] by Peugeot project of the French carmaker offers a system for renting a range of vehicles and models (bicycles, electric-assisted bicycles, electric scooters, electric cars, convertibles and vans). This programme started in France in 2009 and has been available at four Peugeot car dealerships in Berlin since mid-2010. Users pay in "mobility points" or euros. To tie them to the company and the project, customers are encouraged to open an online account that offers price discounts. Charges depend on the vehicle and length of time used. The project was successfully tested in the cities of Brest, Nantes and Lyon, then extended to Rennes and since early 2010 Paris, too (Ruhkamp 2010).

3.4 NATIONAL DEVELOPMENT PLAN FOR ELECTRIC MOBILITY

Electromobility appears to be a development path that offers a solution for problems of fossil fuels and climate change and has the potential to help the automotive industry to meet the EU limits set for 2020. At the same time, it also opens up possibilities of a more comprehensive approach to new car concepts and integrated mobility concepts that have long been demanded, only realised in part (see Chapter 2).

In response to the market success of hybrid technology and efforts of the Southeast Asian – in particular Chinese – automotive industry in the field of electric drive trains, after ensuring its intentions harmonised with existing political bases, policies and programmes,[24] the Federal German government published the National Development Plan for Electric Mobility in August 2009.

EUR 500 million of Stimulus Package II funds were set aside for research and development up to 2011 to promote electromobility and prepare for the market launch (BMBF 2010). As Table 4 shows, this funding is modest by international standards.

Table 4
Selected electromobility support programmes

USA	€ 1.4 billion for battery technology
	€ 18 billion loan for production plants for fuel-efficient vehicles
	€ 107 billion for clean energy technologies (spread over ten years)
	€ 284 million for demonstration projects, infrastructure
China	€ 1 billion for efficient drive train technologies (2009/2011)
	2 billion for 13 pilot regions with 10,000 vehicles (2009/2011)
Japan	€ 145 million for developing traction batteries
Europe	€ 710 million (2010/2013) for the European Green Car Initiative
	€ 2.9 billion loans for green cars (European Investment Bank)
	€ 730 million for energy technologies (2007/2013)
	€ 65 million for, among other things, Energy in Transport (2009)
France	€ 400 million for the Pacte Automobile
	€ 2,5 billion in further investments (over the next ten years)

Source: Compiled by the authors

23 Mu adopted the Greek letter „mu", which stands for movement.

24 National Fuel Cell Programme 2006, Transport Energy Strategy (Hydrogen), Fuel and High-Tech Strategy and Integrated Energy and Climate Protection Programme (IEKP).

The first specific steps of the National Development Plan for Electric Mobility included selecting eight model regions, placing the "Electro-Mobility System Research" initiative with the Fraunhofer Institutes, establishing an "Electro-Mobility Forum", the "Market Activation Programme to launch the first 100,000 electric vehicles" and the creation of competence clusters for "Electromobility focused on Battery Technology and Production" (BMU 2009). According to the ministries, the funding is almost completely tied to specific projects.

The target of the National Development Plan is one million electric vehicles on the streets of Germany by 2020. The goal is to make Germany the leading market for electric mobility. German industry complements this objective by seeking to make Germany the leading provider of electromobility, thereby maintaining and expanding the country's technological leadership in the global automotive industry.

To ensure that industry is integrated into the National Development Plan, the National Electric Mobility Platform was launched on 3 May 2010. The German government and German industry used this occasion to issue a joint declaration in which industrialists and politicians agreed on the common goal of making Germany the leading market and leading supplier of electric mobility. Industry and the energy sector have signalled that they support the goals of the National Development Plan.

The National Platform is technology-oriented. The members of its working groups are drawn from the industry and have the task of exploring Germany's prospects and strengths in the field of electromobility and drawing up proposals for other R&D projects. In view of the anticipated "new" value change and systemic transformation triggered by electromobility, the goal goes beyond solutions to technical issues.

The shaping of systemic change – the medium-term transition from internal combustion engines to alternatives such as electric drive trains – is a sociopolitical task that is both regional and national. It must initiate a dialogue to include in particular all employees and their representative bodies at the corporate and sector levels. The state has a duty to promote this dialogue beyond the automotive industry in the narrow sense at the regional, national and EU levels. This offers an opportunity to overcome industry egoism and develop a mobility concept for society as a whole. There is an urgent need for a concept focused on solutions to both technical issues and ecological and social questions (standardisation, decisions about development paths, securing and creating jobs, the impact of regional and urban planning, energy policy, acceptance, etc.). It opens up possibilities for what was mentioned above in the context of the German high-road production model: negotiated social compromise that advances the prospects of specialisation and growth.

4

IMPACT ON EMPLOYMENT IN THE AUTOMOTIVE INDUSTRY

The aforementioned socio-economic and technical developments considerably impact regional developments in automotive industry locations. The employment implications of structural transformation are evident, although it is difficult to make long-term forecasts about job trends, skills development and the quality of work in the automotive industry. So far, no impact analyses of the impending structural changes have been published.

4.1 DETERMINANTS OF EMPLOYMENT TRENDS

The employment trend in the German automotive industry will be driven by structural changes that are the sum of a number of processes. Although they will not occur simultaneously, they will be mutually impacting:

– Ongoing productivity improvements in the coming decades: the automotive industry expects annual productivity improvements of between three and five percent. At the beginning of 2010 Volkswagen set itself a target of annual productivity growth of ten percent and simultaneously agreed to an employment guarantee. However, given that for the automotive industry as a whole the pace of rationalisation will outstrip the rate of growth, permanent rationalisation will reduce the volume of work.
– In the coming years the value chain will be reorganised to remove overcapacity left in the aftermath of the financial and economic crisis: For SME suppliers and in particular automotive equipment suppliers in the mechanical engineering sector bankruptcies and restructuring raise the danger of further crisis-induced job losses.
– Medium-term market shifts, both geographic towards the BRIC states (above all China) and within the segment towards small and compact cars: these market shifts are also associated with ongoing globalisation of production and R&D structures. New plants and capacity expansion are limited almost exclusively to growth markets. Thus, relocation threatens above all jobs in production, but also in development and assembly.
– Social change accompanied by changes in attitudes towards individual transport and the rise of new concepts of mobility in the medium to long term: a growing shift in emphasis from car ownership to car use will impact the number of cars and, thus, directly affect potential sales and production volumes of carmakers and suppliers. At the same time, new business models (mobility services) will offer opportunities for carmakers.
– Technology shifts towards electromobility with long-term prospects for new value-chain structures: the growing electrification of the drive train, which may culminate in a battery-powered electric vehicle, has far-reaching consequences for carmakers and suppliers. With regard to employment, this development will tend to go hand in hand with lower work volumes in direct production activities in the automotive industry in the narrow sense. There is at least some possibility of new added-value chains, for instance in the energy sector, in batteries, power electronics, recycling and services, but lightweight design and construction will play an increasingly larger role. In addition to the established suppliers, which are already preparing for systemic transformation, there are opportunities for new actors as suppliers or as development and business partners of the automotive industry.

The potential job opportunities and risks associated with this long-term technological transformation will materialise in different time perspectives and chronologies, as will be shown below. All in all, the impacts on employment can be expected to work in opposite directions. Rising (global) production figures are likely to be (more than) offset by productivity improvements and technology-related effects (lower complexity of electric drive trains). But just where the additional volume to meet demand particularly in the emerging markets will be produced it is still open to debate.

After this survey of the various risk dimensions impacting employment in the automotive industry, we examine the systemic transition to electromobility in greater detail. In particular we focus on an assessment of the impact on employment in Germany, both quantitatively and qualitatively. The technological shift towards electromobility – associated with a social shift in concepts of mobility – must be viewed as a radical systemic transformation for the automotive industry. As the range of relevant forecasts shows, there is, however, considerable uncertainty about when and in what form such systemic transformation will transpire. This, in turn, triggers a degree of uncertainty in the automotive industry as well. Although this structural change will be realised over an extended period of time, not overnight, already today it poses enormous challenges for carmakers, their suppliers and all other sectors linked to the automotive industry.

4.2 ELECTROMOBILITY: ASSESSMENT OF THE IMPACT ON VALUE CREATION AND EMPLOYMENT

4.2.1 CHANGES IN VALUE CREATION STRUCTURES

With regard to the transition to electromobility, we identify the following determinants of German automotive production and locations that will result in drastic changes in the current value chain and its structure.

- Electrification of the drive train strengthens the trend towards modular building blocks. As systemic integrators of vehicles and drive trains, carmakers have to decide which modules they want to produce themselves and which they want to buy in from suppliers. That said, they will always be integrators, also with regard to the drive train. Traction batteries and electric engines are product areas that to date have not been part of their core competencies. There is reason to believe that elements of the electric drive train will become standardised components produced for several carmakers mostly by tier 1 suppliers. However, this does not answer the question of where the value will be created, in Germany or abroad.
- Similarly, development trends in procurement will also continue to strengthen. These include an expansion of global procurement, an increase in the proportion of components procured from low-cost locations, and the expansion of modularisation, i.e. buying in complete systems or modules, such as electric engines or traction batteries.
- Given the challenge of maintaining a presence in the different fields of alternative drive-train development, carmakers' level of competence will continue to decline, i.e. the trend of outsourcing development services to suppliers will continue.

The electrification of the drive train will redistribute the share of value added – both between discontinued and newly adopted components and between different actors. The introduction of electric drive train concepts will drive demand for new or radically changed components; plant technologies and production processes will change; demand for manufacturing capacity will need to be reassessed; and not least training, skills and qualifications will have to satisfy new and evolving demands and requirements.

Hence, electromobility not only creates new opportunities for companies, but also creates challenges for them. Jobs in particular are at risk, even if mitigated by the long-term nature of the development. "If you had to flip the switch from internal combustion to electric engine in 2020, of course you would be terrified, but that won't be the case. Between 2020 and 2040 the employment effects of both technologies will slide past one another somehow", says Wolfgang Nieke, chairman of the works committee at Daimler Untertürkheim (Scheytt 2010: 21). In the end, though, as most experts agree, once the systemic shift to electromobility has occurred the automotive industry will offer noticeably fewer jobs. Accordingly, the regions that will be hit the hardest are those whose economies and jobs are traditionally highly dependent on the automotive industry. This is particularly true if the regional automotive industry, as in the automotive cluster in the Stuttgart region, is heavily focused on classic drive train components (Dispan et al. 2009).

4.2.2 STAGES OF ELECTRIFICATION AND THE IMPACT ON EMPLOYMENT

Estimates of the impact on employment must be seen in the context of the phases in the development of drive train electrification. As shown above (see Figure 4, p. 24), initially there will be a sharp increase in the variety of drive units. Within the automotive industry people talk of three phases: an initial phase of continued diversification, followed by a phase of convergence that could culminate in a final phase in which the focus is on electric drive systems.

Phase 1 is characterised by further diversification of the drive train concept. Progress in the electrification of the power train will run parallel to the further development of the internal combustion engine (optimisation, downsizing). At the same time, the importance of lightweight design will continue to grow. Considered as a whole, in this phase it is assumed that work volumes will trend higher, which will have a positive impact on employment. Hybrid concepts will also mean new aggregates for the internal combustion engine (traction batteries, electric engine and power electronics). McKinsey and Fraunhofer IAO have carried out studies on employment in this phase:

- In a study commissioned by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU), McKinsey concludes that employment effects will be substantial and positive up until 2020. The elimination of classic components of the internal combustion engine is forecast to cost 46,000 jobs, which is likely to hit German suppliers disproportionately. According to McKinsey, though, in the same time period the demand for new components such as batteries and electric engines will create 250,000 jobs globally; Germany must just grasp the opportunity (BMU 2009: 5).
- Fraunhofer IAO's structural study on the LivingLab BWe mobil initiative summarises in form of a metastudy a number of consulting studies on the impact of the electrification of drive systems. The first step presents the global change in value creation (production volumes) for the individual components. Germany is assumed to account for a 25 percent share in global automotive added value, and Baden-Württemberg alone a share of five percent.

These assumptions about proportions of added value have been adopted for all conventional and new components. Applying this model calculation produces a loss of 9,000 full-time jobs in classic internal combustion engine manufacturing in Germany by 2020.[25] All other areas grow: components manufacturing for efficiency technologies is forecast to create 32,500 new jobs, 28,000 battery systems and 14,750 electric engines. Other components together are forecast to create another 23,400 jobs by 2020. According to this study, the result will, on balance, be a gain of almost 90,000 full-time jobs in Germany by 2020 (Fraunhofer IAO 2010: 45). The prerequisite, however, is that production of the new components and its associated value creation are located in Germany. In particular in the field of battery systems Germany has little production know-how and even less production capacity; hence, achieving a global market share of 25 percent in 2020 would present a huge challenge. All in all, the forecast gain of 90,000 jobs is based on a number of demanding preconditions; on account of the very optimistic basic assumptions this figure should be critically scrutinised.

In Phase 2, progressive convergence, the significance of the internal combustion engine steadily declines as the electrification of drive systems advances. As a result, the market for conventional drive technology gradually shrinks. At this point at the latest suppliers' and carmakers' assembly plants have to contend with substantial changes in demand for their products. As the popularity of battery-powered electric vehicles spreads, suppliers whose core competence and product portfolio are heavily focused on the development and production of conventional drive technologies could find themselves fighting for survival. If on the other hand they make the transition to the new, for the most part electric technologies, they could open up new, future-oriented market potential (Wallentowitz et al. 2010: 151).

Phase 3 is characterised by the dominance of electric vehicles. In the long run an age of electromobility is the likely future of motorised individual transport, a point on which most representatives of the automotive industry agree. Where they disagree is on the point in time when exclusively electric transport will gain the upper hand. Hence, there is also a broad range of forecasts about shifts in market share and, thus, uncertainty among decision-makers in the automotive industry. To date there are only very rough approximations for a long-term job balance, i.e. for a comparison of the employment impact on internal combustion engine production vs. electric drive production. What is clear is that the employment impact in manufacturing will be accompanied by a reduction in complexity. Compared with the complex internal combustion engine, electric cars will use simpler and, as a rule, less sophisticated components, for which production in many cases will be highly automated.

25 The study assumes that in 2020 97 percent of all vehicles will have an internal combustion engine, though it will on average be smaller (owing to downsizing and because hybrid cars need smaller engines).

4.2.3 ELECTROMOBILITY: AN APPROXIMATE JOB BALANCE

A comparison between conventional and battery-powered electric drive systems shows that a complex internal combustion engine with roughly 1,400 components (engine and transmission) involves considerably more work than an electric engine with a good 200 components in its drive train. In addition, it must be assumed that there will be a greater degree of automation in the production process of the electric drive. A comparison between the output of internal combustion engines in serial production at an engine manufacturing plant and that of electric engines in serial production at a major supplier provides an initial approximation:

- The Daimler plant in Untertürkheim produces internal combustion engines. The annual production of about 700,000 engines is accomplished by 3,300 employees in engine manufacturing – 212 engines per employee. At the Berlin-Marienfelde plant with just under 1,200 employees in engine production some 200,000 high-performance engines are manufactured each year – 170 engines per employee (Automobilproduction 2010).
- Continental has embarked on the mass production of electric power trains at its Gifhorn site. The first complete electric power train (without battery) for the mass produced vehicle of a European carmaker is scheduled to go into production in 2011. The initial plan calls for an annual capacity of up to 60,000 60 or 120 kW electric engines, produced by about 40 employees at a newly equipped production line at the site, i.e. 1,500 engines per employee (Continental AG 2010).

This comparison is not representative and open, of course, to criticism (ranging from differences in performance classes to differences in vertical integration). That said, it is clear that the output per employee is much higher – seven times as high in our example. Various experts in the automotive industry also expect that a comparison of the production of electric engines with far more complex internal combustion or diesel engines will show work volumes in engine plants falling by between 50 and 70 percent. Referring to Stuttgart, a study by the IMU Institute assumes "a negative impact on employment in the medium to long term" (Dispan et al. 2009). Referring to Baden-Württemberg, the German Institute for the Automotive Industry (IFA) assumes that the trend towards electric cars will threaten Baden-Württemberg's automotive suppliers: "About 60,000 jobs in Baden-Württemberg's automotive supply industry would be affected by this development" (IFA 2009). The VDMA came to a similar conclusion for Germany as a whole: if Germany fails to industrialise electromobility, if links in the automotive added-value chain are weak or fail, this will become a "faultline for hundreds of thousands of jobs" (VDI 2010).

4.2.4 INDUSTRIALISATION OF ELECTROMOBILITY AND JOB CREATION

All in all, a long-term systemic transformation can be expected to have a negative impact on employment, even if carmakers and suppliers produce the components in Germany. But the job balance – in particular in production activities – would be even worse if the "industrialisation of electromobility" did not occur in Germany and these technologies of the future established themselves in the emerging markets. It is extremely important for Germany as an industrial location and for the local (manufacturing) job market to retain as much of the value chain as possible in the country and to build as complete a value chain as possible for new drive train components.

Manufacturing industry is of crucial importance for the whole economy – and all the more so after the economic crisis induced by the collapse of the financial markets. In this regard, one should not lose sight of traditional sectors such as the automotive industry; it is not enough to focus only on cutting-edge technology. According to a study of Fraunhofer ISI, German industry remains very strong and successful in R&D-intensive, traditional sectors (such as the automotive industry and mechanical engineering). Cutting-edge technology (such as pharmaceuticals and information technology) cannot compensate for job losses in other sectors (Kinkel 2010). Applied to electromobility, this means that it is not enough to focus only on R&D and technology. Germany's economic and employment policies also have to include steps to ensure that its strength as a manufacturing location does not erode.

In other words, "industrialisation of electromobility" goes hand in hand with crucial questions concerning production and employment in Germany. In the future where will the relevant systems such as batteries, electric engines, fuel cell stacks and power electronics be developed, where will they be produced and where will systems integration be carried out? Which suppliers can transform their core competencies and their innovative capabilities to take account of the new requirements and technologies? Which competencies and skills are needed to develop and produce electric vehicles? Are these skills available in Germany? What needs to be done to create the enabling environment and conditions conducive to the "industrialisation of electromobility" in Germany's automotive regions?

4.2.5 SKILLS REQUIREMENTS

With the electrification of the power train, the development and production of components for electric drives and the auxiliary units will require either completely new or changes in skills, qualifications, know-how and production processes (machine construction, tools). The E/E (electric/electronic) proportion of vehicles will rise sharply. Bosch works on the premise that the E/E proportion of added value will rise from 40 percent in vehicles with internal combustion engines to 75 percent in electric cars (Bohr 2010). Over and above this, the software to run the electronic systems will be more comprehensive and costlier. The increasingly important field of lightweight design and construction will also require new qualifications and skills.

The knowledge requirements for workers in the automotive industry will change. Although knowledge about thermodynamics and materials specific to the internal combustion engine will remain important and necessary for a long time, the emphasis will increasingly shift to knowledge about the principles of operating electric motors, electric engineering and electrotechnology and electrochemisty. The shift to electromobility will increase demand:

- for engineers qualified particularly in the fields of electrical engineering, electronics, mechatronics, electrochemistry, thermal management, control engineering, lightweight materials and system integration;
- for skilled industrial workers qualified particularly in the fields of mechatronics, electrotechnology (working with high-voltage technology, principles of electrical operations), behaviour of materials and process reliability and safety in new production processes and quality assurance for new products; and
- for automotive workshop technicians qualified particularly to work with high-voltage systems and electronic analysis systems.

As a measure to improve qualifications, advanced training as a certified specialised electrician for vehicle technology, including a certificate recognised by the Chamber of Commerce and Industry, has recently been introduced. It qualifies employees in the automotive industry to work on hybrid and electric vehicles. The primary focus of this further education is on high-voltage systems and occupational safety.

In the event of a paradigm shift or systemic transformation such as the transition from internal combustion to an electric engine may involve, it is necessary not least for reasons of social, employment and industrial policy to examine the processes of change more closely precisely in order to react at an early stage. For instance, in connection with basic research, application-oriented research and product development processes, evolving demands on processes, process technologies and above all on the qualification requirements for the employees have to be expected. They have to be analysed and presented in a transparent way. On the basis of these findings the educational, vocational training and further education systems, the added-value chain, and the equipment industry can be prepared to meet the new requirements.

In summary, it is a matter of anticipating social and industrial change at an early stage so as to be in a position to shape it. The challenge is to spell out the strategy that was adopted as a common objective at the European sectoral level in partnership with the European Commission, the European Automobile Manufacturers Association (ACEA), the European Association of Automotive Suppliers (CLEPA) and the European Metalworkers' Federation (EMF) in 2008: Anticipation of Change in the Automotive Industry (Meißner 2010).

5

STRATEGIES FOR THE AUTOMOTIVE INDUSTRY AND ECONOMIC POLICY IN GERMANY

The automotive industry is on the verge of global structural transformation. The factors driving this transformation are finite oil, changing demand and the changing environment for automobility. It poses a significant challenge to value creation, the innovation system, employment and the impacted regions. Developments in the automotive industry in recent years have demonstrated that the sector is incapable of accomplishing the necessary processes of change quickly enough on its own. To overcome conventional patterns of thought and explore new paths requires coordinated, integrated concepts and the strategic, concerted action of all the players involved.

The automotive industry is crucial for Germany; promoting its innovative and economic power must be the guideline for measures to support structural change in this sector. Longer-term perspectives need to be developed for existing production locations and agreed environmental and climate protection targets have to be implemented.

To ensure that Germany retains a successful, sustainable competitive (auto-)mobility industry requires new vehicles, new drive technologies, new use concepts and new service models. Furthermore, there is a need for new location policies that facilitate, accompany and cushion change. Together these needs call for an intelligent mix of instruments to coordinate activities, network actors and provide benchmarks, criteria and incentives.

The following two chapters present the principal recommendations of this position paper. Chapter 5.1 presents strategies necessary to guarantee employment in the German automotive industry on the one hand and to accomplish the expected processes of transformation in the impacted regions on the other. Chapter 5.2 includes measures for sustainable automobility – measures that at the same time have the potential to reduce emissions and the consumption of resources.

The actors responsible for implementing the outlined strategies include political actors, in particular at the federal and European levels, companies in the automotive industry and mobility sectors, works councils and trade unions and the applied sciences.

5.1 STRATEGIES FOR LOCATIONS, REGIONS AND THE MOBILITY INDUSTRY

As the financial crisis has amply demonstrated, leaving the management of the economy to the marketplace's invisible hand alone can produce inadequate results, triggering unprecedented state intervention in the industrialised countries. But this also holds for the real economy and, thus, the economic sectors that are on the brink of fundamental structural transformation. This structural transformation, or what for the automotive industry, as discussed above with regard to electromobility, may be better characterised as a structural shift, needs to be supported by industrial policy measures. With its National Development Plan for Electric Mobility the federal government has initiated an industrial control process that integrates most of the impacted actors through the National Electric Mobility Platform (NPE).

Industrialise electromobility to guarantee manufacturing jobs in Germany

The initial focus of the federal government's National Development Plan for Electric Mobility was on funding research and development. The results of the National Mobility Platform appear to confirm this approach. To date the focus has been on Germany as a centre for technology. Currently R&D concentrates funding on the "pre-competitive" areas of cooperative R&D. What has been largely overlooked to date are the social and employment impacts of the strategy of establishing a position as leading market and leading provider of new cars, drives and use concepts. This objective requires that Germany must become not only a technology centre, but also a location for producing and developing new cars, drives and use concepts. For instance, the industrialisation of electric mobility and the concomitant creation of complete added-value chains is crucial for the sustainability and sustained development of the economy and employment in Germany. In our opinion the approach pursued so far is inadequate.

The focus should not be limited to developing new technologies, but include production technology and the required competencies and skills. The parallel development of the appropriate means of production and human skills must begin at an early stage so as to exploit the opportunities for jobs in Germany. In this respect, the R&D-oriented approach of the National Electric Mobility Platform should be accompanied by a dialogue about the industry at federal level. Main actors: political actors and the National Electric Mobility Platform.

In this connection the general economic and socio-political framework needs to be clarified. Business also requires long-term, reliable strategies for the future organization of mobility. This begins with climate policy targets and in addition to raw material strategies and limits and the definition of transport concepts includes the question of the future role of individual transport. It also involves approaches to educational, research and development policy and the question of what role the state should play in guiding and facilitating these matters.

Initiate dialogue between sectors of the automotive industry

Shaping structural change is a socio-political task to be tackled at regional and national levels. In particular, the employees and their representatives at company and sector levels must be part of the dialogue between industry sectors on how to deal with structural change. This opens up opportunities for socially responsible negotiations and agreement that will underpin the prospects of specialisation and growth.

Sector dialogue also needs to include differentiated analyses to determine how many jobs in which locations are at risk and where there may be an option for new jobs working on new cars, drives and use concepts. Similarly, there is a need to identify gaps in research on the longer-term impact of changes in production locations on the local and regional economy and the community as a whole. A dialogue between sectors at the federal level would, for example, have to examine the following specific questions:

- Which sectors are impacted by structural change in the automotive industry and how?
- To what extent will which companies locate industrial production in which regions and at which of their existing production sites?
- How many jobs can be expected? What skills will they demand?
- To what extent and at which locations are which negative consequences for employment to be expected and what measures should be adopted in respect of the affected employees, for instance can they be offered alternative jobs in other companies or in other sectors?
- To what extent will market developments create the necessary prerequisites and what state support with what objectives will be necessary?
- What structural instruments and what transformation instruments can be deployed?

These questions make it clear that the effects of structural change, both positive and negative, will be felt primarily at the regional level. Correspondingly, regional policy will play a particularly significant role in shaping specific policy instruments. Given the highly regional concentration in the German automotive industry, as described above, and the existing sector-specific cluster initiatives and organisations, points of contact and reference already exist for policy decisions at the regional level; these need to be reinforced and expanded. Regional dialogues in the carmaking regions should be initiated to run parallel to the industry dialogue at the federal level. Main actors: political actors, the National Electric Mobility Platform, sector dialogue at the federal level and cluster organisations.

Develop strategies in the affected regions that include all actors

Structural transformation at the regional level also requires the development of regional strategies, in which all actors in the value chain are integrated and involved. Strategies based on analyses of the regional impact of systemic change have to be developed within the framework of a regional dialogue that includes companies (carmakers, suppliers, and service providers), trade unions, associations and federations, educational institutions, research institutions and labour market actors. Approaches in this direction are already discernible in Baden-Württemberg, Bavaria, North Rhine-Westphalia and, in the very early stages, also in Berlin. These efforts need to be expanded. Main actors: cluster organisations and regional sector dialogues.

Support small and medium-sized suppliers in value chain positioning

Whereas carmakers and supplier groups have already developed their own strategies and are actively positioning themselves for electric carmaking, many SME suppliers lack an adequate strategy to ensure a share of the added value in the progressive electrification of the power train. An industrial policy has the important function of helping in particular these suppliers to recognise the effects of systemic change that will bring new cars, drive trains and service models and to offer them strategy approaches that will enable them to remain competitive in the future. One possibility is increasing the involvement of SME suppliers in innovation processes. Another is to reduce their dependence on vehicle manufacturing, redirect their core competencies towards new products and develop new fields of business. In sum: show SME suppliers the possibilities and opportunities that conversion offers in both the automotive and the non-automotive sectors. Main actors: business development and regional sector dialogues.

Defining skill and qualification requirements

It is foreseeable that with a structural shift qualification requirements and job skills in development and production will also change. Increasingly, new competencies will be required. Regarding electromobility these will include for example electrochemisty and electronics, and new service models will need software development and process management. On the one hand these gaps in qualifications and skills first need to be identified and on the other qualification concepts and corresponding programmes as well as labour market instruments need to be developed so as to close these gaps. Main actors: automotive industry; universities; training and other educational organisations; and labour market stakeholders.

Support for corporate cooperations
Solutions for the mobility of the future are being developed at the interfaces of the automotive industry, battery makers, storage technology providers, mobility providers, energy companies, operators of distribution grids, telecommunications technology and information technology. For electromobility and new mobility concepts to succeed, these diverse economic stakeholders need to cooperate among themselves and with the public sector and obtain clarity about interfaces with as many forms of mobility as possible so as to ensure the integration of the different modes of transport. The associated complexity of implementation, the design of the interfaces and the consultation between the different actors and operators requires coordination and guidance. These functions will fall to the political actors at the federal and regional levels working in conjunction with business development and companies in the public transport sector.

5.2 INCENTIVES AND REGULATIONS FOR NEW VEHICLES, DRIVE TECHNOLOGIES AND USE CONCEPTS

Besides boosting efficiency through technical innovations in drive systems and vehicles, new models and concepts of car use need to be developed. However, the various measures should be technology-neutral rather than focused on specific technology services. The main emphasis must be on achieving ecological, economic and social goals through systemic innovations that impact the automotive industry and mobility needs in their entirety.

Tougher regulations to promote more efficient, low-emission vehicles
Appropriate policies on emission limits can provide incentives for vehicle manufacturers to produce new, more efficient models that emit less CO_2. The manufacturers can achieve these standards by improving efficiency, downsizing the drive unit and using fuels with lower emission values.

The limited success of national efforts on the one hand and the internationalisation of the manufacturing industry on the other has increased the importance of the common EU policy.

It is necessary to continue to lower the EU fleet consumption limit, setting the goal of 120 g

CO_2 per kilometre for 2015 and 95 g CO_2 per kilometre for 2020. Critical points include, for instance, the double counting of electric cars as zero-emission vehicles and the transition period from 2015 to 2020. For the time after 2020 quick adoption of stricter emission limits will provide planning certainty for the automotive industry. Main actors: European political actors and Federal German political actors.

Foster research and development into low-emission vehicle technologies and new car use concepts
Mobility-focused industrial policy may not limit itself to topics about “electromobility”. The motto that holds for companies in the automotive industry also applies to industrial policy: “Do one thing without neglecting the other”. It is important to pursue R&D into alternative drive concepts such as battery-powered drive systems and fuel cell drives, while persisting with efforts to optimise conventional drive systems so as to exploit available potential. Furthermore, the technical and organisational requirements and conditions for success of new car use concepts need to be investigated through pilot projects. Main actors: political actors at the federal and state levels; universities; and the automotive industry.

Provide fiscal incentives
Whereas regulation focuses only on manufacturers, fiscal incentives target buying behaviour and the use of motorised vehicles. The incentive effect of the instruments can be achieved through costs (taxes, levies or fees) or discounts (subsidies or bonuses). Either can promote the market launch of new, efficient, emission-reducing technologies.

Examples include national fiscal instruments such as the CO_2-based motor vehicle tax and the energy and ecology tax. If dynamically structured, these instruments can continue to act as incentives even as the efficiency of vehicles improves. Top runner systems, in which the product on the market with the most efficient technology sets the standard for a specific time frame, are an example of this kind of dynamic structure.

A temporarily efficient instrument may be a bonus for buying a low-emission vehicle. The car scrappage bonus showed that such bonuses can in principle act as strong buying incentives. That said the bonus was not tied to the purchase of an efficient car.

A relevant segment of the new car market is commercially registered and, hence, tax-privileged vehicles (official, company cars). These vehicles are in relatively superior vehicle classes with more powerful engines, higher petrol consumption and higher CO_2 emissions than the average car in a fleet of new cars. In these cases, fiscal incentives for the purchase of cars with lower fuel consumption may not only result in a reduction of car fleet emissions, but also considerably expand the market for more efficient vehicles in the premium segment and provide incentives for technical innovation. Main actors: political actors at the federal level.

Use public procurement to promote more efficient vehicles
Public procurement offers another approach to encouraging highly efficient vehicles. As a rule, public institutions such as public administrations at different levels and the police are bulk buyers of vehicles. Cost savings in the form of efficiency gains may be a decisive criterion in favour of highly efficient vehicles.

The appropriate statutory provisions could encourage consideration of criteria such as CO_2 emissions or the consumption of resources in public procurement. Main actors: political actors at the federal level and public administrations at the federal, state and local levels.

Develop new use concepts for cars
The processes of change in vehicle engineering have a sustained impact on the possibility of individual automobility. Taken in conjunction with the parallel changes in attitudes to mobility, the opportunity of realising new car-related concepts opens up a new development path that promises an ecologically more sustainable mobility.

Table 5
Overview of the recommendations to safeguard value creation and jobs in the automotive sector in Germany

Recommended actions	Actors
Industrialise electromobility to guarantee manufacturing jobs in Germany	Political actors; National Electric Mobility Platform.
Initiate dialogue within the industry	Political actors; National Electric Mobility Platform; dialogue between industry sectors at the federal level
Develop strategies in the affected regions by involving all actors	Cluster organisations; dialogue between industry sectors at the regional level
Support small and medium-sized suppliers in value creation positions	Business development; dialogue between industry sectors at the regional level
Define skill and qualification requirements	Automotive industry; universities; training and other educational organisations; and labour market stakeholders
Support corporate cooperations	Political actors, business development and companies in the public transport sector
Tougher regulations to promote more efficient, low-emission vehicles	Political actors at the European and Federal German levels
Foster research and development into low-emission vehicle technologies and new car use concepts	Political actors at the federal and state levels; universities; automotive industry
Provide fiscal incentives	Political actors at the federal level
Use public procurement to promote more efficient vehicles	Political actors at the federal level; federal, state and local administrations
Develop new use concepts for cars	Automotive industry; mobility service providers
Use communication capabilities to promote new vehicles, drive technologies and mobility concepts	Political actors at the federal level; automotive industry

Source: Compiled by the authors

New efficient cars can be understood as one element of a comprehensive, networked mobility offering in large conglomerations in particular. However, this will require a paradigm shift from individual car ownership to the concept of service-based mobility. Against the background of increasingly individualised and intermodal traffic behaviour this transformation promises a reduction in investment and operating costs and facilitates the needs-based use of mobility options:

This development path tracks the evolution of carmakers from pure vehicle suppliers to integrated mobility service providers. Main actors: automotive industry and mobility service providers.

Use communication capabilities to promote new vehicles, drive technologies and mobility concepts

As a rule, when buying a car consumers demand a great deal of information. This includes not only the car's suitability and functions, but also consumption data, as these are particularly cost-relevant for the operation of the vehicle. Simple, comprehensive information can help to make customers more aware of this aspect and support decisions to buy a more efficient car. Besides the direct labelling of both new vehicles and used cars, information and publicity campaigns can highlight the individual and social relevance of using cars that are as efficient as possible. Given the very different demands on car mobility, approaches should generally be target group-oriented.

It will be a huge challenge to incorporate new concepts of mobility that involve other car uses into daily mobility behaviour, whereby information and communication are only one building block in adjusting to new forms of behaviour. Main actors: political actors at the federal level and the automotive industry.

Table 5 shows the strategies and measures that can actively transform the automotive industry to ensure its competitiveness and innovativeness. The skills and qualifications in the regional locations are an important resource in successfully shaping the transformation processes. It is possible that transformation in the automotive industry will be accompanied by radical changes in the current form of mobility behaviour, which in turn would impact other sectors and political interests. Examples include large-scale retail in non-integrated locations or urban development. These systemic changes need to be thought through and structured within the appropriate context. The goal of retaining industrial competence, production and jobs in Germany, protecting resources, climate and the environment, providing maximum mobility user value and ensuring social acceptance will have to take account of industrial policy. This will put the automotive industry to the test. To pass it will require more than organising dialogue: the industry will have to develop and implement binding guidelines and standards.

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,000s	thousands
ACEA	Association des Constructeurs Européens d'Automobiles (European Automobile Manufacturers Association)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BRIC	Brazil, Russia, India, China – advanced emerging industrial states
Car sharing	A concept of sharing the use of cars
CLEPA	Comité de liaison européen des fabricants d'équipment et de pièces automobiles (European Association of Automotive Suppliers)
E/E	Electric/Electronic
EEA	European Environment Agency
EMF	European Metalworkers Federation
EU	European Union
IEKP	Integriertes Energie- und Klimaprogramm der Bundesregierung (Integrated Energy and Climate Programme of the Federal Government of Germany)
IEA	International Energy Agency
KBA	Kraftfahrt-Bundesamt (Federal Motor Transport Authority)
Kyoto Protocol	Legally binding agreement on reducing emissions of greenhouse gas emissions by 2012; ratified my most states
Megacity	A megacity is defined as a metropolitan area with a total population in excess of 10 million people
MIT	Motorised individual transport
Mt	megaton
NPE	Nationale Plattform Elektromobilität (National Electric Mobility Platform)
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer; retails products under own name
R&D	Research and development
SME	Small and medium-sized enterprises (up to 250 employees)
SWOT analysis	Method to evaluate strengths, weaknesses, opportunities and threats
VDA	Verband Deutscher Automobilhersteller (German Association of the Automotive Industry)
VDMA	Verband Deutscher Maschinen- und Anlagenbau (German Engineering Association)

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