Transition to a low-carbon economy – challenges for the automotive sector

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1. Introduction

The production and use of cars are key elements of modern industrialised countries. A recent study on the development of the automotive sector in Europe states that the automotive industry directly accounts for 1.5 per cent of GDP in the EU and employs almost 2.4 million people. Taking all indirect effects on GDP and employment into account increases these figures almost fourfold. In countries with large automotive industries, such as Germany, almost 13 per cent of all manufacturing jobs are linked to car production and maintenance (Directorate-General for Employment, Social Affairs and Equal Opportunities 2008). Any change in the use of cars, the technical infrastructure or engine technology would therefore obviously have severe consequences for the industry, jobs, qualifications and long-term growth.

At the same time, transport is a large producer of CO_2 emissions worldwide. Road sector emissions dominate transport emissions, with light vehicles responsible for the bulk of emissions globally. In some countries, road freight accounts for up to 40 per cent of road sector CO_2 emissions. And emissions from transport are still growing rapidly. Global CO_2 emissions from transport grew by 44 per cent from 1990 to 2008 (Table 1). Depending on the particular set of assumptions one makes, transport emissions may grow by another 40 per cent by 2030. Such estimates already take account of efficiency improvements.

Given its role in transport as a whole and its economic importance, the automotive industry is one of the key sectors in the process of transforming the economy towards using less carbon and producing less CO_2. Every scenario for a low-carbon economy must answer the question of how growing transport can be managed at a lower level of CO_2 emissions.

Table 1 **CO_2 emissions from transport**

World	2006	2007	2008	Percentage change 2007–2008	Percentage change 2007–2008
Population (million)	6534.54	6610.49	6687.90	27%	1.17%
GDP PPP (billion 2000 US$)	58465.75	61747.93	63865.84	91%	3.43%
CO2 Emissions					
IEA CO2 from fuel combustion (Mt)	28023.96	28945.33	29381.43	40%	1.51%
of which transport CO2 (Mt)	6434.74	6614.87	6604.66	44%	–0.15%
Transport as a percentage of total	23%	22.9%	22.5%		
Road Mt)(	4708.40	4824.29	4848.42	48%	0.50%
Rail Mt) (	128.60	130.61	107.65	–27%	–17.85%
Domestic aviation (Mt)	304.75	310.85	297.34	6%	–4.35%
International aviation (Mt)	436.25	446.59	454.85	76%	1.85%
Domestic navigation (Mt)	122.58	126.36	128.39	31%	1.61%
International shipping (Mt)	556.62	589.09	578.20	63%	–1.85%
Other transport (Mt)	177.53	187.08	189.81	20%	1.46%

Source: International Transport Forum 2010.

Therefore, 100 years after the invention of the automobile the industry is at a crossroads. Is it possible to manage growing demand for transport while reducing its environmental footprint? At least publicly, automobile manufacturers are increasingly taking up this challenge. Everybody is talking about lower-emission cars, vans and trucks. However, there are technological limits on improving the internal combustion engine. Is the introduction of hybrid or even electric cars a real option?

In this chapter we outline the major challenges facing the European automotive industry. What future can be foreseen for the structure of the European automotive industry and for the number of jobs in different sectors of the industry within the framework of a low-carbon scenario?

We start with an overview of the European automotive sector and of the importance of reducing emissions in this sector. We then comment on technological issues and explain the role of hybrid and electric drives, before turning to employment. We look at how a change in the system will change the number of employees and the qualifications that will be needed. Two further sections deal with government programmes to support the introduction of hybrid and electric drives and with European trade union policy. The purpose of the last chapter is twofold. The key conclusions are presented and, based on that, several strategies for a successful and socially responsible transition are outlined.

2. The automotive industry as one of the backbones of the European industrial base

In 2010, more than 24 per cent of global motor vehicle production was located in the EU25 (Verband der Automobilindustrie 2011). The automotive industry has a major impact on the European economy and on people's daily lives, as some of the figures in the next section show. Production and employment range from materials and parts supply, to R&D and manufacturing, and to sales and after-sales services. The automotive industry directly runs over 250 production plants in 18 EU countries, with the majority of European production sites located in Germany, France and Italy (IG Metall 2008).[1]

The supply chain includes a large number of other important industries, such as machine-building, plastics, chemicals, textiles and electric and electronic systems, but also 620,000 repair shops and 110,000 petrol stations across the EU. According to the European Automobile Manufacturers' Association (ACEA),[2] the automotive industry and its supply industries employ a total of 12.6 million people in Europe. Directly in-

1. See also: http://www.acea.be/index.php/news/news_detail/automobile_assembly_engine_production plants_in_europe/
2. http://www.acea.be

volved in the production of vehicles were approximately 2.3–2.4 million employees in 2009. The supply industry has another 10 million employees.

Table 2 provides an overview of employment in Europe linked to the automotive industry. It shows that the majority of jobs are in the use of automobiles (4.2 million) and in the transport sector itself, with a large share of truck companies and logistic enterprises (4.9 million jobs). However, car production itself also provides a lot of jobs directly and in its supply industries.

Table 2 **Automobile sector – direct and indirect employment**

Automotive industry (production operations)	
Automobile manufacturing	
Bodywork, trailers, caravans	2.3 million jobs
Equipment and accessories	
Closely related manufacturing activities	
Manufacturing, re-treading and rebuilding of rubber tyres and tubes	
Manufacturing of bearings, gears and driving elements	
Manufacture of cooling and ventilation equipment	1.2 million jobs
Manufacture of computers and other information processing equipment	
Manufacture of electric motors, generators and transformers	
Manufacture of electrical equipment for engines and vehicles	
Automobile use	
Sale and distribution of motor vehicles	
Maintenance and repair of motor vehicles	4.2 million jobs
Sale of motor vehicle parts and accessories	
Retail sale of automotive fuel	
Transport	
Road transport (passengers and freight)	4.9 million jobs

Source: ACEA (2010), p. 61.

A large part of the annual production of EU countries goes to export. In 2009, 13.9 million passenger cars were produced in the EU25 and 3.44 million of them were exported (about 25 per cent). According to industry figures extra-EU27 exports amount to 53.8 billion euros with a net trade contribution of 30 billion euros. Shipments to the United States represent over 25 per cent of EU car exports in value and about 16 per cent in units. Corresponding to the high production and employment figures are high research and development investments of 26 billion euros a year (Table 3).

Table 3 **Key figures, EU automotive sector**

Production	Total motor vehicles (worldwide)	2009	61.7 million units	
	Total motor vehicles (EU25)	2009	15.2 million units	25% of worldwide production
	Total passenger cars (worldwide)	2009	47.5 million units	
	Total passenger cars (EU25)	2009	13.9 million units	29% of worldwide production
	Production value	2007	€ 756bn	
New registrations	Total motor vehicles (worldwide)	2009	60.5 million units	
	Total motor vehicles (EU27)	2009	15.8 million units	26% of worldwide registration/sales
	Total passenger cars (worldwide)	2009	50.1 million units	
	Total passenger cars (EU27)	2009	14.1 million units	28% of worldwide registration/sales
	Diesel (Western Europe)	2009	46% share	
Employment	Automotive manufacturing (EU27)	2007	3.5 million people	10% of EU manufacturing industry
	Total (manufacturing & services)	2007	12.6 million people	6% of EU employed population
Turnover	ACEA members	2008	€ 536bn	
R&D investment	ACEA members	2008	€ 26bn	5% of turnover
Value added	EU27	2007	€ 155.4bn	9% of manufacturing sector

(*Cont. on next page*)

Table 3 **(cont.)**

Exports	Extra-EU27	2009	€ 53.8bn	
Imports	Extra-EU27	2009	€ 25.2bn	
Trade balance		2009	€ 28.6bn	
Motor vehicles in use (EU27)	Total motor vehicles	2008	268.9 million units	
	Passenger cars	2008	234.1 million units	
	Motorization rate (cars)	2008	470 per 1,000 inhabitants	
Tax revenue from motor vehicles		2009	€ 427.4bn	= 4% of EU15 GDP

Source: ACEA (2010), p. 57

The number of cars in Europe has grown continuously. In 2008, the European vehicle fleet (EU27) had about 269 million vehicles, 87 per cent of them passenger cars. The motorisation rate of 470 vehicles per 1,000 inhabitants gives an indication of the prominent role that cars play in European society (Table 3). Having a car still seems to be an important symbol as well as a perceived necessity for many people.

The economic planning of large European car producing companies, such as Renault, Fiat, BMW, VW and Daimler and also the expectations of companies in the supply industry, such as Continental, Schaeffler and Rheinmetall are all based on the assumption that the number of cars will increase in the future. Of course, the main growth is expected to take place in Asia, Latin America, Eastern Europe and Russia. However, even for the EU27 growth in the number of vehicles is foreseen.

This trend obviously conflicts with the need to reduce CO_2 emissions from transport as long as combustion engines are used. The rapid growth of cars in use has far more impact on the CO_2 emission balance than the effects of technological innovations, especially since cars on average are becoming larger and heavier. Therefore the industry needs major changes in driving technologies which have lower or even zero direct CO_2 emissions. In principle, electrical drive could be a technological alternative which could be ready to use in an acceptable period of time.

Such a switch from combustion engines to electrical drive will have a large impact on the number and quality of jobs in the industry. Even if the industry can continue producing as many cars as at present other things are needed for producing electrical drives than combustion motors. The number of jobs may fall and plants might be relocated in other parts of the world. Before describing and analysing such effects we briefly summarise the solutions industry and policymakers favour for the reduction of CO_2 emissions in the industry.

3. Reducing CO_2 emissions in the automotive sector

3.1 How to reduce CO_2 emissions – long-term strategy needed

Obviously, any long term change in transport systems will happen step by step and over a considerable period of time. At least three phases can be distinguished: a first stage of 10–15 years in which the industry will see a diversification of drive systems (including electric drives). However, the majority of cars will still have combustion engines and hybrid drives. In a second phase the combustion drive might lose its dominance. The infrastructure for electro-mobility should be established accordingly. Finally, in a third phase the number of electro-drives would replace combustion technology. Even for European countries this development may take more than 30 years.

Today, the automotive industry is putting forward a strategy that does not question mobility and cars in general and is compatible even with a higher number of cars and a longer period of combustion engine use.

The first element of the industry strategy is raising awareness among drivers and inculcating more self-discipline, which could (in theory) help to cut fuel consumption by 20 per cent. The second element is a switch to alternative fuels (biofuels). The third element is eco-friendly innovation in combustion technologies. The fourth is better traffic control and better roads build by the state. Finally, the industry is calling for appropriate CO_2 taxation to create more incentives for consumers to switch to cars that are more eco-friendly (ACEA 2010b: 19).

From an environmental point of view this strategy is not adequate. It is immediately apparent that no consideration is taken of reducing the number of cars or of alternative concepts of mobility, with less individual mobility, more public transport and more state intervention.

However, it seems clear that in the future conflicts between a growth-oriented market strategy and the goal of reducing CO_2 emissions will become more and more marked. The industry has a strong interest in changes that do not involve major markets cutbacks or increase the financial burden on the car industry. Therefore, industry representatives are demanding that policymakers across Europe adopt a comprehensive strategy involving not only new technologies, but also market incentives, infrastructural adjustments and changes in driving habits.

It is true that isolated technological innovation will not bring rapid results. To arrive at a more sustainable transport system an integrated approach – which includes the automotive industry, fuel companies, governments and consumers – is needed. There is must be a coordinated, long-term strategy involving all actors.

3.2 Less CO_2 emissions through innovation

R&D investment by the European automotive industry is traditionally high and currently an increasing amount is going into research on more eco-friendly cars. A recent study claims that 'the EU-based automotive industry is the largest private research investor in the EU' (Wiesenthal et al. 2010: 24). The study calculates that about one-third of the money spend goes into research aimed at reducing vehicle greenhouse gas emissions:

> With regard to road vehicle engine technologies, great importance is given to R&D on efficiency improvements of conventional engines and to electric vehicles, with the steeply rising patent applications for the latter indicating rapidly growing activity in recent years. At the same time, R&D efforts concerning other long-term options, such as fuel-cell vehicles, remain more modest. (ibid.)

The report calls for public intervention to bring a long-term perspective to existing research efforts. There are two main directions for research into reducing CO_2 emissions: innovations to reduce CO_2 emitted by private cars and commercial vehicles and innovations in the production and recycling of vehicles. The industry argues that increasing efficiency in production contributes to higher efficiency rates. Efficiency rates are measured by the amount of CO_2 emitted per vehicle produced. According to ACEA, the average energy consumption per produced vehicle decreased between 2005 and 2007 by 6.5 per cent (ACEA 2010b). However, due to the growing number of passenger cars produced, CO_2 emissions resulting from such production increased between 2005 and 2007 at an annual rate of 1.4 per cent.

The recycling of cars is also a source of CO_2 emissions. Between 2 and 5 per cent of all CO_2 emitted during the lifetime of a vehicle occurs during its recycling (ACEA 2010b: 29). Around 8 million vehicles reach the end of their lifecycle in Europe every year. Due to innovations in recycling technologies, the management of materials and information systems has improved and the automotive industry has been able to meet government quotas and to optimise the entire recycling process (ibid.).

But these improvements and innovations make a comparatively small contribution to the CO_2 balance of a vehicle during its lifetime. The greater part of CO_2 emissions is linked to the use of cars for private and commercial transportation. Here various innovations and new technologies have contributed to a decrease in CO_2 emission rates caused by individual new cars. By 2008, the average amount of CO_2 emitted by new vehicles was down to 154g/km (ACEA 2010b: 15). The industry points out that, on average, CO_2 from new cars has come down by around 20 per cent in the past 13 years, thanks primarily to technology and modern trucks that use 30 per cent less fuel than comparable models from the 1970s. In 1995, only 3 per cent of new vehicles had lower emission rates than 140g CO_2/km: now 42 per cent of new vehicles achieve this CO_2 emission rate (ibid.).

In December 2008, the European Parliament and the European Council published new regulations on the CO_2 emission rates of passenger cars. The goal was that over 65 per cent of newly registered vehicles should have an average CO_2 output of 130 g/km by 2012. By 2015, 100 per cent of newly registered vehicles should comply with this target by means of technological measures. Although these innovations contribute to a less dramatic increase in CO_2 emissions in total they do not bring about a noticeable decrease in CO_2 emissions. More radical technological changes are necessary to achieve this goal.

3.3 EU policy and goals up to 2020

Analysis of the strategies of the automotive industry shows the contradictory picture of an industry which is moving only slowly and sometimes even hesitantly in a new direction. Are EU policies giving better and clearer signals for a change towards a low-carbon future? A brief look at EU policy towards the automotive industry shows that environmental questions are becoming more and more important. At the same time, the main objective of the European Commission regarding the automotive sector remains the same: to strengthen the competitiveness of the automotive industry worldwide.

The EU strategy for reducing CO_2 emissions from cars is based on a mix of voluntary commitments by the car industry and new limiting values for CO_2 emissions. Additionally, consumer information and fiscal measures to encourage purchases of more fuel-efficient cars are being introduced by many national governments.

The official limiting values of the corresponding EU regulation for CO_2 emissions (EG No. 443/2009) indicate that all car manufacturers will be under strong pressure to improve combustion technologies and to reduce CO_2 values for fleets (by 2015 all producers have to reduce CO_2 emissions on average to 130g CO_2/km for their fleet and by 2020 the EU guideline calls for a reduction to 95g CO_2/km on average) (Barthel et al. 2010) .

The EU allows exemptions, but even this relatively light approach gives rise to strong protests from the industry. The European Automobile Manufacturers Association (ACEA), representing the European car industry, says that even this proposal

> does not offer the proclaimed balanced framework to cut CO2 emissions and to safeguard EU competitiveness and growth. The system, if implemented, would effectively reduce the competitive strength of the European automobile sector and put car manufacturing in the European Union at risk. The proposal would also lead to disproportionate costs compared to the environmental gains and the costs of carbon reduction facing other sectors. (ACEA 2007)

In order to obtain support for the EU strategy the Commission has introduced the High Level Advisory Group CARS 21. By a Commission

Decision of 14 October 2010, CARS 21 is now an official advisory group to the Commission. The new CARS 21 process, launched by the High Level Group on 10 November 2010, sets out to define policies for 'a competitive EU automotive industry and sustainable mobility and growth in 2020 and beyond'. The group will work on policies that aim at:

– ensuring the competitiveness and sustainable growth of the automotive industry to safeguard automotive manufacturing in Europe; and
– providing an efficient framework for the development and market uptake of clean and energy-efficient vehicles.

4. Scenarios for further development: role of hybrid and electric drives

In an effort to comply with the legislative pressure to reduce carbon emissions, firms have begun to experiment with various competing technologies, such as bio-fuels, hybrids, electrics and hydrogen-based fuels. However, currently these technologies are at different stages of development and most are not ready for immediate commercial production. Therefore, replacement of the internal combustion (oil) engine will be a gradual process. Most observers assume that hybrid technology will start to play a more important role in the next few years. Currently, all car producers are trying to bring cars with hybrid drives to the market. However, the cost of these cars is a major factor limiting the market.[3]

Purely electric cars are even more at the development stage. The technology is still not ready for large-scale commercial production. It is possible that the future of the automobile will be based on electric drives, but this development needs time and electric vehicles will not begin to play a dominant role in commercial production before 2025.

The automotive industry and government envisage step-by-step development over the next 30 years to achieve low emission vehicles. The first step is a move towards more effective combustion engines combined with alternative fuel. The next step is electrification, beginning with hybrid cars. The thinking behind this step-by-step approach is simple: the

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3. The additional cost of hybrid cars is currently between 6,000 and 8,000 euros.

industry believes in a future with more cars but less emissions through a change to new (electric) drives. 'Cars and trucks are not the problem. Emissions are' (Dieter Zetsche, CEO Daimler).[4]

The question is, how long will it take before mass market electrical vehicles become a reality. Obviously, it is a long way from the sale of low numbers of small vehicles mainly used in cities to the introduction of a mass product at European and national level. This strategy requires significant input in research and development and an accompanying public strategy for financing new infrastructure for these cars.

Several new reports forecast that electric cars, plug-in hybrids and battery electric vehicles may achieve up to 10 per cent of new car registrations by 2020 in countries such as Germany and France. Currently, most major manufacturers are investing heavily in research and prototype development for highway-capable vehicles. Optimistic forecasts assume that from 2012 onwards the European market for hybrid cars and electric drive will take off and become a growing market (Gillon and Peatson 2010).

However, actual studies are much more conservative with regard to estimates. A study published by Deutsche Bank and IfW in Germany estimates that by 2020 only 3 per cent of all new cars are likely to be hybrid and electric cars even in countries such as Germany. In all other markets the numbers are expected to be even lower (Deutsche Bank Research 2011).

There are several critical questions regarding this strategy from the economic and technological points of view. The costs of electric vehicles are currently much higher than for traditional cars with combustion engines and battery technology is not sufficiently developed for long distance drives and high production volumes. Therefore the automotive industry is currently asking for more public support, in other words, incentives for both consumers and manufacturers in order to stimulate the market and reduce the costs for the industry.

4. D. Zetsche (2010), The Future of Electric Cars – The Automotive Industry Perspective, Informal Competitiveness Council, San Sebastian. Available at: http://www.acea.be/images/uploads/files/20100211_Speech_Dieter_Zetsche.pdf (accessed 6 June 2011).

> Specific national markets are also beginning to emerge as specialist centres for critical technologies such as battery management systems, vehicle safety and performance, and the integration of wind and other renewable power sources into the grid as a means of validating the green potentialities of automotive technology. Most of the major European and global players (and a significant proportion of smaller specialists) throughout a wide spectrum of industry that includes automotive, components, systems, batteries, drive train, design, grid operators, electrical generation and supply, renewable energy and smart grid, are involved in both individual research and partner programme development and pilot studies in pretty well every country. (ibid.)

Although there is wide variation among the existing studies the majority of experts estimate that there will be a growing number of hybrid vehicles on the market within the next few years (European Commission 2008: 25). Table 4 shows three different scenarios published in 2009 on the number of hybrid and electric vehicles, CO_2 emission rates and the energy consumption of the European automotive industry. The main differences between the projections are the assumptions on the overall number of cars and the number of hybrid vehicles and electric vehicles.[5]

Table 4 **Comparison of scenarios**

Scenario	Year	Vehicle fleet passenger cars (million)	Share of vehicle fleet ICE Hybrid Electro (%)			Energy demand Mtoe	CO2 emissions MtCO2	Change (%)
McKinsey	2006	219	100	0	0		930	Decrease
Mixed-technology	2030	390	88	11	1		750	19.35
DG_TREN	2005	213	100	0	0	180	881	Increase
	2030	352	97	3	0	198	1003	13.85
FONDDRI	2006	227	98.8	0.6	0.5	293	861	Decrease
Basic data	2030	241	67	21	8	185	479	44.37

Source: Syndex (2009), p. 47.

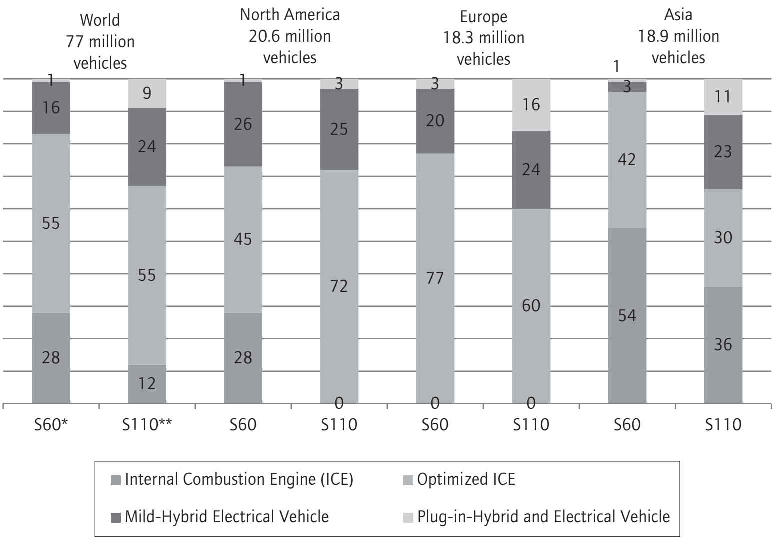
5. In order to obtain comparable numbers between European and global scenarios we have recalculated all numbers in relation to the European region.

The 'mixed technology scenario' of the McKinsey study 'Roads toward a low-carbon future' assumes that CO_2 emissions resulting from passenger cars will decrease between 2006 and 2030 at a rate of 19.35 per cent (McKinsey and Company 2009). This is based on the assumption that the total number of vehicles will increase by 78 per cent by 2030 and that 42 per cent of the new vehicles produced are hybrid or electric vehicles. In 2030, this means that hybrid and electric cars will comprise 12 per cent of the entire vehicle fleet.

The DG TREN study represents a fairly conservative assumption on the share of hybrid and electric vehicles among new vehicles, with the effect that CO_2 emissions will rise by 13.85 per cent by 2030, irrespective of lower growth rates in the vehicle fleet as a whole (Directorate General Energy and Transport 2008).

FONDDRI estimates the real decrease in the CO_2 emission rates of passenger vehicles. This comparatively large decrease is explained by a very

Figure 1 **Scenario 2020 – global sales and share of vehicle fleet (%)**



Notes: * S60: Scenario US$ 60 per barrel. ** S110: Scenario US$ 110 per barrel.

Source: McKinsey 2009 (cited in Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit 2011).

low increase in the number of vehicles up to 2030 and a high share of hybrid and electric vehicles (FONDDRI 2007).

The major differences in the development of CO_2 emissions until 2030 are mainly a result of assumptions about the share of hybrid and electric vehicles in the entire vehicle fleet and the overall number of the vehicle fleet. Anyhow, all studies show that the total number of vehicles will continue to increase in Europe until 2030 and the majority still will have combustion drives.

Figure 1 shows a McKinsey scenario of the global automobile market for 2020. According to it, the market share of plug-in hybrid and electrical vehicles may reach between 3 per cent and 16 per cent in Europe by that year. However, the high market share of 16 per cent is expected to be realised only if the oil price levels off at US $110 per barrel and if there is extensive public funding.

Box 1 **Outlook: Where are the new markets? 'Powertrain' study by Roland Berger**[6]

The strategy consultants from Roland Berger have published a study on the potential market size of and the steps necessary for a European industrial strategy to implement change towards electric drives. They assume that a move towards fast electrification of car drives will reshape the current mobility value chain. The effects will bring more pressure for consolidation and new partnerships because investment in such a strategy is very high. At the same time, this will open up new revenue sources and profits for existing and new players. In the consultants' view, the future will be decided by four major technological developments which are heavily influenced by industrial policy:

1. High-power and high-energy batteries, a market estimated as likely to grow to about 10–30 billion euros by 2020. Several Western companies, such as Süd-Chemie, 3M and BASF, already have a strong position with regard to active battery materials, but it (*cont. on next page*)

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6. This outlook is based on Valentine-Urbschat and Bernhart (2010).

Box 1 **(cont.)**

is mainly companies from Japan and Korea that are dominating cell manufacturing. New companies from China are investing in these technologies with support from their government. Here Chinese access to critical raw materials can play a crucial role. The basic investments for building up production and for R&D are so high in this field that only a limited number of companies will really establish themselves in cell manufacturing by 2020.

2. Producing equipment for battery cell manufacturing will be the second large market which could have a volume of 3 to 8 billion euros by 2020 for automotive applications alone. Hitherto, mainly Japanese and US manufacturers have been active suppliers in this market. Roland Berger consultants believe that some European countries such as Germany can participate if they are able to use their expertise in precision engineering for the highly automated production processes involved in cell manufacturing.

3. Electric motors and drives constitute the third market that could achieve a volume of 4–9 billion euros by 2020. There exist several established manufacturers in this market which have made technological advances. But companies from China are also improving fast in this part of the market. China has privileged access to the rare earth metals needed for electric motors, which rely on permanent magnets.

4. Finally, the need for energy, infrastructure and additional services for an electrification strategy creates a large market. Electricity alone is estimated to account for an 2–10 billion euro additional market by 2020. The market for infrastructure and additional services will be several times that high. Providers of energy and infrastructure all over the world are currently looking to take their chances in these markets. The traditional OEMs of the automotive industry will need a clear strategy if they want to participate in these new markets.

The study argues that governments and industrial policies play a crucial role in market penetration and technology development. Incentives and investments are needed to speed up market development and facilitate the necessary investments.

5. Implications for employment

5.1 What will happen to jobs in the industry?

Employment prospects in the automotive industry in Europe are linked to the success of the industry in participating in these new markets. They are also linked to the number of cars produced and the type of drives used. Today, roughly 25 per cent of the value of a car and also the number of jobs are linked to the drive, that is, the combustion engine (Meißner 2010). If the combustion engine is replaced by an electric drive the consequence will be a comparatively large structural change in manufacturing industry (Table 5). Several components would have to be discarded, while others would have to be modified. However, new components would have to be developed as well. Obviously, this would trigger a change in the number of employees needed (Tables 6 and 7; Figure 2) and especially in their respective qualification profiles (Section 5.2.).

Several studies have compared the spare parts and the workforce needed for the production of combustion drives and electric drives. Based on the comparison of existing production sites the ratio between the number of workers needed to assemble an electric drive and that of the number of workers needed to assemble a combustion engine is around 1:10 (Barthel at al. 2010). Table 5 compares employees and units produced in two combustion drive sites of Daimler with a site for e-drives belonging to

Table 5 **Changing system – changing components**

Components discarded	Components modified	New components
Combustion engine	Gear	Electric motor, further drive sections
Ancillary components (oil pump, turbo charger, generator)	Heat insulation	Battery system with accumulator, power electronics, battery charger, DC/DC-transformer
Exhaust system	Power transmission	
Fuel system	Air-conditioning, heater	
Coupling	Cooling water pump	
Fuel-injection system	Wheel suspension	

Source: Meißner (2010).

Table 6 **Comparison of value added**

Daimler Untertürkheim cylinder size 4,6,8	3,300 employees 700,000 units	221 units/employee
Daimler Marienfelde cylinder size 6,8,12	1,200 employees 200,000 units	170 units/employee
Continental Gifthorn 60+120 kw E-motor	40 employees 60,000 units	1,500 units/employee

Source: Meißner (2010).

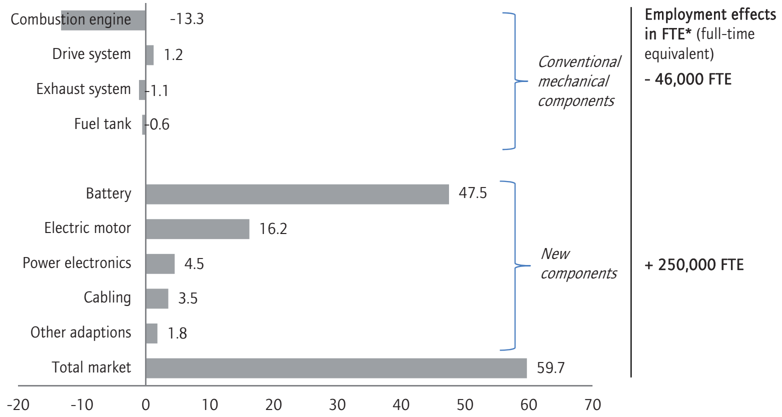
Continental. The result is very clear: Daimler produces on average 170 to 221 combustion motors units per employee. Continental, on the other hand, produces 1,500 electric drives per employee.

For the next ten or more years it seems realistic to expect that the development and production of new and better combustion and electric drives will be pursued in parallel and that a growing number of hybrid cars will be sold. As a consequence, cost per car will increase, but the number of jobs might also increase. A recent study by McKinsey for Germany calculates 60,000 additional jobs on the assumption that 1 million electric vehicles will be sold and the total number of cars produced does not decrease. The majority of these new jobs are linked to battery production (see Figure 2) (McKinsey and Company 2010: 8).

A similar study for Germany done by the Fraunhofer Institute tried to estimate global changes in sales and possible job effects, as depicted in Table 7 (overleaf). Again, a positive net effect for jobs is foreseen. However, this does not mean that national and regional balances will also be positive. Currently battery production is more concentrated in Asia. A switch to electro vehicles therefore also renews the question of global sourcing and the location of industrial production in the worldwide network of the automotive industry.

Questions also arise concerning the future and role of the OEMs. In an electric-motor vehicle the shares of subcontractors are much higher than currently in a petrol-driven vehicle (see Figure 3). The role and the market for OEMs will decrease unless they move into new technological fields.

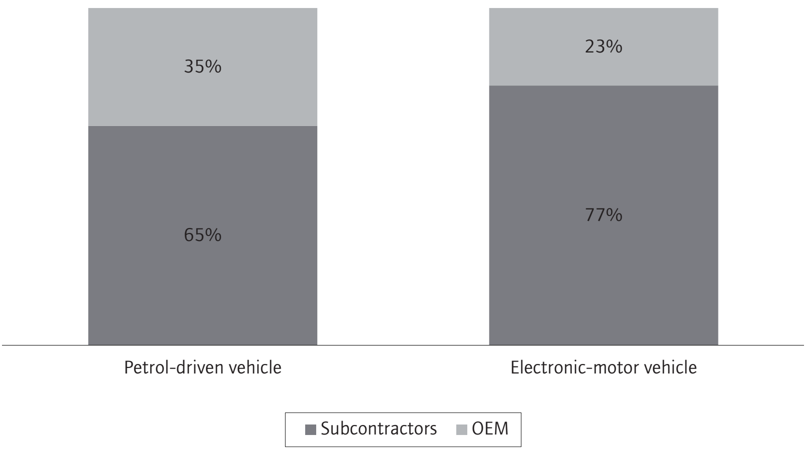
Figure 2 **Global market volume in 2020 (hybrid and plug-in hybrid)**



Note: * Assumption 1 FTE per 300,000 euros production volume.

Source: McKinsey & Company (2010), p. 8.

Figure 3 **Value added by OEM and subcontractors**



Source: Meißner (2010).

Table 7 **Employment effects and changes in sales**

	Global sales – changes in € million	Changes of employment
	2020	2020
Combustion engine	–11,051.5	–8,372
Efficiency technologies	43,385.0	32,867
Exhaust system	5,961.2	4,516
Drive system, coupling	5,966.4	4,520
Fuel system	74.5	56
Starter battery	–76.9	–58
Steering, air-conditioning	7,397.2	5,604
Starter, generator	–154.0	–117
Integrated starter/alternator	10,636.3	8,058
Motor-controller	7,095.8	5,376
Power electronics	3,984.3	3,018
Other electronics	3,106.1	2,353
Traction battery	33,435.0	25,330
Battery charger	2,109.9	1,598
Total	111,889.3	84,749

Source: Fraunhofer IAO (2010); Meißner (2010).

In the McKinsey study on a business case for 1 million electric vehicles until 2010, the authors estimate 61,000 additional jobs in the German automotive sector and a further 15,000 linked to new infrastructure to reload and exchange batteries. Of these 15,000 infrastructure jobs almost half would be related to the creation of recharging stations and the production of specific hardware for these stations (McKinsey 2009).

However, taking the German example these changes will also pose huge challenges for German industry. The leading position of German car manufacturers is directly based on their competence in producing strong and fast combustion engines. If companies such as Volkswagen or Daimler do not want to lose grounds to Japanese companies such as Mitsubishi or Nissan who have electric vehicles already on the market they need to invest very quickly. All in all, it seems possible that one core element of future industrial production (electric drives and batteries) will geographically be centred in Asia.

However, branch experts assume a positive employment effect overall linked to an electrification strategy on the part of the automotive industry for the near future, even if the regional balance can change dramatically (see also Syndex 2009).

5.2 New qualifications needed

Given the considerable structural change that is expected for the sector, a key factor for successful change are the new qualification profiles that will be needed. Engineers, skilled workers and semi-skilled workers will have to meet new skill needs.

Basically, two different fields of activity must be emphasised. On the one hand, advanced training is essential for those already employed in the sector. As skilled workforces are becoming more and more a limited resource this seems crucial. A recent study shows that in many companies training measures are currently limited to existing professional competences and skills (Meißner 2010b: 4). Furthermore, most activities have only a short-term perspective (ibid.). This observation with regard to German companies is confirmed by a study prepared for DG Employment and Social Affairs which indicates that continuing training is essential for extending the skills of workers but is currently 'inadequate in many parts of the industry' (Directorate-General for Employment, Social Affairs and Equal Opportunities 2008: 22).

This study ('Comprehensive analysis of the evolution of the automotive sector in Europe') analyses the job structure in the industry and provides insights into the future pattern of job profiles and skill needs. The report suggests that two policy areas will be of particular importance. The development of adequate human resources (including continuing training) is the first area. Here it is increasingly important to attract workers to the industry with university degrees in engineering and other relevant fields. The same holds true for persons who have completed vocational training or are planning to do so. To update workers' qualifications is, as already mentioned, at least equally important. With reference to the second policy area, the report calls for the establishment of effective social dialogue at company level and the promotion of European Works Councils, as well as social agreements.

Box 2 **Good practice example**

BMW: Motor vehicle mechatronics technicians. Skill gaps and identification of skill needs

'Low carbon hybrid propulsion is a growing trend in the car industry. German car manufacturer BMW, for example, recently included two hybrid cars in its product portfolio, the X6 and its seven series. Cars are equipped with both a combustion engine and additional electric motors and energy storage devices in order to reduce both fuel consumption and GHG emissions. With the right use of hybrid cars a reduction in fuel consumption of up to 15 per cent is possible.

The use of voltages up to 400 volts within hybrid systems creates obvious health and safety issues which require technicians to have good overall technical knowledge of hybrid technologies. This means MVMTs need to develop new skills. To meet this skills gap, BMW implemented a new training module in 2009 in its existing dual apprenticeship for MVMTs. The module comprises technical knowledge for hybrid car technologies. On completion, apprentices receive a special certificate – an extra qualification as an "Electro Technician for Specified Tasks on Hybrid Vehicles".

[...] BMW established the training module for specific tasks on hybrid cars as a permanent feature in their dual apprenticeship for MVMTs. BMW received the Innovation Prize 2009 from the BIBB for the exemplary function of the module, its close connection to the dual apprenticeship programme and its labour market relevance ... only BMW has integrated the hybrid module in the dual apprenticeship. All other car manufacturers only offer their employees continued training in hybrid techniques. ... BMW expects hybrid cars to be a successful product line in the future. ... At the moment, BMW only offers two hybrid models but they plan to increase supply over the next few years after learning from experiences with existing models as well as optimising the technology for mass production.' (CEDEFOP 2010: 41–43)

6. The role of governments: a growing number of national research programmes

Almost all experts agree that

> demand for a new product needs to be created by market-pull policies. Demand is determined by the relative competitiveness of the new low-carbon technology compared to its mature, high-emission alternative. This can be realized both by dedicated technology-specific pull-instruments (such as purchase subsidies, (fuel) tax incentives or preferential taxation of efficient/innovative business cars) and by internalizing the external costs (either directly through pricing of e.g. carbon dioxide or through the setting of standards). Another way of creating niche market demand may be through public procurement that forms a considerable share of total demand in Europe. (Wiesenthal et al. 2010: 23)

During the past two years almost all major industrial countries have launched major programmes to support the introduction of hybrid and electric drives and the necessary infrastructure for an electrification strategy on the part of automotive industry.

Although plans differ in design and instruments used, the goals are comparable. The German Federal Government's National Electromobility Development Plan of August 2009 lays down the following goals:

> The aim of the National Electromobility Development Plan is to speed up research and development in battery electric vehicles and their market preparation and introduction in Germany. The measures adopted in the German Federal Government's Economic Stimulus Package II will act as catalysts. The National Electromobility Development Plan envisages the development and promotion of a concerted strategy with the collaboration of science, industry and government, from basic research to market entry. It encompasses the whole supply chain from materials, components, cells and batteries to the entire system and its application. It also provides for devising a scheme to integrate the additional power demand generated by electromobility into the grid, link this demand with renewable energy sources and use electromobility to contribute to grid load management. This will ultimately position Germany as a lead market for electromobility and enhance the long-term competitiveness of the motor-vehicle manufacturing and parts supply sector as one of the major pillars of national industry. (Federal Government of Germany 2009: 2).

Table 8 **Main programmes in selected countries**

USA	€1.4 billion for battery technologies €18 billion credits for production plants of fuel efficient vehicles €107 billion for 'green' energy technologies (ten years) €285 million for demonstration projects and infrastructure
China	€1 billion for efficient power train technologies (2009/2011) €2 billion in 13 regions with 10,000 vehicles (2009/2010)
Japan	€145 million for the development of traction battery
Europe	€710 million European Green Car Initiative (2010/2013) €2.9 billion credits for Green Cars (European Investment Bank) €730 million for energy technologies (2007/2013) €65 million energy in transport (2009)
France	€400 million Pacte Automobile €2.5 billion further investments (next ten years)

Source: Barthel et al. (2010), p. 27.

In France, the government has introduced a comparable national plan:

> France intends to promote research and development for hybrid and electric vehicles with an overall budget of EUR 400 million over the next four years. Under a bonus-malus arrangement, purchase subsidies of EUR 5,000 are to be granted for vehicles with low CO2 emissions below 60 g of CO2/km. (ibid.: 14).

Countries such as China, the United States and Japan are also investing to support their national industries. China has announced that it will spend about 1 billion euros to promote technological innovations in more efficient drive technologies and the Chinese Ministry of Science and Technology plans to support the development of over 10 pilot regions with more than 10,000 vehicles during the next few years.

The US government plans to invest up to 1.4 billion euros to promote advanced battery technology and components for electric vehicles. Furthermore, regional demonstration projects will be launched worth 285 million euros for electromobility infrastructure. The United States has also announced a 25 billion dollar (18 billion euro) loan programme for motor-vehicle manufacturers and parts suppliers for production centres for fuel-saving vehicles (Advanced Technology Vehicles Manufacturing Loan Programme – ATVM). Similar to the EU, the United States plans to introduce fuel economy regulations for passenger cars and other types of vehicle for domestic sale in the model years 2012–2016 with a target average CO2 emission by 2016 of approximately 155 g/km.

In Japan, the development of improved traction batteries will be supported to the tune of 145 million euros over five years. The goal is to halve costs for batteries by 2010 (ibid.).

Table 8 (facing) summarises these efforts.

7. European trade union policy

Trade unions in Europe are calling for a rapid and consistent change towards more sustainable development in the transport sector. The European Metal Workers Federation (EMF), for example, advocates a coherent and comprehensive strategy in the transport sector and that car production achieve EU policy goals concerning a low-carbon economy. The EMF shares the EU's vision of a largely decarbonised transport system by 2050; however, it also sees a strong need for policy incentives to make this turnaround happen.

Especially with regard to the prospects of electric vehicles in Europe the EMF argues that infrastructure framework conditions must be put in place and that electric vehicles have to be integrated into a systematic approach to transportation, at least in urban areas (EMF 2010: 1).[7] In general, the EMF favours more efforts to achieve quicker market penetration of electric and hybrid vehicles than put forward in the Cars 21 mid-term review. The trade union sees a danger that

7. European Metalworkers' Federation, contribution to the public hearing on a 'European Strategy on Clean and energy-efficient vehicles', Brussels, 2010, p. 1.

> electric cars will be composed of much fewer and much simpler parts than an ICE vehicle. Therefore the impact on the value chain and its jobs will be significant. Workers will need to adapt to the new technology, and some are likely to have to move to other sectors. EU policy needs to ensure that this change is duly anticipated, that there is also good social harmonization and that the businesses concerned are not run 'as usual' until the last day, and then shut down. All stakeholders must strive to have workers gradually move to other sectors and companies, and this movement needs to be encouraged actively via public policy in respect of retraining, career possibilities in other sectors, and aids for mobility (professional and geographical). The social partners should be assisted in preparing this shift collectively. (ibid.: 2)

Supporting e-cars can be part of the solution, but mobility and transport must be considered within the framework of a coherent system. Urban and rural areas have different mobility requirements. This implies that mobility costs must not become prohibitive due to energy prices. Investments in e-mobility and in the further improvement of internal combustion engine fuel efficiency are needed.

A strategy for sustainable transport therefore includes different power train alternatives (hybrid, clean diesel, second-generation biofuels, more efficient petrol engines, hydrogen, plug-in electrical cars and so on). Major investments are needed despite the fact that the market potential of all these technologies remains uncertain and thus there are high risks on returns from these R&D investments. This demands public policy support through standardisation, binding emission-reduction regulation and R&D cooperation.

Summing up, the EMF highlights the crucial point that active measures must accompany future restructuring in the sector. As the social impact may be enormous, change must be anticipated (EMF 2010: 3).

8. Conclusions and recommendations

The road of change towards a low-carbon economy for the automotive industry is a long one. A long-term strategy for new cars for safe and sustainable transport must define sustainable mobility more efficiently, with less emissions and less fuel consumption (see Directorate-General for Employment, Social Affairs and Equal Opportunities 2008). However, it will take until 2050 before cars with combustion engines are the exception on European streets.

From an ecological point of view several other important questions must be answered. How is sustainable mobility to be defined? Is it possible to solve the conflict between environmental needs and economic demand to allow Europe's auto industry to maintain its position in international competition?

Even strong believers in the market economy are not convinced that market signals will be clear enough to induce the necessary changes. Therefore, almost all experts are arguing for an active state policy to support the change.

For a rapid move towards a low-carbon economy and less CO_2 emissions in the transport sector a combined strategy is necessary. Electric vehicles can play an important role in this strategy. However, they will not be available for mass production until 2020. At present, no European car producer can offer a vehicle that meets typical consumer requirements (sufficient operating distance, competitive price and so on). Several technological problems are still unsolved (particularly with regard to battery technology) and the price of electric cars is still on average 30 per cent higher than for traditional ones.

To have a real impact on the CO_2 balance, energy production must also switch to renewable energy and an infrastructure for e-mobility must be created all over Europe. Additionally, from an ecological point of view it seems necessary to compel people to make changes in their mobility behaviour. Only with a different mobility concept and less individual car ownership will there be a chance of ecological change. A simple thought experiment can clarify this. Currently, individual mobility in Europe has the consequence of almost 500 cars per 1,000 inhabitants. If we transfer this mobility concept to countries such as China or India overall CO_2 emissions will increase dramatically, even if all the new cars are powered by electric drives (Barthel et al. 2010: 40).

The move towards electrical drives will also bring changes for the structure of the industry and employment prospects. New actors will enter the stage, among them electric power providers and suppliers of batteries. It is not clear whether the old OEMs of the automotive industry will have the money and the creativity to compete successfully. Regional and structural change will be one consequence. Here the anticipation of change and social dialogue can play a crucial role in managing changes in a socially responsible way. The following strategies can contribute to this goal:

- A European technology policy helping the industry to invest in e-mobility technologies and products.
- The continuation of branch dialogue on a European level to anticipate changes and develop common strategies.
- Strong concentration on regional strategies in the regions that today are highly dependent on the automotive industry.
- More and better regulation in all European countries for cars with less emissions and more efficiency.
- Common initiatives in Europe for tax incentives and other instruments to support the market introduction of electric cars.
- The use of public procurement for the introduction of e-mobility concepts.
- The development of new ideas and concepts for individual mobility. Especially in urban areas car sharing and new options provided by the industry in cooperation with cities can create new mobility markets.

Bibliography

ACEA (2007) *European auto industry insists on need for balanced and constructive CO2 legislation*, Brussels. Available at: http://www.acea.be/index.php/news/news_detail/european_auto_industry_insists_on_need_for_balanced_and_constructive_co2_le (accessed 6 June 2011).

ACEA (2010) *The automobile industry pocket guide*, Brussels. Available at: http://www.acea.be/images/uploads/files/2010924_Pocket_Guide_2nd_edition.pdf (accessed 6 June 2011).

ACEA (2010b) *European Automobile – Industry Report 2010*, Brussels. Available at: http://www.acea.be/images/uploads/files/20090519_ACEA_Industry_Report09FULL.pdf (accessed 6 June 2011).

Barthel, K., S. Böhler-Baedeker, R. Bormann, J. Dispan, P. Fink, T. Koska, H. Meißner and F. Pronold (2010) *Zukunft der deutschen Automobilindustrie. Herausforderungen und Perspektiven für den Strukturwandel im Automobilsektor*, WISO-Diskurs, Friedrich-Ebert-Stiftung, Bonn.

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (2011) *Klimaschutz und Mobilität. Mit welchem Technologiemix fahren wir in die (elektrische) Zukunft?* Available at: http://www.pt-elektromobilitaet.de/mediathek/dateien/nep-ueberblick.pdf (accessed 12 September 2011).

CEDEFOP (2010) *Skills for green jobs*, Country report Germany, Luxembourg, http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_142480.pdf (accessed 6 June 2011).

Deutsche Bank Research and IfW (2011) *Elektromobilität*, Frankfurt.

DG Energy and Transport (2008) *European Energy and Transport – Trends to 2030 – Update 2007*. Available at: http://ec.europa.eu/dgs/energy_transport/figures/trends_2030_update_2007/energy_transport_trends_2030_update_2007_en.pdf (accessed 6 June 2011).

Directorate-General for Employment, Social Affairs and Equal Opportunities (2008) *Comprehensive analysis of the evolution of the automotive sector in Europe*, Executive Summary, Brussels.

EMF (2010) European Metalworkers' Federation: contribution to the public hearing on a 'European strategy on clean and energy-efficient vehicles', Brussels.

European Commission (2008) *CARS 21 – Mid-Term Review High Level Conference – Conclusions and Report*, Brussels. Available at: http://ec.europa.eu/enterprise/sectors/automotive/files/pagesbackground/competitiveness/cars21_mtr_report_en.pdf (accessed 6 June 2011).

Federal Government of Germany (2009) German Federal Government's National Electromobility Development Plan, Berlin. Available at: http://www.bmu.de/files/pdfs/allgemein/application/pdf/nep_09_bmu_en_bf.pdf (accessed 6 June 2011).

FONDDRI (Fondation pour le développement durable et les relations internationales) (2007) Scénarios 'REF' et 'F4 mimétique'. Résultats des simulations harmonisées POLES / IMACLIM-R, Étude 'Scénarios sous Contrainte Carbone'.

Fraunhofer IAO (2010) *Strukturstudie BWe mobil. Baden-Württemberg auf dem Weg in die Elektromobilität*. Available at: http://www.iao.fraunhofer.de/images/studien/strukturstudie-bwe-mobil.pdf (accessed 6 June 2011).

Gillon, A. and L. Pearson (2010) A European future for electric cars, in *Just Auto* (12 November). Available at: http://www.just-auto.com/analysis/a-european-future-for-electric-cars_id107111.aspx (accessed 6 June 2011).

IG Metall (2008) *Branchenreport Automobilhersteller 2008*, Frankfurt am Main. Available at: http://www.igmetall.de/cps/rde/xbcr/internet/Automobilvergleich_2006_2008_0145974.pdf (accessed 6 June 2011).

International Transport Forum (2010) *Transport CO2 Emissions World*. Available at: http://www.internationaltransportforum.org/jtrc/environment/CO2/World.pdf (accessed 6 June 2011).

McKinsey and Company (2010) *Beitrag der Elektromobilität zu langfristigen Klimaschutzzielen und Implikationen für die Automobilindustrie*, Studie im Auftrag des Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit. Available at: http://www.bmu.de/files/pdfs/allgemein/application/pdf/elektromobilitaet_klimaschutz.pdf (accessed 6 June 2011).

Meißner, R. (2010) *Elektromobilität. Auswirkungen auf Wertschöpfungsstrukturen und Beschäftigung*, Presentation IG Metall, Frankfurt am Main.

Meißner, R. (2010b) *Dringend gesucht: Längerfristige Szenarien für die Autoindustrie*, WZBrief Arbeit 06, Wissenschaftszentrum Berlin für Sozialforschung, Berlin.

Syndex (2009) *Climate disturbances, the new industrial policies and ways out of the crisis*, Study prepared for the ETUC in partnership with EMF and EMCEF.

Valentine-Urbschat, M. and W. Bernhart (2010) *Powertrain 2020 –The Future Drives Electric*, Roland Berger Strategy Consultants. Available at: http://www.rolandberger.ch/media/pdf/Roland_Berger_Powertrain_2020_20091001.pdf (accessed 6 June 2011).

Verband der Automobilindustrie (2011) *Automobilproduktion*. Available at: http://www.vda.de/de/zahlen/jahreszahlen/automobilproduktion/ (accessed 6 June 2011).

Wiesenthal, T., G. Leduc, J. Köhler, W. Schade and B. Schade (2010) *Research by the EU automotive industry into low-carbon vehicles and the role of public intervention*, European Commission Joint Research Centre, Institute for Prospective Technological Studies, Seville.

Zetsche, D. (2010) *The Future of Electric Cars – The Automotive Industry Perspective*, Informal Competitiveness Council, San Sebastian. Available at: http://www.acea.be/images/uploads/files/20100211_Speech_Dieter_Zetsche.pdf (accessed 6 June 2011).