

The new mobility paradigm: Transformation of value chain and business models ¹

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Abstract

Four categories of innovations have been identified by Freeman and Perez: incremental innovations, radical innovations, new technological systems (systemic innovations), and technological revolutions or new techno-economic paradigms. New techno-economic paradigms represent changes in technological systems that are so far-reaching in their effects that they have a major influence on the behaviour of the entire economy. Scarcity of oil and external costs like global warming are the key arguments and the main drivers of the change of the current paradigm.

They will affect especially the mobility of individuals and the interlinked business models. Novel business models within newly created markets will raise e.g. extended mobility services, activities aiming at the infrastructure, new opportunities in the field of energy transmission and supply and even new strategies of recycling, reusing or reducing the use of resources in order to address global scarcity issues.

Especially for the established players of the automotive industry like original equipment manufacturers (OEMs) or 1st and 2nd tier suppliers this implicates opportunities and risks at the same time. But also new players will get the chance to create and enter new markets with new or extended products or services and lead the new value chain.

This paper compiles and evaluates current approaches and business models of selected OEMs together with upcoming players. Additionally their positions within the existing value chain are being analyzed and classified. Bringing together the identified drivers of changes with current trends within the

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automotive industry the authors also show new concepts of extended business models, e.g. the idea of an ecosystem, that have the potential to cause an additional shift of power within the global mobility value chain.

Key-words: techno-economic paradigms, business models, automotive industry, mobility, value chain

JEL codes: L62, O33, Q5

Introduction

Economic, ecological and social changes will entail profound changes in the world-wide division of labor. Industries related to mobility and especially individual mobility will be affected and even seem to lead the current developments and innovations regarding the associated value chains and relevant business models.

To understand the impact and consequences of such innovations Freeman and Perez identified four major categories of innovations: incremental innovations, radical innovations, new technological systems (systemic innovations), and technological revolutions or new techno-economic paradigms (Freeman and Perez, 1988; Schumpeter, 1939; Schumpeter, 1942). New techno-economic paradigms represent changes in technological systems that are so far-reaching in their effects that they have a major influence on the behavior of the entire economy. Scarcity of oil and external costs, e.g. triggered by global warming, are the key arguments and the main drivers of the change of the current paradigm. They will affect especially the mobility of individuals and the interlinked business models.

The goal of this article is to examine with an integrated interdisciplinary approach, why the changes mentioned above will affect individual mobility, which form of mobility is presumable for the future and how this will affect the existing automotive value chain. Particular attention is paid on innovative business models of selected manufacturers and suppliers to find out which new business opportunities will appear. Furthermore, also the positioning of

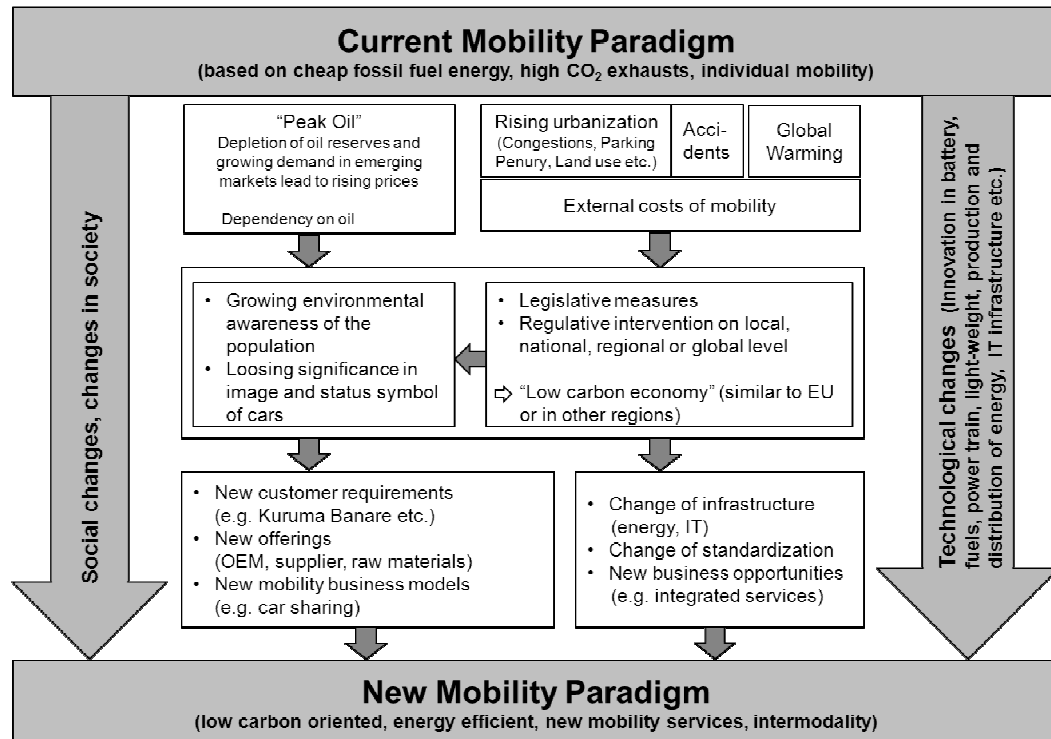
the participants within the value chain will be analyzed and categorized. It is shown, how strategies of manufacturers could develop and which success factors for shaping and controlling of the chain might become decisive.

Drivers of the new paradigm

Currently the energy for mobility needs – and in particular for individual transportation – is predominantly generated from fossil fuels. The resulting dependency on crude oil production and the availability of resources is to be seen very critical when looking at future profit potentials for existing players in the automotive value chain as well as at the aim of ensuring a sustainable energy supply. On the one hand the global oil reserves are limited and on the other hand the combustion of fuel is harmful for nature and the environment (Fournier and Stinson, 2011).

These ecological aspects require suitable and adapted regulatory frameworks on national and supra-national level. Moreover changed requirements in the global market due to current socio-cultural trends push forward the development of a new ways to produce and provide mobility (Fournier et al., 2012). The following figure shows a general idea of these drivers and their effects leading to a new mobility paradigm.

Figure 1: Drivers of the new mobility paradigm (own research)



Ecological drivers

According to the study ‘World Energy Outlook 2010’ of the International Energy Agency (IEA) an increase of the oil production to 96 mb/d (million barrels per day) is expected until the year 2035 (International Energy Agency, 2010). Starting from a production of 65 mb/d in 1990 it is assumed that the demand will increase to 99 mb/d by 2035. However the assumed difference to the produced quantity occurs due to improvements in the refining process.

On the basis of the predicted strongly rising oil demand the IEA also expects increasing costs. Together with the enforced dependency on oil suppliers and oil exporting countries negative effects on economic growth as well as environmental degradation are expected, if no effective measures are taken

to increase efficiency and promote alternatives. Irrespective of this it can be derived from these data that the delivery rate of crude oil cannot be increased significantly anymore. It might even be the case that the production maximum has almost been reached already. The gap between demand and supply can only be closed by non-conventional oils and gases, while not yet discovered oil reserves need to be found and exploited additionally. In any case, in the foreseeable future these facts will have major impacts on the availability and costs of this source of energy (Intergovernmental panel on Climate Change, 2007).

This economically motivated driver is accompanied by additional negative effects when using oil as energy source through combustion. The accumulation of carbon dioxide together with other greenhouse gases in the atmosphere is strongly suspected to be the main reason for the increase of the average global temperature within the last 50 years (Ban Ki-moon, 2011). Studies of IEA and World Wildlife Found (WWF) confirm this fact and warn of the consequences of global warming (Fournier and Stinson, 2011).

Social changes and indicated market trends

When observing current tendencies in societal developments on the one hand an increasing urbanization can be identified. According to the United Nations in 2009 for the first time more than 50% of the world's population was living in conurbations and it is estimated that this number will increase up to 70% until 2050 (University Ted nation, 2010). Increased traffic intensity, local air pollution and the lack of parking facilities are problems to be expected within this development.

On the other hand there are changes of the customer requirements in respect of the future mobility that will influence market opportunities. The privately owned car will be more and more challenged as a solution to satisfy individual mobility needs. An example for this is the phenomenon that young people show a decreasing interest in the automobile. This was observed for the first time at the beginning of the 90's in Japan and was described with the name "Kuruma Banare²". Also statistics made by the German Federal Motor Transport Authority showed that in Germany in 2009 the proportion of customers buying new vehicles at the age between 18 and 29 years was

² 'Kuruma Banare' may be translated by the English term 'de-motorization' describing an attitude towards mobility without personally owning a motor (resp. automobile).

reduced by 50% within the ten years compared to 1999 (Dalan and Doll, 2010).

These social changes indicate that through new approaches in construction and development of vehicles as well as in the design of mobility concepts new market opportunities in the automotive market might arise.

Political and legal influences

Governments and politics react to the above mentioned issues in many respects. Regulatory interventions on local (e.g. inner city tolls in London), national (e.g. bonus-malus system in France) and international (e.g. "low carbon economy"-strategy of the EU, post-Kyoto protocol agreement,) level can be identified.

E.g. the EU has committed to reduce the greenhouse gas emissions until 2020 by at least 20% compared to the status quo in 1990. This resulted in the regulation from 2009 which aims to reduce the CO₂ emissions of passenger cars, responsible for 26% of the CO₂ emissions within the EU (BUNR, 2009). This regulation gives a legal framework regarding the limitation of future CO₂ emissions admitted to the European automobile industry. It includes the binding gradual reduction of CO₂ emissions of the fleets of automotive OEMs until 2020 to 95g CO₂/km. However, it is feasible to expect that these restrictions will be enforced for future decades. Speculations even reach to a restriction between 10g and 35g CO₂/km for all the automobile industry in the world by 2040 to achieve global warming below 2°C K (Auto-Motor-und-Sport, 2010).

These restrictions can be seen as additional and accelerating factors driving the change of the mobility paradigm.

The New Mobility Paradigm

Technological advances in infrastructure development such as smart grid solutions to flexibly control electrical energy networks or IT solutions such as car-to-car or car-to-infrastructure communication enable the described

drivers to develop a new mobility paradigm. Taking the ecological, societal and political changes into account a mobility paradigm basing on lowest possible emissions of greenhouse gases and an efficient usage of energy sources to provide individual mobility related with new, not ownership-oriented but need-driven mobility services must be the result.

Alternatives and consequences for the future mobility

Following this new mobility paradigm new solutions for the future individual mobility become indispensable. In order to achieve the next steps into that direction, alternatives are to be created, how automobiles will be constructed and how mobility will be shaped in the future. For the involved enterprises this means a transformation of the product portfolio as well as the search for a successful role within a re-oriented value chain. Thereby a change in the current business models may become necessary while at the same time opportunities for new players will occur.

Optimization of the combustion engine

The first recognizable step numerous vehicle manufactures were and are taking is the ongoing optimization of the combustion engine in order to reduce fuel consumption and thereby the correlating CO₂ emissions. Developments that are discussed show a potential to reduce fuel consumption starting from 7%, through cylinder deactivation or a more variable valve train, to up to 30% by using variable compression during the combustion process. However due to complex interrelationships between the individual technologies it is not possible to simply add these potentials (Wallentowitz and Freialdenhoven, 2011).

In practice, for instance the manufacturer BMW succeeded to reduce consumption within two years from 2006 to 2008 by 16% (Autosieger.de, 2009). But still the concept of the combustion engine – even though characterized by good performance, cruising range, low costs and driving comfort – shows depending on the type of engine more than 70% of thermal

losses compared to the primary energy applied (Fournier and Stinson, 2011).

Bio-fuels

Bio-fuels from the first generation like biodiesel can reduce CO₂-emissions between 32% and 86% while bio-ethanol can achieve between 30% and 76% of savings compared to fossil fuels depending on the production process. Bio-fuels from the second generation using materials such as straw or wood increase this rate up to estimated 94% (Fachagentur Nachwachsende Rohstoffe, 2010).

Despite the promising advantages of these substitutes for fossil fuels the IEA points out crucial risks in a study about bio-fuels in the transport sector. For example regarding the production costs bio-fuels will be competitive not before 2030. In addition disadvantages such as competition for agricultural land along with rising nutritional requirements, potential damage to biological diversity as well as social implications must be considered (Internationally Energy Agency, 2011).

Electrification of the powertrain

A further step of development is the electrification of the power train. Hybrid vehicles using a subordinate electric motor in addition to a combustion engine are grouped into the four levels micro, mild and full hybrid as well as plug-in hybrid.

The advantages in fuel consumption range from 7%-20% for micro and mild-hybrid vehicles, which only have either a start/stop function or a small electric support engine (Wallentowitz and Freialdenhoven, 2011) to 30%-40% for full hybrid concepts, which allow purely electrical driving over short distances (Stan, 2008). Due to the design of the plug-in hybrid vehicle, where the combustion engine only is the back-up solution for longer distances, which cannot be driven purely electrical, these vehicles offer the greatest potential for reduction in fuel consumption (Wallentowitz and Freialdenhoven, 2011) within the group of hybrid technologies. However this depends highly on the capacity of the installed battery and customer behavior.

The next step in the electrification of the power train is the pure electric vehicle, allowing permanently emission-free mobility as long renewable energies such as solar or wind are used (Wüchner et al., 2007). Electric cars, which gain the energy for the drive of the electric motor from battery,

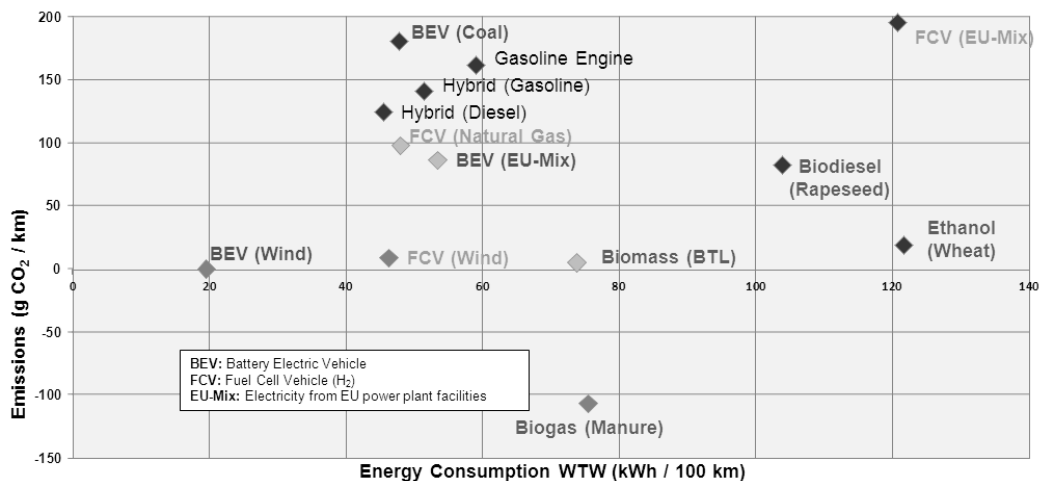
currently offer the largest potential in efficiency regarding the type of primary energy applied (Wallentowitz and Freialdenhoven, 2011).

Comparison and interpretation

Drawing the bottom line from today's perspective it is unlikely to achieve the EU-target of 95g CO₂/km until 2020 exclusively by the optimization of combustion engines or hybrid vehicles. In order to even obey the predicted limit of 10g to 35g CO₂/km in a country like Germany, at least a rate of 70% CO₂-emission-free driving has to be achieved until 2050. Without enhancing the efficiency of combustion engines this figure is expected to rise even up to 83% (Auto-Motor-und-Sport, 2010). Therefore electrical mobility is indispensable to achieve this goal.

Figure 2 draws up and compares the different alternative technologies regarding efficiency and emissions of energy used according to a Well-to-Wheel balance. It can be seen that battery-electric vehicles (BEV) based on nearly emission free renewable energies have high energy efficiency and low emissions.

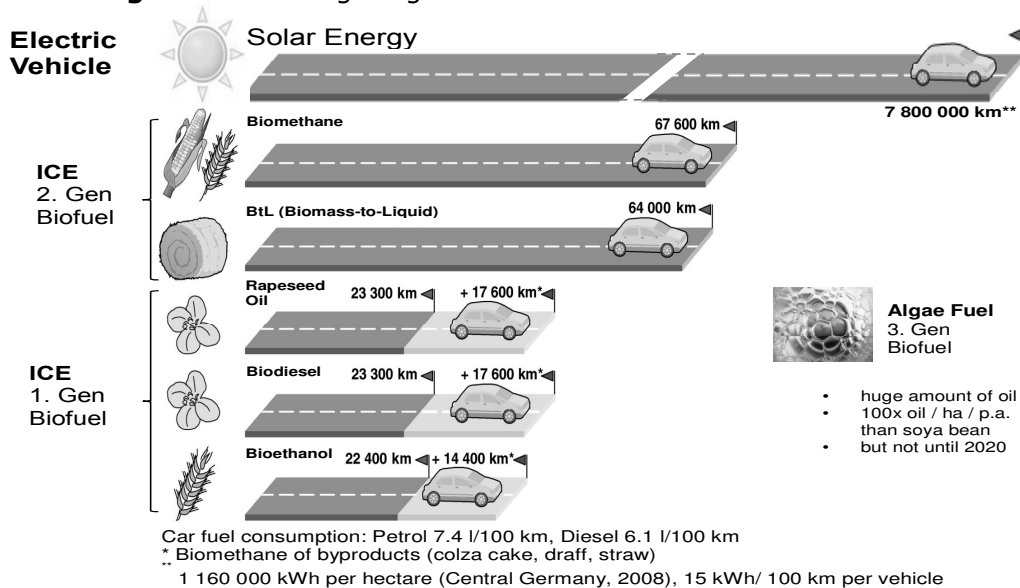
Figure 2: Well-to-Wheel efficiency of individual transport: CO₂-emissions and energy demand



Source: Fournier et al (2012) after Concawe, Eucar, JRC (2007), Optiresource tools.

Besides, Figure 3 shows the superiority of electric vehicles in comparison to biofuel-powered vehicles with combustion engines. Thus on one hectare land it is much more effective to produce electric energy from renewable energies than planting agricultural plants to produce biofuels to achieve greatest possible range.

Figure 3: Cruising range to be achieved with one hectare land



Source: Fournier (2012)

Despite the efficiency and emission advantages of electric vehicles, there are still challenges, such as the high battery costs, the comparatively high weight as well as the small energy and power density of the battery (leading to low ranges) and the hardly existing charging infrastructure (Fournier and Stinson, 2011). Against this background it is expected that the way to emission-free mobility will be implemented in a stage-wise process, with each step, e.g. the optimization of the combustion engine or hybridization, having effects on the value chain of mobility in general and successful business models.

Effects on the value chain of mobility

Due to the expected developments in the aim of electrifying the drive train and the socio-economic changes described above the automotive value chain will change fundamentally. One effect which can be foreseen already is that the access to raw materials will gain a crucial role in global supply. E.g. the predominant use of lithium-ion batteries as energy source for the electric motors leads to greater demand for lithium or lithium carbonate as well as for rare earth elements, e.g. lanthanum for the construction of accumulators or neodymium for the production of efficient electric engines. Additionally further new components, such as power electronics (e.g. inverters) or auxiliary systems, in electrical automobiles become necessary. It is expectable that in the next ten years approximately 300 billion Euros will be invested world-wide in CO₂ reduction. Thereof about 50 billion in alternative drive forms such as hybrid or electric drives (Daimler AG, 2011). These investments will be accompanied by a re-balancing of power within the value chain.

Also the provision of energy and of the increasingly demanded charging infrastructure for electric vehicles, changes the link of the value chain with the energy supply and the energy suppliers fundamentally. At present fuel production and operation of the petrol station network are dominated by an oligopoly of a few large mineral oil companies. In this sector electric energy providers are in a favorable initial position regarding the electrification of mobility because of their access to energy sources of electrical energy as well as to existing distribution networks. However there is also the opportunity for other enterprises to enter that new market.

Driven by the trends of urbanization and de-motorization new mobility services for the individual transport will also play a more dominant role. Concepts like more flexible car rentals or care sharing seem to be promising. Also solutions in combination with various transportation means, e.g. with public transport, trains or even rented bicycles as multimodal mobility services are already being tested in pilot areas (TechnoAssociates Inc., 2009). By offering these services customers might even be sensitized regarding new technologies and encouraged to realize an own investment (Urbschat and Bernhard, 2009).

Moreover, it is assumed that the importance of the recycling of parts of the vehicle in general and the drive train in particular will increase. Thus the re-use or recycling is a central contribution of sustainable and successful businesses due to the scarcity of numerous raw materials. For example the 4R Energy Corporation of Nissan and Sumitomo can be named, which pursues the re-use, recycling, processing and resale of lithium ion batteries

trying to keep track and control of the resources used (Watanabe, 2010).

Furthermore, new requirements regarding information and communication for the driver or even the vehicle by itself will increase and thereby change the value chain through an improved importance of telematics in the near future. For example car-to-infrastructure communication is supposed to flexibly plan routes with sufficient charging infrastructure or in combination with various transportation means, e.g. public transport with car sharing.

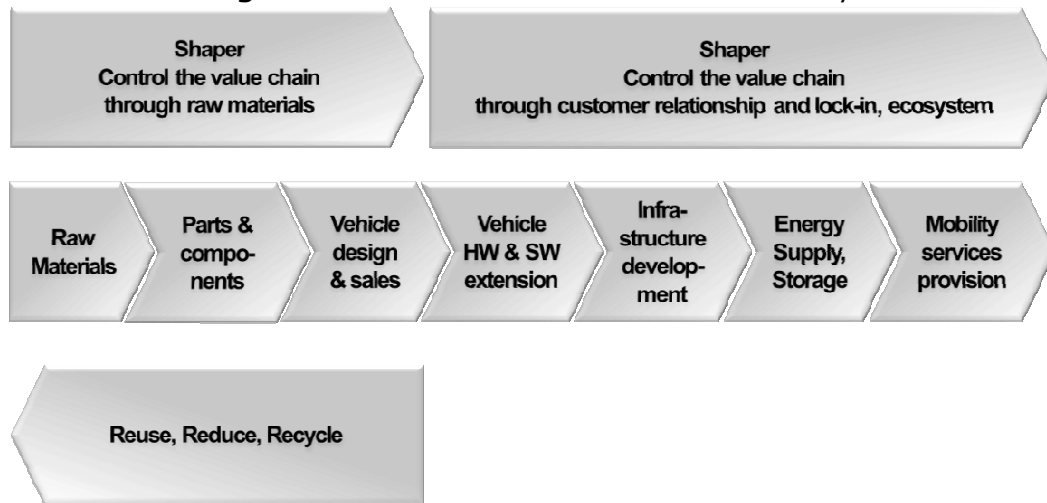
Additionally customers will be able to install software applications on their vehicle ICT (Information and Communication Technology) system in order to enhance vehicle control or personalize the vehicle. These applications could either access uncritical vehicle information and functions or even be integrated in new ICT hardware components afterwards (Fortiss GmbH, 2011a). Since electric vehicles are less maintenance-intensive, this segment might offer opportunities compensating for the income from maintenance work on combustion engine vehicles, which will decrease (Fortiss GmbH, 2011b). New business models will appear to satisfy these new customer needs.

The profound changes in the value chain will also affect the potentials to dominate the value chain. While currently car manufacturers are in the position to shape and control the value chain, in future companies will also have to take care of resource supply or will need to increase services to assure customer loyalty (Hess and Anding, 2003).

Companies within an ecosystem, defined as "an economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world" (Moore, 1996) could thus act as Shaper or Adapter (Buxmann, Diefenbach, and Hess, 2008). Shapers form the core of an ecosystem; they control one or more core subsystems and essential standards and interfaces. Adapters deliver complementary products and services, as specified from the Shapers (Franz, 2003).

As illustrated in Figure 4 this offers great opportunities but also generates new risks for manufacturers. Furthermore, these changes enable new participants and enterprises not yet related to the automotive sector to assess and enter and possibly even shape the market. The future success of the car manufacturers depend thus on their strategy on the way to electrical mobility or rather their positioning within the new mobility value chain.

Figure 4: New value chain of electrical mobility



Source: own research, based on Roland Berger (2009): Powertrain 2020 - The Future drives Electric (cf. Urbschat and Bernhard, 2009: 70).

Positioning of the manufacturers within the value chain

As indicated in the previous section, the pressure to change within the value chain prompts enterprises to redefine their current positioning. Already today trends can be identified regarding the future positioning within the value chain.

Raw materials

The raw material supply is viewed critically by some participants, in terms of being able to operate the further steps in the value chain up to the access to the customers. Therefore the Chinese manufacturer BYD has acquired an 18% stake in the lithium producer Tibet Xigaze Zhabuye

Lithium High Tech Co. (China Daily, 2010). Besides, Toyota secured the access to Argentina's lithium deposits. The company acquired prospecting licenses and plans to start with the mining of the raw material in 2012 (Neue Züricher Zeitung, 2010). Furthermore also the French conglomerate Bolloré intends the mining of the alkali metal and run projects in Argentina and Bolivia at present (Bolloré Logistics, 2010). Activities of other observed participants could not be determined.

Parts and components

The most important components of electric vehicles, which differ from conventional vehicles, are batteries, electric motors and power electronics. At this sector the manufacturer Daimler maintains a joint venture called Deutsche Akkumotive GmbH & Co. KG in collaboration with the battery technology specialist Evonik (Daimler AG, 2008) and even plans a further joint venture with the supplier Bosch for the development and production of electric motors (Daimler AG, 2011). The Volkswagen Group maintains development partnerships with the battery manufacturers Sanyo, Toshiba and BYD regarding battery research and power electronics (TechnoAssociates Inc., 2009) as well as a joint venture company with Varta (Volkswagen AG, 2011). In the future the battery cells shall be supplied by Sanyo and then installed to battery systems by Volkswagen (Frankfurter Allgemeine Zeitung, 2011). It is also targeted to apply to power electronics and battery management (Kaufmann and Sorge, 2012).

The electric motors shall be in-house manufactured in Kassel, as well (Focus, 2010). Although BMW will be supplied with battery cells for the BMW i3 (megacity vehicle) by LiMotive (SB LiMotive Co. Ltd., 2009) the cells will be in-house proceeded into batteries in order to increase their own value added. Furthermore BMW tries to achieve competitive advantages by own developments of battery management systems, power electronics and electric motors. In future BMW will cooperate with Toyota to increase value-added in battery cells (Fasse, 2009).

General Motors (GM) extends their battery production as well as their research and development capabilities, additionally to the purchase of battery cells from the supplier network. Besides also power electronics are developed (General Motors, 2009). Own electric motors will be manufactured from 2013 (General Motors, 2011).

Already today, Renault Nissan produces batteries in a joint venture with NEC (Watanabe, 2010) and also builds up additional capacity for the production of electric motors (Automobil Produktion, 2011). BYD already has long experience in the battery sector and makes use of these advantages. In addition to the batteries, electric motors are produced in-house at Shenzhen plant (Shirouzu, 2009).

Vehicle design, development, production and Sales

If the future product portfolio of Daimler is examined, it is evident that the manufacturer pursues several different solutions regarding the drive train. Daimler presents with the Concept BlueZERO an outlook regarding future concepts of electric drives with battery, battery and range extender as well as fuel cell. In addition Plug in hybrid versions (Weber, 2010) and the development of battery-electrical vehicles in a joint venture with BYD are planned (Daimler AG, 2010). Besides, Daimler approves a co-operation with the E-Bike manufacturer Grace, in order to sell an electrical bicycle under the brand smart in the future.

A decision concerning a "smart" electric scooter is still not made (Automobilewoche, 2011). Volkswagen plans also pure electric vehicles (Volkswagen AG, 2011) beside the plug-in hybridization (Reichenbach, 2009). Furthermore the company presented a study about a electrical bicycle at the Beijing auto shows called Bik.e (Volkswagen AG, n/d). But whether the product portfolio will be expanded is still not decided yet. BMW Group plans building Plug in hybrid vehicles (Pudenz, 2011) as well as full electric vehicles. Unusual is the strategy that under the sub-brand BMW i innovative and sustainable products are offered, beginning with the battery-electric operated Megacity Vehicle i3 and the Plug in hybrid sports car i8 (BMW Group, n/d). Regarding the electric scooter studies MINI Scooter E and BMW Concept C which might have an electric drive, the expansion of the products offered by the BMW Group with electrically operated drives is likely (focus, 2010).

Recently the Renault-Nissan alliance started their electric car offensive. Renault aims to be able to offer four battery-electrical models until the end of 2012 (Renault, 2010). In contrast to competitive manufacturers it can be observed that Renault does not consider a hybrid solution for the transition from conventional to purely electrical vehicles (Pander, 2011). But Nissan uses hybrid technology; however it is not foreseeable whether also Plug in hybrids will be offered. Besides this since 2010 with the model LEAF Nissan has a pure electric vehicle in the portfolio (Nissan Motor Company, 2010). Nissan plans in cooperation with Renault the production of 1.5 million electric vehicles until 2016 (Ghosn, 2011).

PSA Peugeot Citroën aims for a significant extension of their product portfolio. At present the brands Peugeot and Citroën have each two electric vehicles in their product portfolio, which have been developed in co-operation with Mitsubishi and Venturi (PSA Peugeot Citroën, 2009). Furthermore Peugeot has already electrically propelled bicycles (PSA Peugeot Citroën, n/d) and scooters (PSA Peugeot Citroën, n/d) in the production program and plans Plug in hybrid versions of various models with its cooperation partner Cycleurope (PSA Peugeot Citroën, 2009).

GM has already extended the product portfolio by the Plug-in hybrid vehicle Chevrolet Volt (General Motors, n/d). In addition to that further Plug-in hybrid models, the development of purely electrical models (Krolicki, 2009), and also an E-Scooter is considered (Welch, 2009). BYD focuses product-related to the offering of battery-electrical and Plug-in hybrid vehicles (BYD Company Limited, 2011), despite low sales figures of the models F3DM and e6 in 2010 (China Auto Web, 2011).

Reuse and Recycling

As already discussed, due to the scarcity of relevant raw materials the access to them is essential for the stable future development of the company. An important way to secure access to raw materials is the re-use or prolonged use and/or the recycling of components which have been already used. Regarding this, the waste framework directive (Europa Zusammenfassungen der EU-Gesetzgebung, 2009) as well as the end-of-life-vehicle directive (Europa Zusammenfassungen der EU-Gesetzgebung, 2011) has to be considered in the European Union (Braungart and McDonough, 2010).

For example Nissan's ratio of dismantling and recycling of end-of-life vehicles is 83.7 percent. The Japanese guidelines for vehicle recycling stipulate 70% until 2015. Some components such as airbags can even be recycled by more than 90% (Nissan Deutschland, 2011).

Vehicle hardware and software extensions

In the field of software extensions the BMW Group is active. BMW presented its Concept BMW Application Store at the Frankfurt Motor Show (IAA). It was the world's first carmaker to demonstrate the possibility of downloading and storing individual applications either from the car at any time on the move or from your PC at home. It means that, as with a mobile phone, the car can be adapted to the needs and interests of its owners / occupants for the first time, thus benefiting from a very detailed personalization. The Concept BMW Application Store is a further innovation of BMW ConnectedDrive (BMW Website, 2009). Today BMW already offers services like Facebook, Twitter as well as office and E-Mail applications (Dunker, 2012).

Audi and Mercedes-Benz offer comparable services (Audi Website, 2011) and are also planning their own application store (Spiegel Online, 2010). Furthermore both maintain a strategic partnership with Google, which significantly improve their ability to quickly and seamlessly integrate useful Google services into their passenger vehicles (Daimler Website, 2012).

With Entune Toyota offers a collection of popular mobile applications and data services integrated with selected Toyota vehicles (Toyota Website, 2012). General Motors' new infotainment system for selected Chevrolet models is called Chevrolet MyLink. Applications for MyLink will be available in 2012 (Chevrolet Website, 2012).

In the field of hardware extensions the Volkswagen Company is active. The upcoming Audi A3 model will come with new infotainment hardware: The host system works with a plug-in module using an Nvidia Tegra-processor. Therefore the board can be easily exchanged and is always up-to-date (Bretting, 2012).

Infrastructure development

At the moment the Renault-Nissan alliance is a pioneer of infrastructure development. With the establishment of numerous partnerships and the installation of first charging stations in Japan (Watanabe, 2010), Renault Nissan tries to gain a competitive advantage. Examples of cooperative partnerships for the infrastructure development and the marketing of electric vehicles are energy companies, states, regions and municipalities as well as the enterprise Better Place, which markets a battery-change concept at present in co-operation with Renault Nissan (Nissan Motor Company, n/d). BYD pushes forward likewise the expansion of the infrastructure with the development of smart charging solutions for the electric vehicles. This includes 2kW and 10kW charging poles as well as a charging station with four outlets, which was designed similarly to petrol stations in Shenzhen (BYD Company limited, n/d).

Energy supply

In the sector of energy supply the Volkswagen Company is active. Its brand Audi wants to create under the name Balanced Mobility - among other things - offshore wind farms as further economic pillar by selling the produced energy to its customers (Financial Times Deutschland, 2011). Renault and Nissan entered approx. 90 partnerships with municipal and regional energy suppliers, in order to offer electric vehicles, batteries as leasing models and electric energy from one hand (Renault, Communiqué de presses, 2010). BYD provides their customers the possibility to produce their own electricity with a Home Energy system which consists of a photovoltaic and battery system to produce and store the energy (BYD Company limited, n/d).

The Activities in the area Vehicle-to-Grid (V2G) could be as well promising in the future: V2G means that the vehicles are used as flexible energy

storages, which can compensate peak loads and off-peak periods or which can be used for frequency regulation of the power grid. A theoretical revenue between zero and 80 EUR per month and vehicle would be possible, depending on the country and the service offered (Fournier, Baumann, Seign, 2010).

Mobility services

In the rising business area of mobility services Daimler has already positioned itself with the Carsharing model Car2go (Scientific Computers GmbH, n/d) in several cities and tests at present in pilot projects the ride-share concept car2gether. Also Nissan plans its own mobility concept, a Carsharing solution with electric vehicles for commuters as well as an IT-supported journey planning in city and tourism regions (Watanabe, 2010). Peugeot and Citroën serve with the flexible renting concept Mu by Peugeot and the multimodal travel planning multicity by Citroën (Automobiles Citroën, n/d) the customers demand for appropriate mobility concepts.

Recently BMW became active in the area of the Carsharing, too. Their concept is called DriveNow and is operated in collaboration with the car rental service Sixt. Moreover the venture capital company BMW i ventures was founded, which focuses on strategic investments in innovative mobility services, such as the mobility service MyCityWay or ParkatmyHouse (BMW Group, n/d).

As third German manufacturer Volkswagen entered the Carsharing market with their model Quicar in Hannover from autumn 2011 (Volkswagen AG, n/d). Bolloré develops in Paris one of the largest Carsharing projects in the world. In the first stage 250 vehicles (December 2011) then 1,075 vehicles (June 2012) are provided, in order to provide in the final stage of the project 3,000 vehicles and 1,098 charging stations. The city estimates that the project will allow a reduction of traffic in Paris of 22,500 private cars (Barjonet, 2011). So far no actions of BYD and GM have been observed concerning mobility services.

Classification of the activities into the value chain

To sum up it can be noted that the examined manufacturers pursue different strategies to offer their customers emission-free mobility and furthermore adapt with new services to the changed framework conditions. Particularly the broad positioning of the manufacturers must be mentioned. This is due to the risks and uncertainties because of the not yet foreseeable changes in the market, since today nobody can predict the future appropriately. Also emphasized should be the strategies of Renault, Peugeot and Citroën, which are the only European manufacturers already offering electric vehicles and at the same time open with innovative services new business areas.

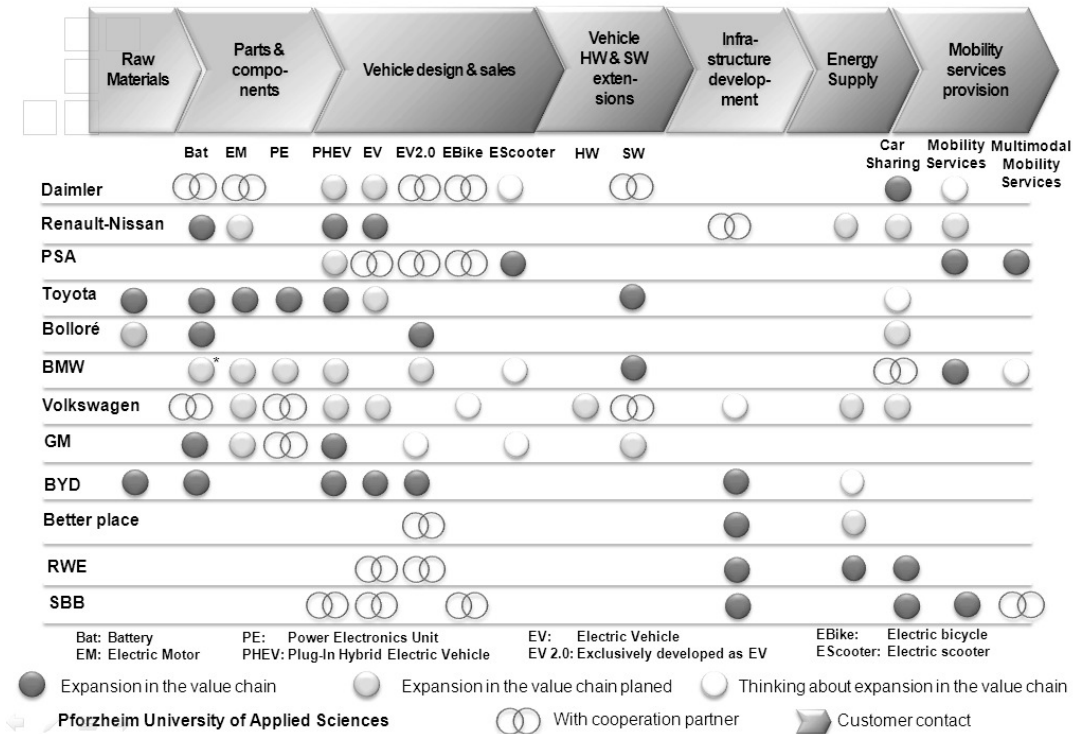
The German manufacturers Daimler, BMW and Volkswagen have broad activities and therefore are – in terms of electrical mobility – in a promising position. Although BYD and GM have already placed Plug-in hybrid and electric vehicles on the market, at the moment they are not active in the area of mobility services. Industry outsiders and new entrants have great potential to shift the market shares significantly by offering additional services such as energy, applications or mobility solutions. These new competitors enter the market due to the changes and the growth opportunities.

Furthermore it could be interesting whether an enterprise will succeed to create a system across the entire value chain and control and shape it. Critical success factor for this could be the access to the customer or rather the ability to bind the customers through innovations and high switching costs (lock-in strategy), as referred by Hess and Anding (2003).

Switching costs can be costs of searching (products or alternatives), investment costs (for instance in new hardware), learning costs (e.g. to learn the new software environment), synthetic costs (e.g. due to contracts) or psychological based, e.g. due to change a habit (Klemperer, 1987). This effect is known as the creation of an „ecosystem “. E.g. companies such as Apple or Amazon have achieved this objective and by this means achieved a dominating position in music and mobile phone industry (Schmidt, 2011).

Finally in Figure 5 the activities of the competitors are classified and categorized within the new value chain of the electrical mobility, based on publicly available information.

Figure 5: competitive positioning within the mobility value chain



Source: Adapted from Fournier et al (2012).

The e-mobility ecosystem

In order to continue the trends and changes of successful business models in the automotive value chain developments in other industries observable during the recent years allow to interpret signs and describe potential future opportunities. When again looking into the smart phone industry the idea Apple has promoted starting with the launch of the first generation of the iPod. Superior innovative technology and trendsetting design (Shuen, 2008) was combined with mandatory software which was indispensable to be able to use the product - in this case for managing music files.

The software itself was not only intended to manage the music on the device but at the same time also provided access to an internet store managed by Apple (iTunes), as mentioned by Hess, Grau and Dörr (2008). Other products, e.g. the iPhone or iPad, and technologies such as touch screens, voice control or cloud services were continuously added to the product portfolio as well as an increasing amount of micro applications – so

called “apps” – for the devices. Due to the tight and in some cases even exclusive integration (devices require iTunes) Apple created an environment which can be interpreted as an independent ecosystem for communication, entertainment and even business functions (Bloomberg Business Week, 2007). Through this ecosystem Apple could increase the switching costs of their customers. For example through the launch of the Apple App Store: All Apps which are bought in this store can only be used with Apple products. That means if a customer would like to change the brand he will be faced with investment costs to replace his apps, with searching costs to find a store with a similar choice and learning costs to learn how to use this platform.0

Given the above described changes and opportunities within the new automotive value chain this indicates that Apple’s approach might be transferable to potential business models for the future mobility. This opens up the chance for the existing or newly rising shapers of the value chain, to not just offer mobility devices or services but to provide a complete mobility ecosystem.

The benefit for the consumer could be combining innovation with simplifying and lowering transaction costs. This system may combine the car or the right to use a car whenever necessary with other products or services. For example, this could include: supply energy including the charging infrastructure, provide apps for car-to-car or car-to-infrastructure communication, manage car maintenance cycles and support the adjustment to each individual user by personal profiles e.g. for seat adjustment, preferred music, personal address book stored and accessed from the cloud belonging to the ecosystem. The opportunity for the shaper would be to use the switching costs to enhance the loyalty of the customer.

Conclusion

The scarcity of fossil fuels, global warming as well as social changes due to increasing urbanization and changes in values can be identified as main drivers of changes in the mobility sector. Additionally, these trends trigger regulatory interventions and therefore enforce the change of the framework conditions leading to a new socio-economic mobility paradigm causing changes in technology and business models.

The optimization of the combustion engine and the use of bio-fuels are first steps to reduce of the fuel consumption and CO₂ emissions of vehicles. The

next phase is the hybridization of the drive train and its electrification with batteries, in order to make emission-free and efficient mobility possible in the long run. The electrification of mobility is most promising in the long term due to the higher energy efficiency and lower harmful emissions.

The electrification together with new services for flexible mobility and information and communication applications will fundamentally change the automotive value chain. This will result in opportunities for business models within new business areas, such as mobility services, infrastructure development and energy supply. This not only offers great opportunities but also generates risks for the established manufacturers along the entire value chain which might lose their strong current shaping position.

The analysis shows that the observed manufacturers pursue different strategies. A broad positioning of the manufacturers seems important, in order to flexibly be able to respond to market changes and to continuously be in the position to shape the value chain. In particular the strategies of Renault, PSA as well as Daimler and BMW show, how seriously the issue is taken by the industry.

The expansion of the business to customers groups, which have mobility needs, but no longer want to possess their own automobile, could generate additional revenue for car manufacturers. Also the focus on the creation of value on the pre-development or the mining of strategic raw materials as BYD and Toyota do, offers manufactures the opportunity to defend or even expand their position in the value chain.

At the same time the changes offer opportunities for actors in the automotive supply chain as well as for companies not yet related to the automotive industry. Completely new innovative business models emerge where sector unrelated IT companies achieve customer loyalty because they provide smart combinations of mobility with other services (lock-in strategy). Eventually this might control the whole value chain similarly as in the music or mobile telephony industry and lead to a complete automotive ecosystem.

Finally it can be noted that the pressure on the industry is very strong to redefine positioning in the market for the future by investing in innovations for the vehicle, in accompanying services or in the process along the value chain. Likewise it is important to observe the further development in the market of emission-free mobility, in order to be able to act rather than react to arising trends in time and in a suitable manner. This transformation process will take many resources, so that new co-operations along the value chain are probable. The ability to establish networks, in order to satisfy the customer needs within more sustainable framework conditions, will be crucial.

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