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Executive Summary

An increased focus on CO₂ emission level from the road transport sector has over the years put immense pressure on the global automobile industry to lower its carbon footprint. Today, the global automobile industry is standing in front of a major technological change, as there are several competing technologies which can possibly become the mainstream in the future. Not to miss out on a potential competitive edge, represented by this technological change, automobile manufacturers have presently undertaken a multi path strategy. In addition to comply with the strict environmental regulations, like EU’s 20-20-20 carbon footprint reducing policy. These factors are creating uncertainty in the evolving future of the automobile industry. Which path will the industry take? Questions like the former are increasingly demanding a plausible look into the future of the global automobile industry in this context.

Among the technologies in emergence, hybrids, plug-in hybrids and electric vehicles are identified to have the highest impact on the future of the automobile industry. How will that affect the internal rivalry among automobile manufacturers is the essential research area of this thesis. This paper follows M.E. Porter’s (1979) model of competition coupled with scenario thinking to provide a look into the future of the global automobile industry, given the impact of the fuel technologies in emergence. Key findings in the paper are that the extent of consumer acceptance of these technologies mainly depends on the volatility in the oil price. Since consumers are primarily driven by their personal economy. Automobile manufacturers, on the opposite, are pushed through the shift by the strict environmental regulations. Whether manufacturers are able to produce the desired quality or not, and to what extent are the consumers going to accept these technologies lays the basis for the industry scenario interpretation in this paper.

This industry study has revealed several major implications for the automobile manufacturers in a given future industry scenario. Firstly, different firms have to strategize differently, according to their resource strengths and capabilities to take advantage of the opportunities and defend against the threats arising in a plausible future. Secondly, there is an increasing focus on electrification of vehicles in the coming years, with many manufacturers already investing millions of Euros into these technologies. Finally, in the future a vast number of changes will be evident in the global automobile industry. New players like start-up firms,
third parties and even suppliers are likely to form a part of the new era of the automobile industry.

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Foreword / Preface

During the course of the thesis writing Najm-Us-Saqib Mushtaq and Jalal Sarwar have both benefitted greatly from the guidance of Professor Poul Schultz. We will especially thank him for his helpful discussions in the thesis topic and general thesis guidance.

Throughout the thesis process both authors have participated in the data gathering and writing process. Although, challenges have occurred during the process, it has been a learning experience for the good. Different chapters in this thesis have been written initially individually by the authors. Najm-Us-Saqib Mushtaq has been responsible of producing Ch. 2, 4 and 5, while Jalal Sarwar has been responsible for producing chapter 7. The remaining chapter 1, 3, 6 and 8 are joint production which have been written together. That said, both have participated in the whole master thesis writing process and in the data gathering of empirical data through interviews. All the chapters have been corrected, revised and summarized together in its final format.
1. Introduction

1.1 Introduction of the Thesis

Within the dynamic global business environment, changes are today occurring with a faster pace than ever; creating both opportunities and challenges for businesses and industries. Global warming as a cause of manmade climate changes is such a change, which has gained increased awareness of late, albeit mostly as a challenge. Porter & Reinhardt (2007), argue that companies who think strategically about their carbon footprint will find sources of sustainable competitive advantage. In view of that, climate changes are not only a challenge, but represent also enormous business opportunities ahead.

One such industry, where the current climate changes are playing a more than peripheral role in the business competition, is the global automobile industry. Nowadays, it is widely conceived and also hyped by the media that the products of the automobile industry in form of the petroleum fuels driven Internal Combustion Engine (ICE) cars, discharge massive amounts of green house gases (GHG), in particular CO₂ which are believed to be harmful for the environment. Given that the automobile industry has the largest consumption of petroleum products in the world (OECD/IEA, 2008); it is widely believed that the CO₂ emissions from cars contribute largely to the climate changes.

The increasing environmental awareness and the view that the automobile industry is one of the biggest contributors to global warming have alerted central stakeholders to take actions to diminish the perceived effects on the globe. Governments are imposing stringent environmental regulations on the automobile industry with the aim to make the industry produce cleaner vehicles (KPMG, 2010a), while consumer preferences are shifting towards cars with a lower carbon footprint (KPMG, 2010c). Such significant industry-wide pressures have put the incumbent automobile manufacturers at a technological cross-road, as there is a widespread understanding that they have to move away from their fossil fuel bound product offerings to stay competitive in the future marketplace.

This thesis is about the impact on the automobile manufactures competitive strategies this technological shift may create. The technological shift has already created a new dimension of competition among automobile manufacturers as there are several competing propulsion and fuel technology solutions in emergence, which is the area of interest in this thesis. The aim is
to give a look into the future of the global automobile industry by illustrating the impact of emerging propulsion and fuel technologies on the rivalry strategy. So incumbent automobile companies can have better understanding of how they have to strategize to take advantage of the opportunities arising, but also defend against the challenges a given future industry scenario creates.

Such a report can be very interesting for both automobile companies and the suppliers industries, as well as to various stakeholders and business professionals with interest in how the future of the global automobile industry relative to propulsion and fuel technologies in emergence might evolve into. This thesis is written in such a manner, that the essence can be easily engaged.

1.2 Introduction to the Global Automobile Industry

The global automobile industry is mainly an assembly industry where the different manufacturers and brands are interconnected and where every final product has received a number of inputs throughout the production process (Dicken, 2007). More precisely, the global automobile industry is a complex network of regional oligopoly markets where the actions of individual manufacturers affect the overall marketplace (ILO, 2010; Besanko, 2007). The multifaceted nature of the production process which consumes nearly half of the world’s output of rubber, 25 percent of its glass and 15 percent of its steel (Dicken, 2007) entail, however, that there are no established relations between these regional markets. Accordingly to supply the world markets, a large portion of the production is exported to foreign countries, which entails high shipping costs. Therefore, many manufacturers have located production near or within the markets they serve.

Global manufacturers managing this very capital intensive industry, which is characterized by relatively high capital-to-labour ratio, due to enormous fixed capital and labour costs, compete primarily on price, product and technology (Haugh et al, 2010). The former also act as high entry barriers for new entrants, making it a high concentration market. Ongoing consolidation in form of mergers and other various collaborations and alliances within the global automobile industry and its suppliers are increasingly globalizing the competition and contributing to the inorganic growth (Dicken, 2007). Historically these consolidations have
been related to factors such as technological change, economies of scale and scope (Weston et al., 2003).

1.3 Problem Area and Research Questions

In the initial years of the automobile industry, there were a few competing solutions to power the automobile with, among them mere disruptive technologies like steam and electricity based propulsion (Pilkington and Dyerson, 2004). As the history has shown, however, the petroleum fuel driven Internal Combustion Engine (ICE) eventually evolved to be the mainstream engine in use. Today, more than hundred years after Karl Benz commercially introduced the first ICE powered automobile (Dicken 2007), the global automobile industry is again facing a major technological transformation. Similarly to what happened more than hundred years ago, today there are technologies in emergence, but with the prospect to replace the core capabilities of the automobile manufacturers, the ICE. Such emerging technologies can often destroy core competencies by making obsolete the slowly acquired skills, knowledge and assets that were needed to master the established (ICE) technology being replaced proposes Day and Schoemaker (2000).

For the automobile manufacturers it is a true battle, as for more than a century, they have kept on producing cars propelled by the ICE. Though ICE configurations vary according to the different manufacturer, the basic principles remain the same (Dyerson and Pilkington, 2005). Naturally, over the years new innovations have been added to or incorporated in with other technological developments (Dyerson and Pilkington, 2005) to make the ICE cars become more efficient and cleaner. However, in order to comply with the challenges ahead, the long term solution is to move global automobile industry completely away from the ICE.

On the other hand, the automobile industry is known to be very conservative, where changes have come by slowly, rather than rapidly. As an interview with Christian Erik Kampmann (2010) revealed “the car industry is afraid of losing one of its core capabilities in the distinctive design of drive train [...] do not want to give up its business model...” Nevertheless, the technological transformation will not take place right away, but rather gradually over the next 5 - 25 years. Findings suggest that it is widely expected that the ICE will continue to dominate in the close future (JD Power, 2010b; Eis Interview, 2010; Morsing Interview, 2010; IEA, 2009). However, to prepare for a future away from the fossil fuel bound ICE, the first question which is answered in this thesis will give an overview of the present
situation of the global automobile industry with an emphasis on the technological shift to identify the main factors in play pushing it through.

Research Question 1:

Cooper and Smith (2002) note that during the time before a "dominant design" are established, there is experimentation with different technical approaches and solutions, while Day and Schoemaker (2000) suggest that when technologies are emerging, there are typically numerous competing models for implementing the different technologies. That fits well with what is going on in the automobile industry, as there is ongoing trialling with several competing propulsion and fuel technologies in emergence (Andersen Interview I, 2010; Morsing Interview, 2010; Eis Interview, 2010). These technologies include different degree of partly or fully electrification such as pure battery electric, plug-in hybrid, hybrid and hydrogen fuel cell, but also alternative fuels from various renewable and fossil sources such as natural gas, hydrogen and bio fuels, which can be run on advanced ICEs. These emerging fuel technologies can potentially redesign the entire automobile industry and established strategies, and may create new markets and attract new customers (Day and Schoemaker, 2000; Gilbert and Bower, 2002).

Presently, all the major traditional automobile manufacturers have taken multiple-approach strategies to comply with the potential new rules of competition, and are pursuing either parts of or the whole selection of the new fuel technologies in emergence to spread the risks related to investments in each technology. Typically, incumbents see emerging technologies as threats proposes Day and Schoemaker (2000) and, therefore, feel that they must participate not to lose share, but also to defend against potential new entrants. All the major automobile manufacturers are complying with this, as well as to not miss out on a potential competitive edge. At the same time, it is noticeable that the financial and economic situation of the majority of the traditional automobile firms create pressures that threaten their long term
economic sustainability (Zapata and Nieuwenhuis, 2010), which is a great distress. Achieving scale economies in large scale production plays a fundamental part in the modern competitive landscape of the automobile industry. The mass production process, however, requires extremely high initial capital investments (Zapata and Nieuwenhuis, 2010). The notion of competition in the automobile industry means that every automobile manufacturer is striving to recover sunk costs through high annual unit sales, in order to reach at least break-even. Since the multi-approach undertaken entails additional sunk costs related to high initial capital outlay in R&D of each new technology, it is of advantage for the automobile manufacturers that they pursue fewer and preferably one approach to minimize these sunk costs. On the other hand, however, as there is currently no common understanding among the automobile manufacturers of which emerging propulsion or fuel technology has the biggest inclination to out-compete the conventional ICE technology of today. Betting on one technology which proves to be the wrong technological path can have huge financial consequences for the incumbent, which justifies spreading the risk on multiple technologies.

Given that there are several uncertain factors in the business environment, industry and markets in play related to the emerging technologies, which outcomes might give different pictures of the future of the automobile industry and can possibly change the rule of the game. The next natural step is to sketch out plausible futures (2010 – 2020) of the global automobile industry through scenario interpretation, to give a plausible future outlook. How will these emerging technologies affect the future industry structure and what impact will that have on rivalry strategy, is the second question answered in this thesis accordingly.

**Research Question 2:**

*How will the new fuel technologies impact the future of the automobile industry (2020) and what are the strategic implications for the manufacturers?*

**1.4 Delineation of the Problem Area**

There are several ways to answer the research questions in this thesis. We have in the paper chosen to conduct an industry survey to give a look into the future of the automobile industry regarding emerging fuel technologies. To get an understanding of whether consumers are interested in the emerging fuel technologies, we have a focus on how the consumers perceive

the new technologies and what the likelihood for acceptance is 10 years from now. Since most of the technologies are not readily available, there are also uncertainties regarding whether automobile manufacturers are able to produce or improve the technologies from their current state today. We will in the paper not dig into any specific market or consumer segment, but stay on a more general level to get a holistic view. Given that there are many fuel technologies in emergence, we acknowledge that not all of them can be touched upon. Therefore, we have narrowed down the scope to only be the technologies which are most likely to have an impact within the next ten years. We have furthermore, not touched upon the minor innovations in the automobile industry as the focus has been on replacement for the ICE technology. Regarding scenario construction, we choose one specific scenario which we built the Porters Five Forces on. However, we acknowledge that the common practice is to consider all the final scenarios on equal terms, and make strategic implications accordingly.
1.5 Outline of the Project

The outline for the project is mirrored in the structure of the paper. To get a better understanding of the present situation of the global automobile industry, Chapter 4 will commence by giving a brief overview of the present situation of the global automobile industry. It will continue with emphasizing on the technological shift by identifying the main driving forces behind, through a PEST analysis. The purpose with the PEST analysis is to identify key trends and uncertainties to use in the future industry scenarios. Having set the battlefield of the thesis in the preceding sections, Chapter 5 will continue with, by analyzing the most important propulsion and fuel technologies in emergence as substitutes to the automobile manufacturers’ core competencies in the Porters Five Forces model in terms of technical benefits and consumer perceptions. The latter is of importance, as the perceptions can decide the degree of acceptance of the emerging propulsion and fuel technologies. The outcome of the analysis will be used in the future industry scenarios in Chapter 6, where the impact on rivalry strategy will be analyzed in the Porters Five Forces model through scenario thinking to show the impact on rivalry and the other remaining forces in a given future scenario. In chapter 7 example firms Toyota and PSA will be analyzed through SWOT to match their present strengths and weakness with the opportunities and threats arising from the particular future industry scenario in chapter 6, to execute and implement strategic actions.
Finally, chapter 8 will commence with a brief discussion of the main findings to summarize the main points to answer the research questions and wrap up and conclude this paper.

2. Theoretical Foundation

In this chapter the main theoretical foundations that allow answering the research questions will be presented. The purpose is, firstly, to ensure that the main theoretical framework in use the Porter’s Five Forces model, is understood and therefore can serve as a departure point for the later analysis covering chapter 5 and 6 and secondly to illustrate the approach undertaken by the authors to answer the research questions. The first research question examines the present situation of the global automobile industry and the underlying main forces for the technological shift. Answering the first research question is based on different consultancy reports, books, journals and market research and by utilizing the PEST categorization, which is a framework for analyzing macro level environmental forces affecting businesses and markets. To give a look into the future, the second research question examines the impact of emerging propulsion and fuel technologies on the internal rivalry in the global automobile industry, hence the rivalry strategy. Answering the second research question is based on Michael E. Porter 5 Forces (1979) model of competition in Thompson, Strickland III and Gamble (2008) coupled with the scenario thinking terminology of Schoemaker and Mavaddat (2000) to give a look in the future. The former authors have made an adaptation of the model to explicitly fit rivalry strategy, which is the backbone of this thesis.

In the following, the different components of the Porters 5 Forces framework and how it is used in the thesis is outlined and discussed.
2.1 Michael E. Porters 5 Forces Model of Competition

Michael E. Porters (1979) Five Forces Model of Competition is one of the most widely known and accepted tools by academics for structured analysis of competition and industry in the fields of strategic management and economics. Originally, the framework was intended for measuring the average firm’s profitability within an industry and originates from the Industrial Organization theory in microeconomics in the fields of economics (Peng, 2009).

Porter’s model holds that the state of competition in an industry is shaped by five competitive forces operating in the overall market (Thompson, Strickland III and Gamble, 2008; Porter, 1979). The framework is widely used to build the picture of the rivalry and profitability in a given industry, by systematically diagnosing the competition in a marketplace in five forces and then determining the nature and strength of each (Thompson, Strickland III and Gamble, 2008) to develop competitive strategies.

These five competitive forces consist of (Thompson, Strickland III and Gamble, 2008);

1. Rivalry among existing competitors

2. Competitive pressures associated with the threat of new entrants into the market

3. Competitive pressures coming from the attempts of companies in other industries to win buyers over to their own substitute products

4. The bargaining power of suppliers of raw materials, parts, components or other resources inputs

5. The bargaining power of buyers

The “rivalry among existing competitors” is very much a function of the other four competitive forces as seen in figure 1 below.

2.1.1 Why FIVE FORCES?

Above all, the Porter’s Five Forces framework is a highly analytical core concept of the industry-based view, and aids to predict the long-run rate of returns in a particular industry. It can also to a large extent be used to determine company strategy and performance based on the opportunities and challenges arising from the competitive conditions within the industry, which is highly relevant for answering the second research question. The strength of the model relative to the scope of this paper, is that it endorses reasonable strategic thinking about how to better fit company strategy to the specific competitive landscape of the industry (Thompson, Strickland III and Gamble, 2008; Porter, 2008), and stake out a position that is more profitable and less vulnerable to attack. Coupled with scenario thinking, it is in the thesis utilized to give a look into the future of the global automobile industry. Thurlby (1998) adds that for organizations it is essential to have an understanding of the nature of each of the five forces as it gives them the necessary insights to craft sound strategies to successfully compete in the market. All these features correspond well with the assignment in this thesis, hence we find the Five Forces as a very suitable theoretical foundation, to serve as a departure point for industry scenario analysis and strategy execution and implementation for example.

firms; PSA Peugeot Citroën and Toyota and Toyota Motor Corporation in the global automobile industry.

2.1.2 Limitations of Porters Five Forces

No theoretical foundations or models are without flaws. There are surely some limitations to the Five Forces Model as well. Firstly, the critiques claim that it has a tendency to oversimplify the environmental surroundings of the industry, especially factors in the macro environment (Grundy, 2006). That is a major limitation as the model may overlook critical factors in the macro environment that can prove to be vital for the industry structure. To complement for the lack of taking into consideration macro factors, the PEST categorization which is a widely recognized strategic tool for structuring factors in the macro environment, can be used. The latter are utilized in the thesis to give an overview of the most important conditions in the business environment of the global automobile industry relative to the technological shift.

Another major drawback of the model is that it was developed more than thirty years ago, and has a tendency to promote an ‘industry’ as a specific entity with ongoing boundaries (Porter, 1979). Much has taken place in the industries since then. For instance, globalization has moved industry boundaries and made the marketplace more dynamic ever since, which indicates that it might not apply to the fast changing global markets and industries of today (Grundy, 2006). However, the industry investigated, the global automobile industry is one of the mature manufacturing industries who produce tangible products and where changes have been slowly adapted and the industry boundaries have remained almost the same. Accordingly, we believe that the Five Forces model is still useful for the purpose of this thesis.

The model is also criticized for not taking into account that the value chains of the industry have more segments than proposed (Grundy, 2006). For example, the buyers can be divided into different markets, product and consumer groups. That is, however, deemed irrelevant in the scope of this thesis as the usage is taking a general approach.

2.1.3 Scenario thinking

Scenario thinking is a strategic tool to prepare for the future, and is in particular useful for an industry which is about to experience change (Miller and Waller, 2003), like the automobile

Industry. Originally scenario planning was developed and utilized by Royal/Dutch Shell in the 1960s and 1970s to prepare for future oil crises (Wack, 1985a; 1985b), but have over the years gained wide popularity as a future planning tool. There are many definitions and description by various academics of the scenario interpretation process (see Porter, 1985; Wack, 1985a; Schoemaker, 1995). Lindgren and Bandhold (2009) define scenarios as a way to handle uncertainties, while Schoemaker & Mavaddat (2000) define scenario planning as a framework “designed to address complex and highly volatile environments by revealing and organizing the underlying uncertainties (206)”. The latter authors especially emphasize the use of scenario planning relative to emerging technologies, which is highly relevant in this thesis as there are many industry uncertainties and possible impacts on the future internal rivalry. Since the emergence of the different fuel technologies cause uncertainty in decision making for the manufacturers, scenario thinking based on influencing factors in the business environment of the industry can be facilitated to envision plausible future(s).

In this thesis we will make use of the most dominant model for scenario building, as pioneered by Wack (1985a), Schoemaker and Mavaddat (2000) and Lindgren and Bandhold (2009) to pick out two key uncertainties that are considered together in a scenario cross. Four different scenarios will come out in the corners of the cross (Lindgren and Bandhold, 2009). We will utilize the PEST framework and expert interviews to identify the main forces shaping the future of the global automobile industry. The next step is to extract the key trends and key uncertainties out of the list of the main forces. Finally, we will take the two key uncertainties identified through the above steps and consider these together in a scenario cross, which creates four plausible futures in each corner.

2.2 Authors’ adaptation of the model:

The way we will apply the Five Forces model differs from what it is intended too. Instead of applying the model in its traditional way of combining the four competitive forces to influence the fifth force, the intensity of rivalry, we take departure in the “Substitution” force and show how this affects the internal rivalry, but also the other forces through the above mentioned scenario thinking process and what implications the consequential opportunities and challenges has for the illustration firms. According to Grundy (2006) there exist interdependencies internal to the five competitive forces. The most relevant in this context are
that buyers may actively search for substitutes, here emerging fuel technology vehicles and thus encourage new entrants to enter the industry. Moreover, the threat of substitution can possibly also affect the suppliers force by changing suppliers and can potentially create an entire new value chain.

### 2.2.1 Model of Analysis

The model of analysis covers two chapters; chapter 5 is about the “Substitution” force, while the impact through scenario thinking on the “Internal Rivalry” and other competitive forces constitutes chapter 6, as illustrated in the figure 2 below:

**Figure 2: Authors own adaptation of the Porters Five Forces model**

In chapter 5 the fuel technologies in emergence (1) will first be defined as substitutes in the model. Given their status as potential substitutes for the ICE technology, each technology is examined on two parameters to determine whether it has the propensity to become a significant threat to internal rivalry;
(2) Technical benefits: whether the different emerging propulsion and fuel technologies are readily available and attractively priced. The aim is to determine the technology(s) that are likely to be most competitive in the future.

(3) Consumer perceptions: whether potential buyers view the different emerging propulsion and fuel technologies as being comparable or better in terms of quality, performance and other relevant attributes and whether the switching costs associated are high. The aim is to identify a general global trend in demand and consumer acceptance.

The conclusion of the “Substitution” force in chapter 5 is used as input to chapter 6, where the impact on mainly “internal rivalry” (4), but also the other competitive forces surrounding the global automobile industry through the previously mentioned scenario interpretation process to give a look into a given plausible future is analyzed.

The timeframe and scope of scenario thinking is set to 2020 as the automobile industry is constantly in motion, and in our view much can happen until then. Finally, the opportunities and threats arising from the analysis of the most likely industry scenario in chapter 6 are used to showcase the strategic actions automobile companies have to take, to be prepared and react to the plausible future industry scenario. Since we presume that different automobile companies will have different reactions and strategy implementations, based on their resource capabilities, Toyota Motor Company and PSA Peugeot Citroën are used as examples to illustrate this. SWOT analysis will be used to evaluate the respective firms’ resource capabilities.

3. Research Methodology

The research procedure undertaken for the knowledge, data gathering and analysis of the global automobile industry with stress on emerging fuel and propulsion technologies will be illustrated here. The goal of this chapter is not to present a comprehensive and full report on the different methodological issues related to the topic under investigation. Instead the aim is to highlight some of the main issues related to the research methodology. In the following we will present how the research was conducted, the approach undertaken, the collection of data.
and how validity and credibility was secured. In the end the delimitations of the scope will be presented.

3.1 Research Strategy

The research strategy undertaken in this thesis is that of triangulation. According to Saunders et al, (2003; 2007) triangulation is a multi-path research approach which refers to the use of different data collection methods aiming to ensure plausible and valid data. The triangulation approach has in this thesis been applied through studying the problem area from several angles. By combining secondary data from a variety of plausible sources with primary data collected through qualitative interviews, triangulation has been accomplished to issue the subject from several perspectives.

Since the goal first and foremost of the thesis is to examine the rivalry strategy impact related to propulsion and fuel technologies in emergence within a global industry, the industry-based view of strategy coupled with scenario thinking as represented by the authors own version of Porters Five forces framework, is applied to back up the empirical data with theoretical foundation. Furthermore, other theories and framework from the field of strategic management are applied where needed.

Various consultancies have made research and focus reports on how they foresee the future of the automobile industry with regard to propulsion and/or fuel technologies in emergence, see (KPMG, 2010a, BCG, 2009, JD Power 2010b) for example. However, these reports have mainly been concentrated around driving force analysis and scenario planning and not in the field of industry and competitive environment surrounding the automobile manufacturers. For instance, research conducted by KPMG (2010a) on the environmental regulations effect on the transformation in the automotive industry assessed the impact on automobile manufacturers and auto suppliers’ strategies. Accordingly, the angle taken by the authors in this thesis represents a relatively fresh insight into an ongoing issue in the automobile industry. Since it is here assumed, that the technological shift is a relative new event, the research design has been of an explorative nature. Ankersborg and Bolsen (2009) say that the explorative design is used when the objective is to identify an unknown field, which has not previously been studied. That fits well with the problem area in hand.

Hence, the research strategy applied in this paper is of an explorative nature and rather flexible. The aim has been to provide a look into the future of the global automobile industry relative to the impact of emerging propulsion and fuel technologies on the rivalry strategy. This has been undertaken by interpretation of collected empirical data through interviews and by searching in literature and other secondary data.

3.2 Research approach

Since our area of interest are mainly in understanding why something is happening, refer to the first research question, and what impact that has to shape a possible future outlook, refer to the second research question, the research process has been of an exploratory nature and open-ended with no pre-determined outcome. Therefore the research approach can be described as inductive (Saunders et al, 2003), however as the Porters Five Forces framework coupled with scenario thinking have been pre-determined to be used in the paper, there are also elements of the deductive approach in the paper (Saunders et al, 2003).

The research process was commenced by conducting qualitative interviews to measure specific observations and to collect primary data. These primary data were held up against various sources of secondary data and the existing literature, to develop future industry scenarios and to finally draft and execute strategic options for selected global manufacturers and draw conclusions. This illustrates the open-ended approach applied in the research process.

3.3 Collection of Data and Evaluation of Sources

In order to attain a deep understanding and to provide a clear and concise answer to the research questions, a variety of sources from people, documents, institutions and events have been pursued.

3.3.1 Primary data: Qualitative Interviews

The primary data was gathered through qualitative interviews with representatives from both different automobile manufacturers and experts within alternative propulsion and fuel technologies in emergence. The means of qualitative interviews is actually a very common used primary data collection method in qualitative research (Saunders et al, 2007). Besides, there were also conducted one telephone and an e-mail interview. All of the interviews, as

presented in the following table were conducted in the period: January - August 2010. Each of the qualitative face-to-face interviews lasted around 1 hour, except the telephone interview which lasted 30 minutes. The last interview, which was an email interview were both sent and replied back in the same manner by the participant.

Table 1: Interviews Conducted

<table>
<thead>
<tr>
<th>INTERVIEWE D:</th>
<th>DATE</th>
<th>POSITION</th>
<th>EXPERTISE AREA</th>
<th>INSTITUTE / COMPANY</th>
<th>Interview conducted at</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morten Rask</td>
<td>23.02.2010</td>
<td>Associate Professor</td>
<td>Electric vehicles and the power grid of the future</td>
<td>Aarhus Business School</td>
<td>Aarhus Business School, Aarhus</td>
</tr>
<tr>
<td>Christian Erik Kampmann</td>
<td>17.03.2010</td>
<td>Associate Professor</td>
<td>Emerging Propulsion / Fuel Technologies</td>
<td>Copenhagen Business School</td>
<td>Kilen, Copenhagen Business School, Frederiksberg</td>
</tr>
<tr>
<td>Jens Andersen</td>
<td>29.01.2010</td>
<td>Environmental Manager</td>
<td>Representative for the Automobile Industry</td>
<td>Peugeot</td>
<td>Peugeot HQ, Glostrup, Greater Copenhagen</td>
</tr>
<tr>
<td></td>
<td>15.04.2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erik Morsing</td>
<td>20.04.2010</td>
<td>Communication Manager</td>
<td>Representative for the Automobile Industry</td>
<td>GM / Opel Denmark</td>
<td>GM HQ, Charlottenlund, Greater Copenhagen</td>
</tr>
<tr>
<td>Volker Eis</td>
<td>30.03.2010</td>
<td>Sustainability Manager</td>
<td>Representative for the Automobile Industry</td>
<td>Ford Europe HQ</td>
<td>Telephone Interview</td>
</tr>
<tr>
<td>Håkon Tveten Eriksen</td>
<td>04.08.2010</td>
<td>Marketing Director</td>
<td>Representative for the Automobile Industry</td>
<td>Toyota Norway</td>
<td>Email Interview</td>
</tr>
</tbody>
</table>

Taking into consideration that there might be biases in terms of subjectivity, in the information collected from the interviews with both representatives for automobile companies and experts, we have been evaluating the relevance of them to this project critically.

3.3.1.1 The Design of Qualitative Interviews

The interview design approach undertaken was that of semi-structured design (Saunders et al, 2003). The main reason for choosing semi-structured as the particular design was to create a dialogue on unanticipated subjects. As the aim was to gather knowledge and insight into the future of the automobile industry related to the emerging propulsion and fuel technologies, an open-ended discussion was essential. The approach chosen involves that the interviewer starts off with a set of interview questions, where it is possible to vary the order and ask new
questions in the context of the research situation (Saunders et al., 2003; 2007). This corresponds well with the explorative approach.

The authors acknowledge that because of our roles as outsiders, the willingness of the informants to reveal information of sensitive character might be limited. Since the interviewees have been experts in field of propulsion and fuel technologies in emergence or representatives from automobile companies, we acknowledge that the responses may be coloured by their respective backgrounds. The latter can weaken the integrity of the answers collected. For instance, a different sample of automobile companies and specialist researchers could have potentially given a totally different illustration of the future. Accordingly, to keep a critical stance when interpreting the primary data has been important.

3.3.2 Secondary data

The secondary data, as opposite to the primary data, were gathered through wide research into various external and internal sources in the area of global automobile industry, propulsion and fuel technologies in emergence, emerging technologies, strategic management, economics and future outlook. The vast amount of secondary data were in form of annual reports from automobile companies, industry reports and market statistics from renowned market research databases such as Frost & Sullivan, Datamonitor, Economist Intelligence Unit and J.D. Power; consultancy reports from well-known management consultancies such as BCG, Roland Berger, McKinsey & Co, KPMG, Strategy+Business and Deloitte amongst others; and from numerous publications, white papers and news from instances such as governments, agencies and media.

The book of Thompson, Strickland III and Gamble (2008) has been extensively used to provide the core theoretical foundation of Porters Five Forces in this paper. Other books, as well as a variety of academic articles from leading business journals and other publications within the field of strategy, scenario thinking, competition and industry analysis, economics, the future of the automobile industry and emerging technologies are also referenced in this thesis.

The secondary data was initially collected to supplement the primary data. However, as the primary data did not provide with enough insights, the secondary data is used all through the paper. The authors recognize that the collection of secondary data might have a different
intended use than what it is used for in this project. That can potentially give a biased picture of reality (Saunders et al., 2003). To avoid the latter, we have considered both the quality and reliability of the secondary sources used. That was mainly done by cross checking references.

We also conducted backward- and forward citation search in academic journal articles, consultancy reports, various market research reports and databases in order to get comprehensive insight in the area of study and also to recognize other relevant sources.

### 3.4 Securing validity and reliability of Primary Data

The goal with the semi-structured interviews was to generate qualitative data in order to understand the interviewees’ perceptions and opinions about the future outlook of the automobile industry with regard to propulsion and fuel technologies in emergence. In order to get hold of valid empirical data the asking techniques were designed in a descriptive manner. Furthermore, to get valuable insights, the interview questions were made explorative to create a dialogue. The authors acknowledge that in such exploratory interviews there are always a risk of asking leading question as well as a risk of interpreting the answers in a different way than intended (Saunders et al., 2003). The interviewees were therefore asked a number of similar questions and all were tape recorded or documented to minimize the risk of subjective biases.

In all of the face-to-face interviews, there was only one person from the company or institution present. The number of persons in the other two interviews is unknown due to their nature. The nature of face-to-face interviews can for instance, indicate risk of subjectivity related to the responses and perceptions of the interviewees’, which can possibly differ from the views of the company or institution. On the opposite, however, this type of setting can also make the interview object more frank and open. Since, all the people interviewed are in possession of management or higher positions in their respective fields, our conclusion is that their answers represents the company’ or expertise view and secures high validity. Lastly, to ensure that no critical data was lost during the interviews or that the answers cannot be interpreted wrongly, all of the interviews were tape recorded (Saunders, et al. 2003; 2007).
3.5 Scope and delimitations

It is necessary to make clear limitations to our study. Since the purpose of this thesis is to provide the automobile industry and other interested parties with useful insights on how to strategize given the future industry scenario outlook the language is set so the paper can be read by many stakeholders. We are of that opinion that there is an extensive need for this type of research and knowledge sharing among these groups. It is of utmost importance for the industry players to understand how crucial a shift, the emerging technologies are creating, and also get an understanding of how to strategize; otherwise they can lose market shares which can affect their competitiveness, future possibilities and position in the market place.

Since the paper can be read by many stakeholders, it is important to clarify that we will take an industry perspective in the paper. In addition, through the rest of the paper the words; auto, car and automobile will be interchangeably used; the same will also go for the automobile industry and the car industry. The focus will be on the private consumers only. Furthermore we will only focus on the passenger vehicle segment and not the automotive segment, which also covers heavy vehicles like trucks and buses. Due to the scope of this thesis, we refer the global automobile manufacturers as the producers of both passenger cars and light commercial vehicles. We acknowledge that due to the complex geographical nature and local preferences it is not viable to cover all the worlds’ automobile markets. However, as the purpose is to derive a general trend rather than digging deep into one particular market, we will make use of the Triad markets; the US, Japan and Europe, and the emerging market of China if necessary to generalize. Furthermore we will not focus on specific product and market segments to ensure a general picture.

In regards to engine technologies the authors have disregarded the conventional petroleum fuels such as, gasoline and diesel, and will neither focus on the ongoing improvement of these technologies. However, the authors acknowledge that it was not possible to gather data on all of the different emerging propulsion and fuel technologies. Consumer perceptions are also touched upon, we have not conducted questionnaires, instead the data we have gathered are from secondary sources, but to ensure a global trend we will refer to both studies which are global, and surveys conducted on private consumers in Europe and the US. This also ensures that similarities and differences are identified. We have been very careful on drawing
conclusion from this material, as these studies are made under different assumption, research methods and strategies.

Lastly, the authors acknowledge that we did not cover everything, as the ongoing technological change in the global automobile industry implies that there is constant motion, which means that new information may have appeared after our data collection ended. All information gathering for the analysis was conducted until early 2011. During the data collection the scope was kept intentionally broad. An effort is made to make high validity to the paper to the optimum capability.

4. Present Situation of the Global Automobile Industry

In order to give an overview of the present situation, we will first give a brief overview of the global automobile industry with an emphasis on emerging fuel technologies. Further, there will be conducted a PEST analysis of the business environment of the automobile industry relative to the technological shift to identify the key trends and uncertainties pushing through the change. Finally, the outcome of the analysis will set the stage for the forthcoming analysis. Political and technological factors are more emphasized than other factors.

In the following there are given a short current snap of the global automobile industry.

4.1 Major Global Automobile Manufacturers

Once the industry was dominated by regional American and European manufacturers, but the rise of first Japanese, then Korean and now also Chinese and Indian producers have increasingly globalized the scope of rivalry. In 2009, a total of 48 automobile manufacturer groups or alliances stood for the production of 60,499,159 vehicles of which 58,899,300 were automobiles\(^1\) (OICA Production Statistics, 2009). As seen in the following table, ten global automobile manufacturer groups or alliances located mainly in Japan, the US and the EU accounted for more than 3/4 of the total production. Total market share of these ten large companies counted 76 percent, while the remaining 24 percent was dispersed on the 38 residual manufacturers.

\(^1\) Authors own estimation based on OICA production statistics, 2009

Table 2: Global Market Share 2009

<table>
<thead>
<tr>
<th>Position</th>
<th>Manufacturer Group / Alliance</th>
<th>2009 Global Production*2</th>
<th>Global Market Share 2009</th>
<th>HQ Location (Origin)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Toyota</td>
<td>7,234,439</td>
<td>12,0 %</td>
<td>Japan</td>
</tr>
<tr>
<td>2.</td>
<td>General Motors</td>
<td>6,459,053</td>
<td>10,7 %</td>
<td>United States</td>
</tr>
<tr>
<td>3.</td>
<td>Volkswagen</td>
<td>6,067,208</td>
<td>10,0 %</td>
<td>European Union</td>
</tr>
<tr>
<td>4.</td>
<td>Nissan – Renault Alliance</td>
<td>5,040,571</td>
<td>8,3 %</td>
<td>Japan / European Union</td>
</tr>
<tr>
<td>5.</td>
<td>Ford</td>
<td>4,685,394</td>
<td>7,7 %</td>
<td>United States</td>
</tr>
<tr>
<td>6.</td>
<td>Hyundai-KIA</td>
<td>4,645,776</td>
<td>7,7 %</td>
<td>South Korea</td>
</tr>
<tr>
<td>7.</td>
<td>Fiat – Chrysler Alliance</td>
<td>3,419,292</td>
<td>5,7 %</td>
<td>European Union</td>
</tr>
<tr>
<td>8.</td>
<td>PSA</td>
<td>3,042,311</td>
<td>5,0 %</td>
<td>European Union</td>
</tr>
<tr>
<td>9.</td>
<td>Honda</td>
<td>3,012,637</td>
<td>5,0 %</td>
<td>Japan</td>
</tr>
<tr>
<td>10.</td>
<td>Suzuki</td>
<td>2,387,536</td>
<td>3,9 %</td>
<td>Japan</td>
</tr>
<tr>
<td></td>
<td>38 Other manufacturers</td>
<td>14,504,941</td>
<td>24,0 %</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Production</td>
<td>60,499,159</td>
<td>100,0%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors own compilation of OICA Production Statistics 2009

Japanese company, Toyota, with a market share of 12 percent was the largest automobile manufacturer in 2009 with a global production of 7,234,439 vehicles alone. In comparison, the 38 remaining manufacturers, included the likes of Daimler AG, B.M.W and Tata Motors, together produced only 14,504,941 vehicles (Ibid.). Therefore, the global production is concentrated among and dominated by the ten largest rivals, which are also the principal players in the industry.

Due to the global scope of competition, it is essential for the incumbent manufacturers to have a global presence to stay at least level-head with the rivalry. Presently, all of the ten major global manufacturers are competing in each other’s markets mainly through exports, divisions, wholly owned subsidiaries, joint ventures, and other alliances. Moreover, to cover the various demand and consumer preferences across the different geographical regions in the world, all of the ten major manufacturers offer vehicles within all product segments for all types of customers in the major markets (Culpan, 2002). The products are mainly differentiated and segmented on size and price classes and include the whole range from small city cars to luxury cars and SUVs with all sorts of different features targeting specific customer groups (Oliver Wyman, 2010; Frost & Sullivan, 2010c). On the opposite, a diminutive number of small scale manufacturers, such as Japanese companies; Subaru and

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2 Included heavy buses and Heavy Commercial Vehicles (HCV)

Isuzu are only focusing on niches, 4WD\(^3\) and commercial vehicles\(^4\) respectively. The chase for market shares has made volume manufacturers also introduce niche models to move into product segments, which they previously did not serve and vice versa reports Frost & Sullivan (2010c).

4.2 Market Performance: Size (Revenues) and Growth Rate

Research conducted by Datamonitor (2010) reports that the global automobile industry\(^5\) generated some $1,469.3 billion in turnover in 2009. In comparison, the same study suggests that the revenues were $1,553.4 and $1,561.1 billion in 2008 and 2007 respectively. Given that 2007 was a peak year\(^6\), the market size declined with almost 5.9 percent in 2009. Comparatively speaking, the average annual turnover is equivalent to the sixth largest economy in the world\(^7\), which in a perspective shows the importance of the automobile industry to the world economy. Furthermore, more than 8 million people are directly employed by the sector\(^8\). In major car producing nations like Germany and the US, 1 out of 7 and 1 out of 10 jobs correspondingly are related to the industry (Schmid & Grosche, 2008), illustrating the magnitude.

In 2010, automobile sales amounted to only 61.4 million\(^9\) units globally, in comparison to 70 million units in 2007\(^10\). The poor sales numbers, in our view, are an effect of the 2008-2009 economic crises. The likes of Toyota, General Motors and Ford, all lost revenues due to the declining sales, as most of the major automobile markets performed poorly throughout the economic crisis period\(^11\) (Frost & Sullivan, 2009a; 2009b). Especially the established markets of Japan, the US and Western Europe which were hit strongly, had high negative growth rates in sales during the crisis period (Frost & Sullivan, 2009a). On the opposite, despite the financial recession, the emerging markets of China and India continued to show positive sales-growth with 12.1 percent and 2.1 percent in 2008 and 3.6 percent and 11 percent in 2009, respectively (Ibid.). Even though the negative growth in the established markets,

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\(^3\) Subara-Global.com, 2011  
\(^4\) Isuzu.com, 2011  
\(^5\) Datamonitor includes automobiles, light commercial vehicles and motorcycles in their definition of the global automobile industry  
\(^6\) Authors own estimates based on Datamonitor (2010) data  
\(^7\) Oica.net, 2011  
\(^8\) Ibid.  
\(^9\) Cens.com, 2010; Aftenposten.no, 2011  
\(^10\) Ilo.org, 2009  
\(^11\) Here: 2008-2009
(Datamonitor (2010) reports a CAGR\textsuperscript{12} level of 0.8 percent for the whole automobile industry in the period 2005–09, largely due to adequate growth in 2006 and 2007, of respectively 5.7 percent and 3.7 percent.

The future outlook, on the other hand seems brighter. J.D. Power Global Automotive Forecasting Services\textsuperscript{13} estimates that the global automobile sales for 2011 will end with 75.4 million\textsuperscript{14} units sold. Frost & Sullivan also foresees positive future growth in global automobile sales. It estimates that the global sales level will exceed 86 million units sold by 2015 with a CAGR on 3.7 percent in the period 2008-2015 (Frost & Sullivan, 2009b). Although, those different research agencies differ on their estimates, the general future outlook illustrates positive growth prospects with an increase in global sales.

### 4.3 Market Trend: Stagnation in mature markets...Rapid growth in emerging markets

Historically the established markets of US, Japan and Western Europe have had the largest sales numbers. With years these, in particular the US and Western Europe have become mature and also saturated to some extent due to strong sales in the previous decade, fuelled by discounts (Haugh et al, 2010). Market growth is slow, and the notion of competition is fierce to gain or prevent losses in market share. Above all, the US market has declined rapidly since 2000, when it accounted for 37 percent of the global demand, with a huge fall to merely 22 percent in 2009 (Hill, 2011). Moreover, global overcapacity in production of 25 – 30 percent is a major challenge, especially in the mature North American and Western European markets (Dicken, 2007), pressuring manufacturers to cut costs. The economic crisis worsened that (Haugh et al, 2010), and not to lose competitiveness, several major manufacturers have either been halting the production or closing plants, according to Frost & Sullivan (2009b). This global excess capacity conditions are expected to continue in the future at an average of 21 million units per year during the 2010-2014 period (Ford Annual Report, 2009). Imbalance in the supply and demand conditions is hence evident in the industry, and is diminishing

\textsuperscript{12} Compounded Annual Growth Rate
\textsuperscript{13} Is a division of J.D. Power and Associates, an internationally renowned leader in consumer opinion research and a business unit of McGraw-Hill Companies
\textsuperscript{14} Bloomberg, 2010b
manufacturers’ pricing power considerably and pushing profit margins down adding to the already intensified rivalry for market shares.

The volume decline in the traditional markets is outshone by the opposite rapid development and rising economical growth in emerging economies such as China and India, which together account for approx 1/3 of the total world population of 6.9 billion\(^\text{15}\). The consumers in these countries are becoming wealthier due to higher personal income while there is still a fairly low level of car ownerships. That has boosted the automobile demand in those markets. Since 2009, when China surpassed the US, with its 13.6 million units sold\(^\text{16}\), it has been the world’s largest automobile market. The US market came second with 10.4 million sales\(^\text{17}\). In 2010, China cemented its position as the world’s largest automobile market, with a record 18.06\(^\text{18}\) million units sold, which is a growth of 32.37 percent compared to 2009 numbers\(^\text{19}\).

Furthermore, Frost & Sullivan (2009b) have made estimates that 30 percent of all automobile sales in the future will be generated in the BRIC countries. This view is also substantiated by JD Power in Hill (2011) who expects that total demand in BRIC will by 2018 outstrip the demand in the developed countries. While, the Asian region including China and India, alone is expected to have a CAGR of 8.9 percent in 2008 – 2015 (Frost & Sullivan, 2009b). This growing demand in the coming years stemming from the emerging markets renders an opportunity for automobile companies to increase their revenues and market shares by shifting their presence to these regions.

4.4 Specific Characteristics of the Global Automobile Industry

In this section there will be given an overview of some specific features of the global automobile industry which are deemed to be important in the forthcoming analysis.

4.4.1 Economies of Scales in Manufacturing

The production of automobiles is a very capital intensive process, which requires large investments in plants and equipment (Culpan, 2002). Accordingly, to gain a sustainable

\(^{15}\) http://www.worldometers.info/population/

\(^{16}\) Bloomberg, 2010a

\(^{17}\) Reuters.com, 2010a

\(^{18}\) Caam.org.cn, 2011

\(^{19}\) RTE.ie, 2011
production, manufacturers have to achieve scale economies to bring down the costs. This implicates high production volumes to recapture the investments outlay. A global manufacturer needs to produce a minimum of 4 million units to achieve global scale economies in manufacturing (ILO, 2010). Few manufacturers today are able to realize such high volume production themselves, which has spurred mergers and acquisitions among rivals in order to gain scale economies (Haugh et al, 2010). Consequently, consolidation among incumbent manufacturers has been increasing lately. According to Husan (1997), the larger the manufacturer, the greater aptitude and prospect it has to achieve scale and other economies. In the automobile industry it is evident that a large scale manufacturer such as VW Group has a significant average unit cost savings advantage over a smaller scale firm such as Tata Motors due to greater degree of scale economies. Although, findings by Liker and Morgan (2006), on the other hand, suggest that the rise of lean production methods along side innovations in technology, on the contrary, have diminished some of the effects of scale economies, but arisen other important economies, such as economies in R&D and scope economies. The latter economies typically stem from knowledge transfer across dissimilar but related product lines in the industry (Husan, 1997).

Presently, the tremendous capital requirements and achievement of significant scale economies in production, as well as other economies makes it very difficult for small scale manufacturers and potential entrants to compete with the major established players.

### 4.4.2 Learning/ Experience Curve Effects

Husan (1997) propose that learning curve effects exist in all levels of output in the automobile industry. These experience curve effects are most notable in time of bringing a new product to the market and in manufacturing knowledge in the industry (Culpan, 2002). For the incumbent manufacturers it means that the more experienced and knowledgeable they are the better competitive edge they have over rivals. Experience curves also play a major role in lowering unit costs, and improve quality and efficiencies for the incumbent manufacturers (Culpan, 2002). For instance, Japanese manufacturers have for the past three decades had a

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20 "lean" principles including a focus on the customer, continual improvement and quality through waste reduction, and tightly integrated upstream and downstream processes as part of a lean value chain: delivering high quality at low cost
sustainable competitive advantage over its European and American counterparts, due to the development of lean manufacturing techniques, resulting from years with continual improvement experience. The Toyota Production System, in particular, has been a role model for automobile manufacturers (Liker and Morgan, 2006), and proven to be a distinct core competency advantage for Toyota as it has helped to reduce costs significantly (Teresko, 2007). Today, it is almost a precondition that an automobile manufacturer needs some sort of “lean” initiative to stay in the industry as the lean production model has gradually displaced the traditional mass production (Liker and Morgan, 2006).

Vietnamese manufacturers are also leaders in the development of products and new models (Teresko, 2007), and manage more new vehicle launches than most of the American and European competitors (Honda Annual Report, 2010; Culpan, 2002; Liker and Morgan, 2006). Toyota through its product development scheme, TPDS, based on the same lean values as TPS, can regularly develop higher quality automobile faster than the rivals at lower unit costs and higher profits (Liker and Morgan, 2006). Chinese and Indian manufacturers, on the other hand, are not so experienced and lack in particular strong technological know-how and manufacturing knowledge (Hill, 2011).

4.4.3 Vertical Integration

Vertical integration in the automobile industry is found on various levels, the most important being towards the supplier industries and the dealerships.

4.4.3.1 Supplier Industries

As mentioned in the introduction of chapter 1, the manufacturers are mainly assemblers who bring together a vast number of components to make the final product. In fact, automobiles are complex machines consisting of more than 3,000 moving parts made of raw materials such as rubber, glass and steel (OICA, 2009; Dicken, 2007). These parts and components are usually made by the automotive supplier industries, which consisted of merely 4,500 suppliers.

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21 The focus of TPS is on reduction of lead time which then has benefits in cost, quality, and delivery

22 Toyota’s Product Development System

globally in 2008 compared to 16,500 in 2002 (KPMG, 2009b; Culpan, 2002), indicating that consolidation among suppliers have increased over the years as there are fewer suppliers than earlier, but also that suppliers have lost business as manufactures may have abandoned them.

The global automobile manufacturers are largely dependent on their suppliers for a larger part of their business as a large share of the manufacturing process, approx 75 percent\textsuperscript{23}, is outsourced globally to the automotive suppliers industries. Only the core capability in form of the ICE powertrain\textsuperscript{24}, are traditionally developed and produced in-house by the manufacturers themselves (AT Kearney, 2009). This connotes that the automobile manufacturers are only slightly backward vertically integrated.

It is common that manufacturers collaborate with various international independent component suppliers (Dicken, 2007), and form buyer-supplier partnerships or strategic alliances on a global scale (Haugh et al, 2010). Suppliers are typically rewarded long-term contracts, as they also incur most of the R&D and program costs (Culpan, 2002), which also means that more and more responsibility is passed on to them of the automobile manufacturing process. According to Dicken (2007) these suppliers account for between 50 - 70 percent of the cost price of the average car.

Suppliers to the automobile industry are typically from different industries and come from several tiers. The 1st (top) tier suppliers supply non-standard, differentiated key component systems such as electric systems, steering wheels, and car seats direct to the manufacturers and possesses significant R&D and design expertise (Gaughan, 2007; Dicken, 2007; Peng, 2009). Second tier suppliers generally produce to design provided by the manufacturers or by the top tier suppliers, while third tier suppliers consists of suppliers who make the standard and undifferentiated basic components like commodity products such as belt buckles, cup holders, or simply nuts and bolts (Dicken, 2007; Peng, 2009). Top tier suppliers are the most important for the automobile manufacturers, and possess more bargaining power than bottom tier suppliers. Companies such as Denso, Robert Bosch, Magna, Continental and Delphi are among the largest independent automotive suppliers (Frost & Sullivan, 2009c). Other suppliers are subsidiaries of large conglomerates or other diversified companies such as Honeywell and Harman.

\textsuperscript{23} Clepa.be, 2011
\textsuperscript{24} ICE and Transmission
 Manufacturers have extensive bargaining power towards suppliers with low switching costs, mainly due to the many players in the industry which gives them the opportunity to play them against each other. The automobile industry is generally able to dictate their terms to their suppliers, due to that many suppliers rely on a small number of manufacturers to buy majority of their products. This frequently leads to price concessions and quality improvements by paying off suppliers against each other. Hence, automobile manufacturers can control the price. As a result; suppliers are extremely susceptible to the demands and requirements of the automobile manufacturer and hold very little power.
4.4.3.2 Dealerships and distribution channels

The majority of the manufacturers are, on the other hand, highly forward vertically integrated. Some have their own part manufacturing subsidiaries, distribution channels, and most have their own financial services divisions to provide consumer loans (Culpan, 2002). Most of the major manufacturers also operate their own sales subsidiaries or have local dealerships in foreign markets. Accordingly, automobile manufacturers typically exert considerable power over the terms and conditions with which they supply new vehicles to their independent automobile dealerships, meaning that there is further forward vertical integration here.

Concluding wise it can be said that vertical integration is primarily pursued by the manufacturers to have better control of costs and also to have influencing power over supply and distribution channels. For instance, lowered transaction costs are one of the possible cost advantages of being vertically integrated, while the many vertically integrated alliances acts also as barriers to potential entrants.

4.4.4 Long lead times

Interviews conducted with representatives from the automobile sector revealed that the industry is characterized by long lead times (Morsing Interview, 2010; Andersen Interview I, 2010). Lobby organizations such as the European Automobile Manufacturers Association (ACEA) affirm that the development and production phase of automobiles can take up to as much as 12 years\(^{25}\), of which 5 to 7 years are the typical production cycle and the rest comprises the development period. This means that an entirely new car model undergoes years of development and testing before reaching the market. The extensive lead time demand that the vehicles which are expected to be market launched in the period 2018 - 2020 are already under the development phase.

\(^{25}\) Acea.be, 2010
4.5 Summary

The rivalry for market shares within the increasingly globalized automobile industry is fiercer than ever before. Manufacturers are reacting to the increasing pressures, such as cost cutting due to overcapacity, and many have moved into markets or products which they previously did not serve. Established markets have reached maturity and are experiencing an increasing level of saturation; while the immense growth prospects in the rising emerging markets render several opportunities.

Nevertheless, the industry is still characterized by being capital intensive meaning that achievement of economies of scale in production is substantial to compete. The presence of learning curve effects are equally important and can be found in all levels of outputs of the industry, with manufacturers in possession of those hold a competitive edge. The many vertically integrated alliances are primarily pursued to achieve cost reductions, but also valuable experience and know-how. All these features also act as entry barriers. Lastly, the long lead times, continue to be a challenge for the industry.

4.6 Technological Shift within the Global Automobile Industry

The automobile sector has for the past 15 years made large scale R&D investments in innovative technologies to lower CO₂ emissions from their vehicles.²⁶ Annually, close to 85 billion Euros²⁷ in R&D are spent to develop future technologies. Current R&D investments are within the development of next-generations alternative propulsion technologies and alternative fuel vehicles²⁸, both in incremental technologies like CNG and hybrid technology, as well as more radical innovation and potentially disruptive technologies such as hydrogen fuel cell and electric vehicles (Zapata and Nieuwenhuis, 2010). The primary impetus is to avoid being penalised by the strict environmental regulations (See PEST), but also to achieve potential first-mover advantages. Using the terminology of Porters generic strategies in Thompson, Strickland III and Gamble (2008), we have found that the majority of volume automobile manufacturers are pursuing a broad differentiation strategy which undertakes a broad cross section of the market with multiple product variations and differentiation features.

²⁶ Oica.net, 2008
²⁷ Oica.net, 2007
²⁸ Ibid.

Today, however it is becoming increasingly difficult for auto makers to differentiate their products from the competitors (Tay, 2003), apart from smaller innovations in design and style (ILO, 2010). Here the technological shift is the major differentiating opportunity for the manufacturers and hence a competitive advantage.

4.6.1 Multi-approach Strategies

Depending on the overall business strategy and stage of development, different automobile companies are currently prioritizing different alternative propulsion and fuel technologies for commercialization. Some companies are pursuing the whole technology portfolio, while others are only following parts of it. These alternative vehicles are currently introduced in a few selected product segments only. The following table shows the current efforts within the automobile industry, and which manufacturers have a temporary advantage on which propulsion or fuel technology in emergence.

Table 3: Automobile Manufacturers strategies

<table>
<thead>
<tr>
<th>Natural gas</th>
<th>Hybrid</th>
<th>Plug-in hybrid</th>
<th>Battery Electric</th>
<th>Hydrogen Fuel Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Automobile Manufacturers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VW</td>
<td>Toyota</td>
<td>BYD Auto</td>
<td>Nissan-Renault</td>
<td>Daimler</td>
</tr>
<tr>
<td>GM</td>
<td>Honda</td>
<td>Toyota</td>
<td>BYD Auto</td>
<td>GM</td>
</tr>
<tr>
<td>Fiat</td>
<td>Ford</td>
<td>GM</td>
<td>Mitsubishi / PSA Peugeot Citroën</td>
<td>Honda</td>
</tr>
<tr>
<td>Daimler</td>
<td></td>
<td>Fisker</td>
<td>Tesla</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volvo</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toyota</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>BYD Auto</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toyota</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vehicles available (select)

<table>
<thead>
<tr>
<th>Natural gas</th>
<th>Hybrid</th>
<th>Plug-in hybrid</th>
<th>Battery Electric</th>
<th>Hydrogen Fuel Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>VW Touran</td>
<td>Toyota PRIUS</td>
<td>BYD F3DM (?) – segment</td>
<td>Nissan LEAF (C-Segment)</td>
<td>Daimler</td>
</tr>
<tr>
<td>Opel Zafira</td>
<td>Honda Insight</td>
<td>Toyota PRIUS PHEV (D-segment)</td>
<td>BYD e6 (C-D segment)</td>
<td>GM</td>
</tr>
<tr>
<td>Fiat Panda</td>
<td>Chevrolet Tahoe</td>
<td>Chevrolet Volt (D-segment)</td>
<td>Mitsubishi iMiEV / Citroën C-Zero / Peugeot iOn (A-segment)</td>
<td>None</td>
</tr>
<tr>
<td>Ford C-Max</td>
<td>Lexus RX 400h</td>
<td>Fisker Karma (Premium Sports segment)</td>
<td>Tesla Roadster (Sports segment)</td>
<td></td>
</tr>
<tr>
<td>Mercedes B-Class</td>
<td>Ford Mariner</td>
<td>Volvo V70 (E-segment)</td>
<td>Smart Fortwo ED (A-segment)</td>
<td></td>
</tr>
</tbody>
</table>

Broad market availability (year)

<table>
<thead>
<tr>
<th>Natural gas</th>
<th>Hybrid</th>
<th>Plug-in hybrid</th>
<th>Battery Electric</th>
<th>Hydrogen Fuel Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>2010 to 2014</td>
<td>2012 to 2020*</td>
<td>2015 to 2020</td>
<td>Not foreseeable</td>
</tr>
</tbody>
</table>

Sources: A.T. Kearney 2009; CS, 2008; KPMG, 2010a and Belzkowski and McManus, 2010

As seen from the table 3, European manufacturers VW, Daimler, Fiat and American manufactures Ford and GM are forerunners in natural gas options, while Japanese Toyota and Honda are the leaders in hybrid technology solutions with Prius and Insight, respectively. New players from other industries like the former Chinese lithium-ion battery maker “Build Your Dream” (BYD), which launched the world’s first mass-produced PHEV in 200829, and start-up electric vehicle makers like American Tesla Motors and Fisker Automotive are among the top new manufacturers in plug-in hybrid and electric vehicles. Among established players, Nissan-Renault and GM have both launched mass-marketed electric vehicles in the time of writing, while the collaboration30 between Mitsubishi and PSA Peugeot Citroën have resulted in the iMiEV and the corresponding models C-Zero and Peugeot iOn, which are expected to begin selling to the general public in 2011. These vehicles are however limited to

29 BYD.com, 2010
30 AutomotiveWorld.com, 2010

a few test markets in the beginning with a limited number being produced and does not appeal to all consumers as they are marketed in specific product segments only, as the above table illustrates. Other companies like Daimler and VW have chosen to introduce different types of alternative vehicles for different means of use. Like electric vehicle for city use, hybrid for middle distances and a clean diesel for longer distance (E-trends, 2009). These efforts show that established automakers are strategizing their options into a few product segments only, and not all over their product portfolio.

Interviews and various reports suggest that there is a clear affection towards the various electrification technologies, both hybrid and pure electric versions (KPMG, 2011; Eis Interview, 2010; JD Power, 2010b). Most of the major global automobile manufacturers have announced plans for the introduction of electric vehicles in the near future. Also, several start-up companies have announced their intentions to bring electric vehicles to the market in the next 12 to 18 months (Deloitte, 2010b).

4.6.1.1 Strategic alliances and Technology Sharing Collaborations

An increasing numbers of joint ventures and international strategic alliances to develop emerging propulsion or fuel technologies and gain access to specialized technological know-how and pool of resources have been evident in the automobile industry lately (KPMG, 2010a).

Not to be on a disadvantage, aware of the threats posed by the highly competitive environment due to the ongoing technological shift, even leading manufacturers are continuously innovating and making alliances and collaborations with rivals to remain competitive, as well as to minimize risk and control costs. Regardless of the manufacturers scale and status, there is no safe haven in the industry, which entails that there exist opportunities to overtake key rivals by being first-to-market with new technology and next generation products. The latter can be seen as a key inspiration for automobile manufacturers to gain market shares. For example, the joint venture (JV) agreement between Toyota Motor Corporation and Tesla Motors will enable Toyota to use their lean production techniques with the core capability of Tesla in electric drive trains to develop electric cars for the mass-

Deloitte (2009) propose that mergers and acquisition like the former are going to increase in the future. Other non-traditional collaborations such as the proposed Electric Vehicle project by the Renault-Nissan alliance, French utility EDF and Better Place signed in 2008 is also on rise. This type of collaboration is mainly to provide the necessary conditions for the commercialization of electric vehicles. A similar JV agreement between Volvo Cars and energy power provider Vattenfall was signed in 2007 for the development of plug-in hybrid technology to market launch in Europe in 2012. There are also an increasing numbers of manufacturer-supplier alliances apparent in the global automotive sector. Renault-Nissan alliance, for example, has a partnership with battery provider NEC, while Toyota has a JV with another battery manufacturer Panasonic (CS, 2008). Likewise, GM is collaborating with Hitachi (KPMG, 2010a) among others. Therefore, consolidation and collaboration is well in progress in the global automobile industry where rivals are engaged in strategic alliances and other collaborations to stay ahead of the competition.

4.7 PEST Categorization of the Business Environment

In the following there will be conducted a macro-level PEST categorization to give an overview of the major political, economical, sociological and technological factors pushing through the technological shift within the automobile industry. The PEST analysis is a framework which is useful for analyzing the forces affecting the business and markets environment on a macro-level of a given industry. Here, the analysis is used to categorize the most important macro environmental forces to firstly give an overview of the present situation, and secondly to outline key trends and uncertainties which can shape the possible future directions of industry evolution. The usage of PEST model to gather the most important forces will provide a broad view of forces and their sources shaping the future global automobile industry scenarios.

31 Teslamotors.com, 2010
32 BetterPlace.com, 2010
33 Vattenfall.com, 2010
34 global automobile and suppliers industries
4.7.1 Political Conditions

Political or more importantly regulatory actions are critical determinants for the future of the global automobile industry. The political and regulatory environment is constantly in motion. In an attempt to push the automobile industry, which contributes largely to the 16 percent of the world’s CO₂ emissions stemming from the road transport sector, towards developing cleaner vehicles, governments across the world have reacted with imposing stringent environmental regulations on the industry, which is following next.

4.7.1.1 Environmental Regulations

Although, there exist a global consensus for environment emission control, the Kyoto Protocol, which is an addition to the UNFCCC. The protocol, however does not give any specific direction to governments for specific regulations of CO₂ and other emissions from the automobile sector, except reducing the countries overall GHG levels. It is up to every nation to find own solutions. None of the two largest automobile markets in the world have pledged to obey the Kyoto Protocol either. China is not obliged to reduce its GHG levels due to its status as a developing nation, while the US has chosen to not ratify the agreement (JD Power, 2010b). Although, governments of the world’s largest auto producing nations like the US and the EU have targets in place for improving fuel economy and reduce tailpipe emissions; there is little agreement about the timing or manner in which these objectives are to be achieved. Prior lessons from the state of California in the US reveal that the governing bodies can have a major effect on the technological development in an industry through regulatory frameworks (Dyerson and Pilkington, 2005). Accordingly, as there is currently no global regulatory framework for emissions control within the automobile sector, the vast nature of geopolitical forces, priorities, access to resources and local market preferences means that the environmental regulations and governmental policies vary throughout the regions.

The most forceful environmental regulations at present for the regional automobile sectors are to be found in the European Union (EU) through the European Commission’s specific CO₂ targets for the European automobile industry (SEE APPENDIX 1), which must be compiled by 2012 throughout the EU countries. The automobile manufacturers’ fleets average carbon emission must be below 130 g/km, while in 2020 the fleet average cannot exceed 95 g/km.

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35 Oica.net, 2008
36 United Nations Framework Convention on Climate Change (UNFCCC) treaty of 1992

CO$_2^{37}$ With the directive the EU is forcing automobile manufacturers to focus on minimizing the cars’ CO$_2$ footprint and produce more environmentally friendly cars like hybrids and electric vehicles, and other fuel efficient cars. The stringent rulings will not only affect European car manufacturers, but every manufacturer considering selling their vehicles in Europe. Those who fail to meet these will be financially penalized (SEE APPENDIX 1). The US government also follows, primarily motivated by concerns regarding security of oil supply, with strict fuel economy standards in the CAFÉ$^{38}$ applying for manufacturers selling cars in the US. A new and stricter CAFÉ standard that require the miles per gallon of a manufacturers total fleet to not exceed an average of around 35 mpg, corresponding to a CO$_2$ quota of 250 g/mile is to be complied by model year 2016, starting from model year 2012$^{39}$, to help reduce pollutant emissions (KPMG, 2010a). Manufacturers operating in Japan currently abide to strict vehicle inspection controls and strict carbon emissions reducing standards (KPMG, 2010a; JD Power, 2010b), while China, on the other hand, follow their own adaptation of the EU emission regulations (JD Power, 2010b). Albeit uncoordinated solutions, the common denominator is that these various regulations and policies are pushing the automobile manufacturers to a technological shift, and will continue to play a major role in moulding the future automobile industry.

4.7.2 Economic Conditions

Economical and business factors are substantial for the automobile sector as they can directly affect the firm’s revenues and operations.

<table>
<thead>
<tr>
<th></th>
<th>2009 (Actual)</th>
<th>2015 (Projected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>US</td>
<td>-2.6%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Japan</td>
<td>-5.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Euro area (incl. Germany)</td>
<td>-4.1%</td>
<td>1.7%</td>
</tr>
<tr>
<td>China</td>
<td>9.1%</td>
<td>9.5%</td>
</tr>
<tr>
<td>India</td>
<td>5.7%</td>
<td>8.1%</td>
</tr>
</tbody>
</table>

*Source: IMF, 2010; WEF, 2010*

$^{37}$ EC.Europa.eu, 2010b

$^{38}$ KPMG (2010a) : CAFÉ stands for “the sales-weighted average fuel economy in miles per gallon (mpg) of an OEM’s fleet of passenger cars or light trucks with a gross vehicle weight rating of 8,500 lbs or less” (p. 1).

$^{39}$ Greenblog.com, 2010

As seen from the above table, the emerging markets of China and India are experiencing rapid economic growth, which is projected to continue into the future. China, which is already the world’s largest automobile market, will have on average, a yearly growth in Real GDP of approx 9 percent until 2015, while India will experience rapid growth from 5.7 percent growth in Real GDP in 2009, to projected 8.1 percent growth in 2015. These numbers indicate the vast growth opportunities in those countries, which also designate that as more and more persons experience growth in their income, the demand for cars will increase.

4.7.2.1 Volatility in commodity prices – price inflation

Volatility in prices of important commodities may have a conductive effect in the negative direction of the automobile manufacturers' earnings and cash flow. Increase in price of raw materials such as steel, glass, rubber, oil and other precious metals which are extensively used in the manufacturing process of the automobile, its parts and components have a major impact on the automobile sector, as it may lead to higher production costs (Toyota Annual Report, 2010). This could, in turn, negatively impact the manufacturer’s future profitability as it may not be able to pass all those costs on to its customers or require its suppliers to absorb such costs. This can also lead to less profitable projects are postponed due to lack of financial strength.

4.7.2.2 Exchange and Interest rates

Volatility in currency exchange rate, are another exposure which the automobile sector is prone to. Automobile manufacturers operations and sales are subject to currency and interest rate fluctuations as the majority of the value chain is international (Schmid & Grosche, 2008). This makes the industry members sensitive to fluctuations in exchange rates towards major foreign currencies. A depreciation or appreciation of the domestic home currency towards foreign currency may affect the manufacturer’s revenues, financial condition and results of operation, positively or negatively e.g. sales as pricing of products sold and materials purchased in foreign currencies.
4.7.2.3 Lack of skilled labour

The increasing ageing population (see section about sociological conditions) in the mature markets, will cause a large part of the existing labour force to retire in the future. That could be a major concern, especially in the automobile sector, as the skills of the retiring labour is not being replaced in the workforce by new graduates as there are few students in the mature countries which are studying engineering (Ernst & Young, 2010b). This can create a shortage in supply of qualified labour in engineering and research, and can possibly hamper the technological transformation in the automobile sector. Hence, there will be an immense need for skilled labour in engineering and research in the future in the traditional car producing nations. To attract newly qualified graduates the automobile industry must improve its image and promote sound understanding of the high-tech era it is entering.

4.7.2.4 Demand for Oil

The global demand for oil in 2010 is 86.6 million barrels a day, which is a small increase of 0.1 million barrels a day in demand compared to 2007\(^{40}\), as 2008 and 2009 had decline in growth due to the financial crisis. More than 60 percent of the roughly 87 million barrels consumed every day power the world’s transportation, with petroleum fuels accounting for more than 96 percent of the energy supply, making it the largest oil consuming sector in the world (OECD/IEA, 2008; WEF. 2011a). That is expected to rise to as much as 69 percent of the expected total oil demand of 120 million barrels by 2030 (Appert & Pinchon, 2006; Sperling & Gordon, 2009). Oil is a scarce resource, which is widely believed to peak and deplete in the future. That can prove to be problematic for the automobile sector as it relies on continuously petroleum supplies to power its products. Experts however, disagree about when the oil is to peak or whether it has peaked already. Taking that into consideration, jointly with the fact that more than half of the world’s proven oil reserves of 1.2 trillion barrels are in the hands of state-owned national oil companies in the Middle East (WBSCD, 2004; Sperling & Gordon, 2009). Many countries which rely on foreign oil imports to fuel their transport sectors want to move away from oil as the main source of energy. This dependency will only grow more austere in the coming decade, with key automobile markets, the US and China’s crude oil imports are projected to increase to 80 and 68 percent of the total consumed by 2020, up from 65 and 49 percent current (WEF, 2011a), respectively.

\(^{40}\) Omrpublic.iea.org, 2010 http://omrpublic.iea.org/
4.7.3 Sociological Conditions

4.7.3.1 Changing consumer preferences

Actions undertaken by the governments worldwide to reduce the automobile industry’s dependence on oil products as the powering source have motivated consumers to alter preferences. Although, consumers are becoming more aware of the environment, due to the growing focus on climate challenges KPMG’s (2011) annual global auto survey, identifies fuel efficiency as the single most decisive factor for customer purchases now and in the future. The latter suggest that consumers are driven more by their personal economy than green conscience. Consumers from the developed markets in North America, Western Europe and Japan have in general become more price sensitive, in the aftermath of the economic crisis (Haugh et al, 2010), while the consumers in emerging markets in Asia and Africa, where there is still a fairly low level of car ownership demand sub-compact cars (E-Trends, 2009). To illustrate, the car ownership in China in 2002 was 16 vehicles per 1000 people compared with more than 600 vehicles per 1000 people in the US (Hill, 2011; EIU, 2010). By 2014, Economist Intelligence Unit estimates that this number will be 71 per 1000 (EIU, 2010), which is still very low, but shows the tremendous growth potential in that market. The other emerging market which is experiencing rapid growth is India, which has similarly to China, a fairly low level of car ownership with 17 vehicles per 1000 people in 2008, so there too rapid growth in demand has been occurring (Hill, 2011; EIU, 2009a). People in these countries are experiencing rising incomes and new wealth due to rapid growth of their respective countries economies. Yet the biggest sales are expected to come from a large number of first-time buyers who are most likely to demand basic cost-efficient and reliable vehicles. Still, there are high expectations towards environmental friendly cars in the future. Frost & Sullivan (2009b) foresee that environment friendly cars will make up 20-25 percent of total global sales by 2015, while Deloitte (2009) envisages that these will represent one third of all automobile sales in the developed markets in 2020.

Nevertheless, the historically high oil prices along with the fear of disrupted future supplies of petroleum have larger impetus for the consumers’ altering perceptions and motivations, in our view. Historically, the real price of oil has been very steady, with average of $16.71. Various events since the 1970s, however, such as the 2011 Libyan uprising, formation of

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41 A/B segment
42 Wtrg.com, 2011

OPEC\textsuperscript{43}, discovery of new oil reserves and the rising oil demand (See Economic section) have increased the short term volatility of the oil price and created hikes in oil prices like now in 2011 where the oil price has surged around $117 per barrel\textsuperscript{44}. This pattern with surges in prices over a short period is believed to increase in the future until demand for oil drops\textsuperscript{45}. According to the EIA Annual Energy Outlook (2010) the oil price from 2010-2020, is expected to be around US $ 50 in a low and stabilised scenario, while in a high and volatile scenario the oil price is expected to increase from US $ 80 to $180 until 2020 and increase above US $ 200 by 2030. Since the fuel prices are directly impacted by the oil price, periods with high oil prices cause increase in the conventional automobile fuels; gasoline and diesel prices at the pump too. The latter can explain why fuel efficiency is regarded so highly by consumers. The rise in fuel prices are a major driver behind European consumers increasing interest in alternative fuelled vehicles as their next vehicle purchase reveals a consumer study by Frost & Sullivan (2008a).

In view of the preceding arguments, there is certainly a growing demand for emerging propulsion and fuel technology driven cars, which are more fuel efficient than the conventional ICE cars. However, currently it is a matter of personal economy for the consumers. The high fuel prices are a major motivation to move away from the conventional petroleum driven ICE cars, along with the increasing environmental awareness. On the other hand, what if the fuel prices decrease significantly instead, what will happen then? Most likely consumers will continue to drive the conventional ICE cars of today. Only people who are either very conscious about the environment will consider to shift, or those who want to assist their country to lose dependency on foreign oil imports, and reduce demand for oil are likely to purchase emerging propulsion or fuel technology vehicles.

\textbf{4.7.3.2 Demographic change}

A demographic trend is the growing level of the world’s population, which is set to reach 8 billion by 2025(UN, 2009), up from today’s 6.9 billion, as revealed earlier. This growth will stem almost entirely from transition economies, which are projected to grow as much as eight

\footnotesize\textsuperscript{43} Market cartel consisting of 12 oil producing nations: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE and Venezuela
\footnotesuperscript{44} As of 31st March 2011; http://www.oil-price.net
\footnotesuperscript{45} Wtrg.com, 2011
times faster as in the developed nations (Roland Berger, 2011b). Emerging regions are expected to have the strongest population growth in the coming fifteen years, with 36 percent growth in the population in Africa, while 19 percent growth in total in the Middle Eastern/Central Asian region (Ibid.). In 2025, as much as 84 percent of the global population will be located in emerging markets (Ibid.). These areas are also experiencing rapid industrial growth, with rising income levels creating new middle classes, as previously mentioned.

On the other hand, the developed nations will experience in the coming years, more ageing population. In 2009 people aged over 60 constituted 737 million of the world’s total population which is projected to reach 2 billion by 2050 (UN, 2009). There were 12 countries with more than 10 million people aged over 60 including some of the world’s largest automobile markets; China, the US, Japan, and Germany (Ibid.). Presently, 21 percent of the population in the more developed regions is aged 60 years or over, which is projected to increase to almost 27 percent by 2025 (Ibid.). Europe is the continent with the highest proportions of elderly above 60 with close to 22 percent of the population, which is projected to be nearly 35 percent in 2050 (Ibid.). Hence, the evidence shows that there is a trend of a more aging population in the mature economies and in the Western world.

4.7.3.3 Urbanization

In 2008, some 3.3 billion people lived in urban areas across the world (UN, 2008), with 60 percent of the EU’s population living in the urban areas (EC, 2007). The former number is projected to reach 5 billion by 2030 (UN, 2008), which shows that there will be a growing number of people living in urban areas around big city centres in all regions in the future. The global average will be 57 percent in 2025, in industrialized nations 80 percent with North America leading the way with 85 percent, while in emerging countries, the urban population is expected to reach 52 percent of the total population (Roland Berger, 2011b). The continuing urbanization means creation of new mega-cities, with the number expected to rise from 22 today to 29 by 2025 (UN, 2008). Eight of the ten largest mega-cities will be located in emerging markets, with only Tokyo and New York to be in mature markets (Ibid.).

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46 Cities with over 10 million people
47 Kolkata, Mumbai, Delhi, Dhaka, Sao Paulo, Mexico City, Shanghai and Karachi

This pattern in growing urbanization across the globe will change people’s travelling and driving patterns, as more people in urban areas also means more commuting and increased motorization. Hence, this will lead to more smog and reduced air quality due to rising local air pollution, higher emission levels, and increasing congestion problems are likely to occur too. The impulsion for the automobile sector is to take into consideration urban planning as a part of their differentiation strategy.

4.7.4 Technological Conditions

In this section the concentration will be on the emerging propulsion and fuel technologies only.

4.7.4.1 Government promotions

Different governments are promoting different emerging fuel technologies. Some governments are promoting hybrid vehicles, while others are focusing on pure electric vehicles, and still other governments are considering other technology options.

A nation’s access to local resources, and the political stance of the ruling government are decisive factors in which propulsion or fuel technologies there are made investments in, and will be offered in a particular market. These factors were also revealed in the interviews conducted with the automobile sector representatives (Morsing Interview, 2010; Eis Interview, 2010; Andersen II Interview, 2010). For example, given the possession of vast fields of sugarcane, the Brazilian government has as a direct consequence of the 1973 oil embargo, since 1975 mandated the usage of eco-friendly bio-fuels as a way of reducing their dependency on foreign oil imports (EIU, 2009b).

In the world’s two largest automobile markets, both the Chinese and the US government have set their sights in favour of battery based electric vehicles. The Chinese government aims to have 20 million battery based vehicles on the roads by 2020, and has earmarked close to RMB 100 billion\(^{48}\) to domestic Chinese automobile manufactures to facilitate that, mainly due to its possession of vast lithium reserves (KPMG, 2010a; JD Power, 2010b). Likewise, the US government has issued a total of $ 2.4 billion to the US automobile industry, to develop the

\(^{48}\) 1 RMB = US $ 0,154, XE.com, retrieved 07-05-11
next generation of electric cars, and improve the existing fleet with alternative propulsion technologies (KPMG, 2010a). The Japanese government as well are positivistic to promote electrification. In 2009 the Japanese government boosted £ 100 billion into the economy, which includes funding to mass produce electric cars within three years. The geographical nature of the European markets, on the other hand, implies that there are many individual approaches. However, there is a trend toward focusing on advanced diesel power trains (DB Research, 2009; KPMG, 2010a).

These efforts are promoting a sustainable and cleaner environment, but simultaneously, the disparate efforts of the governments across the world, have put the global automobile industry under an immense cost pressure. Regulation is being used to create technological shift in the automobile sector with new paths that may leave many existing competencies obsolete (Pilkington and Dyerson, 2004).

4.7.4.2 Automobile Manufacturers Efforts

The conservative nature of the established automobile manufacturers, especially the US and European, have traditionally been reluctant to fundamental changes in technology. Even though, there have been innovations and technological developments in the ICE car over the time course. Most of these contemporary innovations such as multi valve designs and direct injection technologies have rather added or supplemented the ICE technology without challenging the basic principle (Pilkington and Dyerson, 2004), before now.

The lack of consistency of governmental regulations and policies globally, however indicate that global auto manufacturers have to hedge their options by seeking strategic alliances and technology-sharing agreements. Thereby they achieve a faster speed of technology transfer to adapt their efforts to the various regions and markets. However, to not miss out on a potential competitive edge opportunity, most of the major incumbent automobile manufacturers are developing multiple fuel technology options, as mentioned earlier. This is not the optimal solution, as it implicates heavy capital investments, including investment in skills and expertise in both R&D and product development areas, as well as in manufacturing (Zapata and Nieuwenhuis, 2010; Morsing Interview, 2010), in addition to the already very high capital investments in existing technology. A breakthrough of the technologies would mean a

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49 Guardian.co.uk, 2010
premature abandonment of the existing high capital intensive systems (Zapata and Nieuwenhuis, 2010), or if the technologies fail to prosper, enormous sunk costs. Further improvements in these technologies will also require large investments in the R&D, and increased product costs. These costs might be unsustainable in many markets, as people cannot afford the high initial prices, meaning that the most advanced fuel technologies will in the beginning be reserved to a few markets, for instance in industrialized countries. A broader market availability, like in emerging markets, may first be realized, when the costs are sufficiently reduced.

Acknowledging the growing role of governments, OICA have explicitly made calls for a coordinated approach by the various governments towards a mainstream technology to reduce the increasing R&D, product development and manufacturing costs. Even so, there are no implications in the close future on a global coordination. The lack of a coordinated approach, also means that the adoption of a mainstream fuel technology which can take over for the conventional ICE cars, can possibly be deferred (JD Power, 2010b), simply because it is too cost or capital intensive for the majority of automobile manufacturers capital intensity e.g. financial strengths and resources.

50 Oica.net, 2010

4.7.5 Summary of PEST

From the PEST categorization we have identified some trends which are likely to continue into the future, creating both opportunities and challenges for the automobile industry regarding the technological shift. Since the business environment of the automobile industry is constantly in motion there are some uncertainties connected to these.

One such trend is that, governments across the world have imposed strict environmental regulations on the automobile industry to reduce the industry’s carbon footprint, with the EU taking the lead. In our view these legislations will become stricter in the future when other countries follow. Economic conditions have also large effect on the automobile manufacturers’ performance. Rising incomes due to the economic growth along with low car ownership in emerging markets is opening up opportunities. However, simultaneously, volatile oil prices, together with the rising oil demand are creating challenges. A potential disruption of oil supplies in the future can mean the end of the business for a large portion of the industry, if they do not move to alternative technologies. Another challenge which is expected to have an impact in the future is the shortage of skilled labour to the industry. Economic exposures such as volatile commodity prices, exchange and interest rates cannot be ignored either, as these impact the financial performance of a firm. In our view, those
manufacturers who are capable to take advantage of the many challenges in the coming future, are on the right path.

The coming years, will see two noteworthy demographic changes which may have an effect on the automobile industry. Emerging economies are experiencing a growing population which are expected to grow further; while in the mature regions the trend is opposite with ageing population. Cities will increasingly urbanize, and to accommodate this we believe that there are market opportunities for new business models, such as mobility services and advanced car sharing systems. Even though consumer preferences are changing, with good prospects for environmentally friendly and fuel efficient cars in the future, findings suggest that consumers are primarily motivated by personal economy. Volatility in fuel prices will to a large extent determine the consumer’s motivation to alter towards a more fuel efficient and environmental vehicles.

Emerging fuel technologies are changing the landscape of the auto sector. Although, different governments are promoting and investing in different technologies, there is a growing focus on electric vehicles, especially in China and the US. However, as there are no specific indications to which technology will prevail, therefore manufacturers are forced to pursue a multi path approach to not be at disadvantage if they pursue the wrong technology. This on the other hand also puts the already cost pressured industry at an even tighter position cost wise.

From the above discussion of PEST summary, we find environmental regulations and the volatility in oil prices as the factors which have the highest degree of uncertainty connected to them. Our reasoning for picking the two factors is firstly that environmental regulations are pressuring the auto industry to pursue multiple strategies to lower the carbon footprint, and general emission levels of their fleets. Secondly, we have identified oil prices to have a major impact on consumer’s mindset regarding conventional vehicles. Especially, times with high oil prices make consumers consider changing over to alternatives. These factors are interrelated (SEE APPENDIX 2) as governments play an important role by both influencing the consumers and pressuring the automobile industry.
5. Substitutes Products (Technology change)

In this chapter which accounts for the “substitutes” in the adapted Five Forces model, there will be given an assessment of the most important alternative fuels and propulsion technologies in emergence within the automobile industry. As illustrated in chapter 2, the evaluation will consider the technical benefits and consumer perceptions of these technologies. Not all emerging technologies will be touched upon. The conclusion of the assessment will serve the basis for the future industry scenario analysis in the next chapter.

5.1 Defining Emerging Propulsion and Fuel Technologies as “Substitutes” in the adapted Porters 5 Forces Model

Porter (2008) defines a substitute as a product or service which performs the same or similar function to an industry’s product by a different means. Thompson, Strickland III and Gamble (2008) highlights that incumbents in one industry come under competitive pressure from the actions of companies in a closely adjoining industry whenever buyers view the products of the two industries as good substitutes. These views suggest that the traditional way of looking at substitutes for an automobile would be alternative modes of transportation.

In this thesis, however, since the ongoing technological transformation within the global automobile industry is the area of interest, the technologies in emergence will be regarded as substitutes. Cooper and Smith (1992) argue that established firms see major product innovations that have the propensity to create new industries as substitution threat, while Porter (2008) put forward that advances in technology are actually one of the most common factors for the emergence of new substitutes. Accordingly, given that technology change within an industry are also regarded as substitute products, the emerging propulsion and fuel technologies will here be regarded as substitutes to the automobile manufacturers’ core capabilities, the petrol or diesel driven ICE. The competing emerging propulsion and fuel technologies are not from outside industries, but from within, therefore incumbent automobile manufacturers are internally competing for new market opportunities, but also to defend against potential new entrants or suppliers who change or plan to forward integrate, and also to some extent buyer power.

There are, however, an important distinction between the propulsion technologies and fuels in emergence. Hybrid and electrification technologies persuade that the automobile
manufacturers must partly or entirely replace their core capabilities, hence direct substitutes to existing ICE technology. Results reveal that, while sometimes firms from threatened industries were able to build upon their own core technical capabilities, in most cases important new capabilities were required that were not associated with the traditional product (Cooper and Smith, 1992). The same is the case in the automobile industry. Some of these emerging fuel technologies will require entirely new value-add, and will move the value chain towards the suppliers industries, which creates the threat that suppliers can forward integrate or if the incumbent manufacturers decide to backward integrate and acquire the necessary technology to build the desired technology (Cooper and Smith, 1992). It also render that the sunk investments in the ICE technology may become outdated and would require new investments into a different production system for the new type of powertrain and may also involve hiring or re-educating engineers with expertise in the new and different technologies, making the expertise and knowledge of current engineering forsaken or replaced technology excess.

Alternative energy sources which can be used with no or minimal modification in existing engines, on the other hand, are actually substitutes for the conventional automobile fuels, products from the petroleum industry, and not the automobile manufacturers. Despite of that, since an automobile is useless without its source of energy; here the fuels are seen as complementary products to the automobile. Therefore, it is reasonable to say that the emerging alternative energy sources means that there is an indirect substitution threat towards the conventional ICE driven cars as the demand for those will decrease due to an opposite increase in demand for alternative fuelled ICE cars. To stay competitive and also to meet the consumers, the implications for the automobile manufacturers are that they have to develop ICEs which can run on the alternative fuels.

5.2 The Competing Technologies

Basic economic theory states that substitutes will only be adopted when they are cost competitive with the original good (Besanko, 2007). In other words, the emerging propulsion and fuel technologies will not be adopted unless the performance, price and infrastructure needed are in the same range as the conventional ICE technology. Furthermore, the success of an emerging technology also depend on whether customers want the technology or not, as
they have power to direct a company’s investments (Bower and Christensen, 1995). Further, findings by the latter authors suggest that typically leading companies fail to stay as market leaders when technologies or markets changes because they fail to recognize the needs of prospective customers which they might not be serving now, but will emerge as cause of the change. Hence, consumer’s acceptance of the technologies is an important mark of whether a technology will succeed or not. Given the nascent state of most of the technologies in emergence, it is here presumed that customer acceptance of a specific technology will depend on two parameters: the actual technical benefits and consumer perceptions of those, as revealed in chapter 2, and give inclination on whether the technology have the potential to compete with and pose a significant threat to the core capabilities of the automobile manufacturers. At the same time, given governments’ role to influence the perceptions of the consumers, as revealed in chapter 4, not every technology will be offered in every key market, as the offering is bounded on the individual governments’ influences and goals.

Cole and Flynn (2009) propose that consumers’ perception about automobiles are primarily driven by their evolving needs as well as dependent on the changing performance of competitive offerings quality which could affect the consumers’ willingness to buy and the price they will pay. In view of that, consumers’ perception about the different competing technologies is very much tied to the need of the individual consumer and may vary over time. Consumers may also come from different age groups, society classes and cultures and have a vast diversity of preferences determined by the different geopolitical and socio-cultural nature of the world’s automobile markets. Given the diversity, the authors deduce that consumer perceptions will most likely vary across the world. To capture a global picture, data from key markets such as the US, China, Europe and Japan is applied to outline a general trend on consumer demand. We have identified four main competing fuel and propulsion technologies, but acknowledge that not every technology in emergence like different versions of bio-fuels and LPG (SEE APPENDIX 3A and 3B) is touched upon.

In the following there will be given an assessment of natural gas, hydrogen fuel cell, hybrid technology and electrification technologies.

5.3 Natural Gas

Today, natural gases in either compressed (CNG) or liquid format are used as automobile fuel. These are not as widespread as petrol or diesel, and their usage is limited to markets where governments have promoted those. However, there are vast amount of natural gas resources in the world, more even geographic spread than crude oil (WEF, 2011a) which can be an advantage in reducing the automobile sectors dependence on oil. Natural gas is not a renewable source, but it is still much cleaner than petrol and diesel. In the future natural gas could potentially be made renewable through biogas production (WEF, 2011a). Below, there is given an appraisal of CNG.

5.3.1 Compressed Natural Gas

5.3.1.1 Stage of Development

Natural gas vehicles have been successfully used for decades in numerous countries. Worldwide, 11.3 million natural gas cars circulate\(^51\), which is approx 1% of the world’s light duty vehicle fleet (WEF, 2011b) and the numbers are growing as seen in chart 1.

*Chart 1: Growth in NGV World Wide 1991 - 2009*

Source: International Association of Natural Gas Vehicles

\(^{51}\) IANGV.org, 2010

From chart 2 it can be seen that Asia Pacific and Latin America are the regions which have had the largest growth in natural gas vehicles fleet in the period 1991 - 2008.

The vast amount of natural gas resources in these regions are one explanation for the rapid growth. The other is the governments’ promotion of natural gas vehicles in people rich countries. The two largest markets for natural gas vehicles are also to be found in these regions; Pakistan and Argentina with 2.3 million and 1.8 million natural gas vehicles respectively. In comparison, the likes of the US and China have only 110,000 and 450,000 natural gas vehicles correspondingly.

CNG powered vehicles are relatively inexpensive to produce (Carle et al, 2005), as they are either factory built or converted from conventional petrol ICE cars, where an additional fuel tank for CNG storage is fitted in the car (DB Research, 2009; BCG, 2009; PWC, 2007). This conversion is relatively inexpensive, if the CNG car is factory built, with a slightly higher retail price from the manufacturer. Erik Morsing at GM Denmark says “For an additional cost of 500 – 600DKK the factory built petrol ICE car is able to also propel on CNG” (Morsing Interview, 2010). Often the petrol ICE is retained and these cars are sold as bi-fuel vehicles, meaning they can be driven with either petrol or CNG. There are some

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52 Ibid.
53 Ibid.
inconvenience related to the heavy steel tank onboard to hold the gas, as it is usually placed in the trunk, hence takes a lot of boot space. It is however, not a significant issue, as with time if this technology is to prevail, there will be solutions to that as well.

5.3.1.2 Technical Benefits

CNG is a fuel in gaseous form when fuelling takes place. It possesses, however, a few key technical benefits, compared with petrol or diesel. Most notably, in the drive phase, tailpipe emissions produce 60 – 90 percent less pollution and 30 – 40 percent less GHG than petrol or diesel (JD Power, 2010b), which includes 20 – 25 percent less CO₂ emissions due to its high level of hydrogen (Morsing Interview, 2010; BCG, 2009). For an environmental conscious consumer it offers an attractive alternative. Moreover, the fuel economy of CNG is another major advantage compared to petrol and diesel, as it is a cheaper fuel at the pump in many markets (WEF, 2011a; JD Power, 2010b). In the drive phase, CNG costs on average half of the costs of petrol per kilometre and 25 - 30 percent less cost than diesel per kilometre (Frost & Sullivan, 2010b; PWC, 2007; DB Research, 2009). The low operating costs makes the CNG powered car more cost efficient, which is attractive economically for the consumers. Accordingly, those countries which have plenty of domestic natural gas also possess key advantages in domestic supply.

CNG has, however, on the other hand very low energy density, 70 percent less than that of petrol or diesel (JD Power, 2010b; WEF, 2011b), which means that the driving range of a natural gas vehicle would be 70 percent shorter with similar fuel tank as a petrol or diesel vehicle. The latter is a major disadvantage and can possibly prevent private consumers to choose this fuel technology. On the opposite, fleets that possess their own fuel depots are more likely to be attracted to CNG.

5.3.1.3 Infrastructure

Due to the different means of storage, the conventional network of fuel stations cannot be used to distribute and deliver natural gas to consumers. There exist approx 16,500 natural gas refuelling and service stations on a global plan. However these are suffering from an embryonic and patchy network infrastructure (JD Power, 2010b; Frost & Sullivan, 2010b) as

54 Ibid.
there is no standardized gas solution across the globe. For natural gas to prosper there has to be built separate gas refuelling stations infrastructure to deliver natural gas vehicles.

The time and cost involved to develop such entirely new natural gas distribution system, however, will be extensive. Further, there are concerns about how to fund the costly investments related to the new infrastructure (BCG, 2009). Governments have a significant role to play here, as there will be need for both government aid and promotions. Presently, there is not much help from the automobile manufacturers either, which have down prioritized investments in this technology for the next five years (KPMG, 2011), despite that this technology is already readily available and the infrastructure exists in parts of the world. Research by Carle et al. (2005) suggest that the development and market introduction of more efficient CNG and hybrid natural gas cars emitting between 70–90 g/km CO₂ will take some years to produce.

5.3.1.4 Consumer Perceptions of natural gas

A global study among 4,000 drivers by Ernst & Young (2010a), as seen in table 5 shows that approx half of the respondents in the major markets of US and Europe are familiar with the technology, while the number for China and Japan are a bit lower.

Table 5: Potential Consumer Familiarity with Natural Gas

<table>
<thead>
<tr>
<th>Potential consumers familiarity with Natural Gases</th>
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</thead>
<tbody>
<tr>
<td>US</td>
</tr>
<tr>
<td>47 %</td>
</tr>
</tbody>
</table>

Source: Ernst & Young, 2010a

People know about this technology, and even though it is readily available, CNG is lacking promotion and support by both governments and other stakeholders; according to Frost & Sullivan (2010b). Consumers’ perception affirms that, as there is a widespread misconception
among the general population that the safety of natural gas is insufficient. People associate the usage and storage of natural gas in cars as dangerous. This negative perceived image of natural gas indicates that there is little information about this fuel technology among the public. Accordingly, people are not attentive of the benefits of natural gas either. In a European consumer study the respondents ranked CNG as the least appealing fuel technology, although also perceived to be among the fuel technologies with the lowest emission levels (Frost & Sullivan, 2008a). This illustrates, the there is a need for consumer education on the benefits of natural gas and the economical savings which can be gained from using the technology. Given the negative perception of CNG, the majority (41 percent) of the respondents were not willing to pay above the cost of similarly equipped petrol car (Frost & Sullivan, 2008a), which also shows that consumers are not aware of the relatively competitive retail price of a natural gas vehicle either.

### 5.4 Hydrogen Fuel Cell Technology

The hydrogen fuel cell vehicle is a hybrid vehicle which runs on hydrogen fuel cell powered electric motor (CS, 2009; DB Research, 2009). With similar mechanical and electrical systems of an electric car, the hydrogen fuel cell vehicle operate on electric power, however, without a battery or an ICE, as the onboard hydrogen fuel cell generates the electricity (Copeland, 2009; DB Research, 2009).

#### 5.4.1 Technical benefits

Hydrogen is one of the most promising energy carriers. As an alternative energy source, hydrogen allows more efficient usage of energy compared to conventional petrol ICE when used in fuel cells, as it converts energy twice as effective (PWC, 2007). Further it proposes zero emissions from the tailpipe if the source is renewable except other than water (OECD/IEA, 2008). Hence, this technology possesses some key advantages over petrol and diesel. Since the technology is not using any fossil energy source to power the vehicle, it has also full savings in fuel consumption compared to the conventional cars.

55 The fuel cell is a means of very efficiently converting the substance energy in a fuel directly into electricity without any form of burning (Fueleconomy.gov, 2010). Hydrogen can be inserted into these fuel cells and power the electrical engine producing electricity directly from the fuel.

On the other hand, the low density of the technology require it to be either compressed or cooled to liquid to be stored (IEA, 2009; E-trends, 2009) onboard an automobile. That possesses a major challenge for the automobile industry as the optimal solution for storage is not found yet; meaning additional investments related to the development of safe hydrogen storage onboard vehicles, which will be mirrored in the likely high retail price of the vehicle. Another challenge is that energy equal to 20 – 40 percent of the energy content of hydrogen is used to produce and compress hydrogen for storage on board the vehicle (E-trends, 2009; WEF, 2011b), implying that a lot of the energy is wasted.

5.4.2 Stage of development

Even though the ratio of Kw/$ of hydrogen has improved significantly over the past 15 years, there are limited number of hydrogen powered vehicles on the roads, namely a few prototypes and a few buses (Zapata and Nieuwenhuis, 2010). The issue is twofold. On one hand, that can be related to the infant stage of hydrogen technology as there are several technical and expenditure constraints related to production, storage, transportation, infrastructure and distribution channels (BCG, 2009; DB Research, 2009; IEA 2009; OECD/IEA, 2008), which are not developed yet. On the other hand, the production of hydrogen fuel cells, is on a nascent R&D stage (CS, 2009), despite the early promises of fuel cell manufacturer Ballard. The current costs of fuel cell production are around €3000–5000/kW (Carle et al., 2005), which reflects the technical difficulties with the technology. These costs have to go down to the range €40–60/kW in order to be competitive (Carle et al, 2005) with conventional cars. In addition, the high development costs of hydrogen will most likely be reflected in the elevated hydrogen prices at the pump, about 10 times more expensive than petrol if the hydrogen source is renewable, meaning that the costs of ownership for the driver will be unsustainable (WEF, 2011b; OECD/IEA, 2008). Hence, from an economic and convenience point of view the technology is currently not competitive for the consumers, unless the costs of the fuel cell stack, hydrogen storage system and hydrogen fuel are driven dramatically down. Evidently, at present hydrogen is not readily available or attractively priced. Despite of that, KPMG (2011) survey reveals that more than one fifth of the automobile companies interviewed consider hydrogen fuel cell as a major area of investment. In our view, this is because the technology is seen a high potential propulsion technology for the long-term future as it can reduce the industry’s dependency on petroleum products.
5.4.3 Infrastructure

A successful market penetration of hydrogen fuel cell vehicles will also be very much dependent on the availability of sufficient hydrogen refuelling stations network on a global plan. The present infrastructure of petrol filling stations cannot be utilized, due to transportation and storage issues of hydrogen as depicted earlier. Therefore, the technology needs to firstly, be fully developed, and reach scale economies to cut down the high production and development costs, and at the same time, there has to be built an entirely new infrastructure for hydrogen distribution.

Both the infrastructure and the development of the technology will require very high investments; the latter has been estimated to be $5000 per car (Zapata and Nieuwenhuis, 2010). On the other hand, a prospective natural gas refuelling stations network may easily be converted to also deliver hydrogen carriers in the future (JD Power, 2010b).

5.4.4 Consumer Perceptions

Table 6: Potential Consumers Familiarity with Hydrogen

<table>
<thead>
<tr>
<th>Familiarity with Hydrogen</th>
<th>US</th>
<th>Europe</th>
<th>China</th>
<th>Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30%</td>
<td>28%</td>
<td>6%</td>
<td>27%</td>
</tr>
</tbody>
</table>

Source: Ernst & Young, 2010a

Given the nascent stage of development, projecting the market penetration of hydrogen fuel cell vehicles is unforeseeable for now as there are too many features which need to be improved significantly. Even though, Zapata and Nieuwenhuis (2010) estimate one million
hydrogen fuel cell vehicles on a yearly basis before 2020, which stage the technology would be cost competitive with conventional cars.

Consumers’ from the largest automobile markets familiarity with this technology, as table 6 illustrates is not very high. Although, approx one third of the respondents in the traditional markets are familiar with hydrogen power, the Chinese are least familiar with hydrogen power as the table show, and have also high doubts about its maturity level and reliability (TNS, 2008). Further, consumer studies from China reveal that the hydrogen fuel cell are perceived to be among the least best for environment (TNS, 2008; TNS, 2009), which is very interesting as the opposite is actual if the source is renewable. Another study in Europe, on the other hand, shows that Europeans perceive hydrogen to offer the best fuel economy and have lowest emission levels (Frost & Sullivan, 2008a) and is also the fuel technology there are highest expectations about in terms of fuel savings. Every third out of 10 European consumers would expect the greatest improvement in fuel consumption (greater than 41 percent) over other alternative fuels (Frost & Sullivan, 2008a), while it was placed last for the overall performance, and almost a fifth of consumers believe that hydrogen would be more expensive to run.

In the authors view, it is unlikely that hydrogen fuel cell vehicles will appeal to the mainstream consumer as long as there is a lack of knowledge, lack of infrastructure, there are high initial price and hydrogen prices are expensive.

Without low-cost sources of hydrogen or a breakthrough in on-board hydrogen production, the hydrogen technology seems to be years away from commercialization. Accordingly, the customer acceptance is difficult to judge, because the incompleteness of the technology. Hence, in view of that, the mainstream usage of hydrogen fuel cell vehicles is not possible for the next 10 years. Nevertheless, given the massive potential, hydrogen cannot be written of totally as it is already being considered as the ultimate technology option by the automobile industry for the long-term future, but only if the hydrogen production from renewable sources reaches scale economies (Bain, 2010). Therefore it can be concluded that the transition to successfully compete in the market will likely take many decades. Hence, the substitution threat entirely based on the technological readiness alone will be very low until 2020.
5.5 Hybrid Technology

A vehicle with hybrid technology can be driven both directly via a petrol (or diesel) ICE and by an electric motor powered by a battery, or a combination of both, to provide full vehicle performance capability (Bain, 2010; Hensley et al, 2009). This technology possesses few key technical advantages compared to petrol and diesel.

5.5.1 Technical Benefits

The combination of petrol with electric power reduces the fuel consumption on average with 25 percent compared to similar petrol ICE car models (DB Research, 2009; Bain, 2010). Effect wise, the emission levels are also reduced constantly. On average the hybrid vehicle emits 30 percent less CO₂ emissions (CS, 2009). The fuel savings, however, depends strongly on the usage and driving behaviour of the consumer. A hybrid vehicle provides lower fuel consumption and very low emissions in urban and city areas, as mainly the electric motor is used to power, while on longer distance at higher speeds the extra weight of the electrical motor puts the hybrid vehicle on a disadvantage, making the fuel consumption higher than the conventional vehicles (PWC, 2007; DB Research, 2009; Bain, 2010). Another major technical benefit is the regenerative brakes, which means that the hybrid vehicles recovers the braking energy and store that in the battery to power the electric motor (Bain, 2010; CS, 2009; OECD/IEA, 2008).

5.5.2 Stage of Development

Battery technology is the single major challenge at present with hybrid vehicles. These are not capable of providing enough energy for longer ranges in electric only mode (PWC, 2007), an issue which is shared with both plug-in hybrid and battery electric technologies. Further developments are necessary to improve the battery capacity and bring down the relatively high battery costs (OECD/IEA, 2008; CS, 2009). These batteries can potentially reduce the hybrid vehicles penetration in the markets as a full worthy substitute product to the conventional car, as they put the technology on a significant disadvantage. Nonetheless, there

56 where the ICE typically provides power during longer and faster distances, while the electric motor can be used to support the ICE or power the vehicle for shorter distances
are more than 3 million\textsuperscript{57} hybrid vehicles circulating around the world, mainly in the US and Japanese markets.

Due to the high development and production costs of its two traction systems, the hybrid vehicle are priced relatively higher, typically 30 – 40 percent (JD Power, 2010b), to a comparatively sized conventional ICE car. These costs are expected to go down in the future as the technology progress and achieve scale economies and stronger experience curves (DB Research, 2009). Therefore in our view, with time, when significant scale economies are achieved and further progression in the technology are evident, the costs of development and manufacturing will likely go down, bringing the prices of the hybrid vehicle lower. This will make it more competitive akin to the conventional ICE cars; given that it out-competes the other emerging technologies. Nevertheless, JD Power (2010b) have projected global sales of hybrid vehicles to be 3.88 million units in 2020 which is merely 5.5 \% of total automobile sales that year, with more than half of the sales expected to come from the US (53\%), followed by Japan (20\%) and Europe (16\%). These numbers indicate that there is relatively little confidence in hybrid vehicles to be the mainstream technology in the future, which is surprising, because more than one-third of the automobile sector's investments in alternative fuel technologies over the next five years are made in hybrid technology (KPMG, 2011). On the other hand, it also indicates that a widespread consumer acceptance will come slow by.

### 5.5.3 Consumer Perceptions

Findings suggest that consumers around the world are little aware about the technical features and benefits of the hybrid vehicles. Studies from the US market, for example, reveals that although American consumers are familiar with the technology as shown in table 7, they are largely unfamiliar about the basics as there are misconceptions about its fundamentals, usage and technical features (Synovate, 2011; Deloitte, 2010b). This is fairly astonishing, since hybrid vehicles have been readily available in the US market for more than a decade\textsuperscript{58} and the sales are growing. Similar trends were to be found among Chinese consumers in 2008, where a study reveals that hybridization of vehicles are among the best known emerging fuel technologies, but relatively few people were really familiar with it (TNS, 2008).

\textsuperscript{57} New.yahoo.com, 2011
\textsuperscript{58} Hybridcars.com, 2006
In order to become competitive with the conventional car there is an extensive need for consumer education, about the hybrid technology in some of the major markets. Furthermore, it is clear that while consumers worldwide are driven by different incentives (TNS, 2008; Caulfield et al, 2010); potential fuel costs saving are the most appealing factor for considering a hybrid vehicle. Other incentives like reduced emission levels and tax reduction came second. On the other hand, general trend derived from findings in various studies among American, European and Chinese consumers (JD Power, 2010a; JD Power, 2010b; Frost & Sullivan, 2008a; TNS, 2009), show that potential buyers dislike most the high initial price, are confused about the total cost of ownership, and are in general concerned about seeing not any significant increase in fuel economy and the overall performance.

5.5.3.1 Dislikes

A study by JD Power (2010b) on US consumers revealed that the interest among respondents for hybrid vehicles decreased from originally 61 percent to 30 percent when potential customers were made aware of the high initial price, $5,000 more than that of a comparable ICE car. Evidence from other regions suggests the same (TNS, 2008; TNS, 2009; Frost & Sullivan, 2008a). This put forward that while consumers are willing to pay more for a hybrid vehicle opposed to a conventional car, they are not willing to pay a premium, but rather within limits and as long as they get the desired benefits.

The overall cost of ownership over the life of the hybrid vehicle is also an unclear issue to potential consumers. People are concerned about how long one would own such a vehicle to
recover initial investments and realize fuel cost savings, compared with a conventional ICE car. This indicates that people need to see the economic gains, to consider a hybrid vehicle as a viable option to the conventional car. Other financial considerations which weigh a lot on consumers’ minds are the resale value as well as the cost of replacing depleted battery packs, according to JD Power (2010a). If potential consumers are not able to see any significant economic gain, the technology will most likely not become competitive.

There are also concerns about, whether the hybrid vehicle possesses any significant fuel economy advantages. Diesel hybrid, for example, is perceived to be the technology that offers the best fuel economy by the European respondents as there are high expectations to improvements in the fuel consumption, 20 to 60 percent improvements, compared to conventional ICE cars (Frost & Sullivan, 2008a). These numbers are much higher than actual, and propose that consumers in general have an incorrect image of the technology.

5.6 Electric Technologies

5.6.1 Plug-In Hybrid Technology

A plug-in hybrid electric vehicle (PHEV) works in almost the same way as the hybrid vehicle, with both an ICE and a battery-powered electric motor. However the main differentiating feature is that PHEV possesses a larger onboard battery, which can be recharged by being plugged into an electricity socket (DB Research, 2009; Hensley et al, 2009). Hence, it is unlike the hybrid vehicle, an electric car.

5.6.1.1 Technical Benefits

This technology has a few key technical benefits compared to a petrol car. Firstly, it has improved fuel efficiency given that electricity is the main energy source. The tailpipe emission releases are also very, close to zero. Secondly, it have a higher driving range on electric only than a hybrid vehicle, up to 30 km as a cause of the easy access to energy (WEF, 2011a), a driving range that covers the majority of daily journeys which can be extended by the backup ICE for longer distances. This combination reduces the range anxiety concern which the EV technology is currently dealing with. Another important feature of the PHEV is
the “vehicle to grid” capability, which combines the benefits of hybridisation with the possibility to partly drive on electricity provided by the grid, rather than through the vehicle’s internal recharging system and the ability to recover energy from braking (OECD/IEA, 2008; CS, 2009). Hence, the PHEV offers the same convenience and flexibility of a conventional ICE car.

5.6.1.2 Stage of Development

At present, the technology is undergoing a pilot testing phase. Likewise the full electric vehicle, the battery technology is still in early development stage (see section about EV), and thus very costly to make, albeit a bit cheaper as the battery is smaller (WEF, 2011a). It needs major improvements both in size, capacity and recharging time (CS, 2009). Nevertheless, GM released their first PHEV, the Chevrolet Volt in early 2011. Another hurdle is that, since the PHEV is more complexly built and carries two power plants, it is heavier and more expensive to make than an EV (WEF, 2011a; CS, 2009). These costs are addition to the above mentioned very high battery costs. The complex system also implies that the maintenance costs would be higher than an EV for instance.

5.6.2 Battery Electric Technology

A pure battery electric vehicle (EV) has a drive train, comprising a battery as the main source of power to the electric motor (Bain, 2010; Rask Interview, 2010). Typically the battery can be recharged with electricity from any conventional electrical outlet like the PHEV. Furthermore, the construction and features of the EV are mechanically much simpler than a conventional ICE car.

5.6.2.1 Technical benefits

The high level of energy efficiency of the electric motor, which is up to five times higher than the petrol or diesel powered ICE (DB Research, 2009) is one of the main technical benefits. That advantage is related to electricity as the sole energy source to propel the electric motor

59 “Vehicle to grid” technology allows a bi-directional sharing of electricity between the EV and the electric power grid. The technology turns the EV into a power storage system, increasing power reliability and the amount of renewable energy available to the grid during peak power usage: http://www.pge.com/about/news/mediarelations/newsreleases/q2_2007/070409.shtml retrieved 26.9.2010.
along with the ability to recover energy from braking, meaning an EV uses only approx 25 percent of the energy (WEF, 2011a), that conventional cars use. In view of that, likewise other electrification technologies, there are full savings in fuel consumptions and no fuel related costs compared to the conventional petrol cars. The EV is also one of the cleanest technologies around, with close to or zero emissions of pollutants and CO₂ (Clark, 2010). Nevertheless, for the consumer, the main benefit is still the very low running costs of the EV due to the high energy efficiency. Research by Deutsche Bank (2009) suggests that, the costs of electricity per 100 km driven are as low as one third of the costs of fuel for the average petrol or diesel ICE car. The prices of electricity increases the attractiveness, and hence the competitiveness of the EV. The latter has to be taken with a pinch, as it will also depend on electricity prices across the world, which are typically in the region of US$ 0.1 per kWh (WEF, 2011a), and the size of the car. Other technical benefits include, very low or almost nonexistent noise, which is very similar to the hydrogen fuel cell technology and like the PHEV, the capability to run on the “vehicle to grid” (CS, 2009). The maintenance costs for the EV are much lower than for conventional ICE cars due the mechanical simplicity.

5.6.2.2 Stage of Development

In 2010, there were sold around 20,000 EVs on a global basis, this number is projected to reach 1.31 million units in 2020 with the majority of sales will come from Europe (62%), China (21%), the US (7.5%) and Japan (4.5%) reveals JD Power (2010b). In our view the high projected number in Europe are mainly due to that EU has stricter environmental regulations for CO₂ emissions than for example Japan, as mentioned in chapter 4. The automobile sector also show high confidence as more than one-third of the automobile companies cite the battery electric technology as a major area of investments over the next five years (KPMG, 2011). The projection of JD Power is just one forecast, as the following figure illustrates. Major differences in demand forecasts of the EV are occurring and only show the complexity of predicting future demand for a product which is just about to be commercialized.
Despite of the capable features and the mechanical simplicity, the main drawback to the EV, are the batteries. The nascent stage of the lithium-ion battery technology\(^{60}\) (Andersen Interview 1, 2010) with high battery prices and low production volumes implies that it is costly to produce the EV. The costs of the 25kWh lithium-ion battery pack of current EVs are today US$ 375 – 450 per kWh of usable energy, which are expected to be less than US$ 300/kWh for the entire battery by 2020 (WEF, 2011a). This calculation puts the battery costs at US$ 9,375 – US$ 11,250 today and around US$ 7,500 by 2020. These costs will most likely decrease further when scale economies in production are achieved. The production process also occur additional development cost related to electronic devices such as air conditioning in the EV that is typically run by the ICE in the conventional cars (Deloitte, 2009). Currently, these factors make the initial retail price of the EV very high, which has to go down, if the technology is to gain customer acceptance, and substitute the ICE technology. Nissan LEAF, the world’s first mass-produced all electric car are on average priced EUR 30,000\(^{61}\) in Europe dependent on the different countries government incentives, while a comparable petrol ICE, Ford Focus are on average priced EUR 28,500\(^{62}\), which implicates that the EVs are becoming competitive with conventional model in the same segment (C-

\(^{60}\) Individual manufacturers are following individual battery technologies such as NiMH. However the lithium-ion battery is expected to be the mainstream in the future. Accordingly we pursue that.

\(^{61}\) Nissan-Global.com, 2010

\(^{62}\) E-pages.dk, 2010
segment). Customers are more likely to buy an EV if the price is reduced significantly or are comparable to an ICE vehicle, if it is higher, people will not buy. Consumers will not sacrifice themselves to save the environment and a driving experience in which the EV is not equivalent to the ICE vehicle.

Another major barrier for the mainstream customer acceptance is the limited range of the batteries. These batteries, provided that they are large enough, can typically run between 120 - 200 km, before they need to be recharged or replaced (Bain, 2010; Deloitte, 2009; DB Research, 2009). The insufficient battery capacity means that EV cannot be used to drive longer distances as there will be a need for constant recharging, which puts the technology at a disadvantage compared to the ICE car. For instance, the development of a battery pack with longer range will represent additional costs and can possibly increase the retail price of the EV further. Deutsche Bank Research (2009) has estimated an additional expense of EUR 10,000 or beyond to extend the current range of the EV.

Lastly, compared to refuelling of the ICE car, the full recharging can take very long time, up to several hours (Bain, 2010; DB Research, 2009; Bilimportorene.no, 2010), which diminish the usability of the EV considerably, and also raises the issue of an easy accessible public infrastructure for charging or replacement. However, the aim is to get the consumers to charge their electric vehicles at night, as it is less costly and more environmental friendly, due to a lower electricity output during night-time (Rask Interview, 2010).

5.6.3 Consumer Perceptions of Electrification Technologies

Assessing future demand for electric and plug-in hybrid electric vehicles are testing consumer preferences for a product which they are largely unfamiliar with. Findings by various consultancies and market research firms suggest high inclination among global consumers towards electric vehicles. In our view, that is because the governments worldwide are promoting electric mobility on a large scale. Like 37 percent of the 483 European respondents answered “very likely or likely to buy an EV” (Roland Berger, 2010b; 2010c), 1 in 10 of 22,000 European respondents are willing to consider EV for their next vehicle purchase (Frost & Sullivan, 2010a), while between 7 – 37 percent of total 4,000 drivers in the US, Japan,
China and Europe are willing to consider EV or PHEVs for purchase as soon as it is available (Ernst & Young, 2010a). China for example is the market with the biggest demand, where 60 percent of 1,000 drivers are willing to consider purchasing PHEV or EV as soon as they are market launched (Ernst & Young, 2010a). This indication represents large embracement and potential for large volume sales in the country. These studies clearly give an indication that consumers worldwide are attracted to electrification technologies and show a high interest in them, and will most likely consider buying when such are available. Hence, there is already a tangible demand for these types of vehicles.

5.6.3.1 Awareness

The overall awareness level about the PHEV and EV technologies are in general very low. Even though global consumers show substantial interest, 62 and 40 percent of 4,000 global respondents have never heard of the PHEV and EV technologies or have heard but don’t know what they are, respectively (Ernst & Young, 2010a). Given the early stage of commercialization, studies from the US market, illustrates that the operative knowledge of EV and PHEV are rather low and potential consumers are confused about the performance and features such as charging time, operation and emission levels of each technology (JD Power, 2010b; Deloitte, 2010b; Synovate, 2011). Consumer’s interests in EV increases significantly when they learned about the capabilities, Frost & Sullivan (2010a) reveal.

5.6.3.2 Appealing factors

In general, consumers around the world perceive the plug-in hybrid and battery electric technologies as eco-friendly by the means of reduced fuel consumption, and reduced fuel costs (Frost & Sullivan, 2010a; Ernst & Young, 2010a; TNS, 2008). People in the major markets are primarily showing interest due to the expected fuel savings, which is also the most important favourable factor encouraging the purchase of these technologies, reveals Ernst & Young (2010a). The fuel prices are an important factor in the decision making process (Deloitte, 2010b). As long as the petrol prices are low, the mainstream consumers won’t consider purchasing these technologies, except if there are specific motivations behind their decision. On the opposite, if the petrol price rises, then consumers will probably consider these technologies more. Other factors, such as positive impact on environment, government incentives and dependency on foreign oil, are not nearly as significant to respondents. Hence, it shows that consumers primarily motivation is economic than anything else.
5.6.3.3 Dislike factors

The initial price is identified to be single greatest factor which can both accelerate or prevent a widespread adoption. Several consumer studies (see Frost & Sullivan, 2010a; Ernst & Young, 2010a; JD Power, 2010b; Deloitte, 2010b) outline the current high initial price to be among the major dislikes with plug-in hybrid and battery electric technologies. Although, Roland Berger (2010b) results show that around 25 percent of the 483 respondents are willing to spend over EUR 3,000 more for an EV than they would for a conventional car. Evidence from the US market, on the other hand, indicates that consumer interest in these technologies declines when they are advised about the high price premium associated with the purchase (JD Power, 2010b; Deloitte, 2010b).

Besides the expensive vehicle price, the overall performance is another major concern, as consumers’ dislike the restricted convenience and freedom of mobility in the means of limited battery driving range, accessibility of charging stations, the long time of charging and the lack of understanding about total cost of ownership amongst other factors (Frost & Sullivan, 2010a; Ernst & Young, 2010a; JD Power, 2010b; Deloitte, 2010b; JD Power, 2010a). These factors make people hesitant to purchase PHEV or EV and they play a major role in hampering the interest. One additional general trend outlined from the various survey results, is that the consumers across the globe are anxious about the battery driving range. Although, the range will vary depending on traffic conditions, weather conditions and driving styles, consumers want the freedom and comfort of driving from one point to another without worrying about running out of battery power. Like Ernst & Young (2010a) study identified that 60 percent of the global respondents believe a battery driving range of less than 62.5 kilometres is unacceptable, whereas only 2% drive more than that range a day. Essentially, consumers want the equivalent range of an ICE vehicle on a tank of petrol. On the other hand, pilot trials have found that range anxiety decreases as drivers become used to EVs (WEF, 2011a).
5.7 Chapter Summary and Conclusion

From the assessment of the different emerging fuel technologies we have compiled the table below, which summarizes the technical readiness of the different technologies. From a technical point of view only natural gas vehicles and hybrid vehicles are readily available in the markets. Efforts are made to market introduce plug-in hybrids and electric vehicles within the next couple of years, while hydrogen fuel cell vehicles are by no means ready for a market introduction in the close future.

Table 8: Summary of the Technical Benefits of the different fuel technologies in emergence compared to a petrol car

<table>
<thead>
<tr>
<th></th>
<th>Purchasing Costs</th>
<th>Running Costs</th>
<th>CO2 reduction</th>
<th>Infrastructure Expansion</th>
<th>Performance (Range, acceleration, flexibility)</th>
<th>Time until market readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas Vehicles</td>
<td>Slightly more (–)</td>
<td>Slightly less (+)</td>
<td>Slightly better (+)</td>
<td>Needed (–)</td>
<td>Slightly worse (–)</td>
<td>Available</td>
</tr>
<tr>
<td>Hybrids</td>
<td>Somewhat more (–)</td>
<td>Slightly more (–)</td>
<td>Somewhat better (+++)</td>
<td>Not needed (0)</td>
<td>Same (0)</td>
<td>Available</td>
</tr>
<tr>
<td>Hydrogen Fuel Cell Vehicles</td>
<td>Much more (––)</td>
<td>Much more (––)</td>
<td>Much improved (++++)</td>
<td>Very much needed (––)</td>
<td>Much less (––)</td>
<td>Not before 2020</td>
</tr>
<tr>
<td>Plug-in hybrids</td>
<td>Somewhat more (–)</td>
<td>Slightly less (+)</td>
<td>Somewhat better (+++)</td>
<td>Very much needed (––)</td>
<td>Same (0)</td>
<td>2011-2012</td>
</tr>
<tr>
<td>Electric Vehicles</td>
<td>Somewhat more (–)</td>
<td>Much less (+++)</td>
<td>Much improved (+++)</td>
<td>Very much needed (––)</td>
<td>Much less (––)</td>
<td>2011-2012</td>
</tr>
</tbody>
</table>

Source: Authors own compilation

Even though natural gas vehicles are technically ready and have some key advantages over the conventional car, the switching costs for the consumers in the major automobile markets, in our view are high. Mainly because there is a lack of infrastructure and the low density of the energy source puts the technology at a disadvantage. Hybrid vehicles are also technically ready and the infrastructure is already in place. However, the price label is somewhat higher than a comparable ICE vehicle in the market where it is sold. That in our view makes the switching costs for the consumers low. On the other hand, the PHEV and EV’s are currently not widely available in the world’s markets, for which reason the correct infrastructure has neither been built to support the sales. There is also an issue in regards to the overall performance and convenience of these vehicles, as the battery technology still needs further improvements. Hence, in our view the switching costs for the consumers are high. Then there
is the final technology of the hydrogen fuel cell vehicles which is not expected to be readily available for the mainstream markets before 2020. There are many hurdles regarding production, storage, transportation, distribution channels and infrastructure which means the switching costs are currently very high for the consumers.

Based on the above mentioned, we see the Hybrids, and the electric cars e.g. EV and PHEV to have the highest likelihood to have an impact on the automobile industry in the next ten years.

6. Industry Scenario Analysis – Impact through Porter 5 forces framework

In the preceding chapters we have presented an overview of the global automobile industry with an emphasis on the technological shift and evaluated key emerging technologies. Natural gas, hybrid technology and electrification technologies are in our view the most likely to be pursued by the manufacturers based on the technical readiness, commercialization stage and consumer perceptions.

Through the assessments in chapter 4 and 5 we have identified the following key trends to affect the future of the automobile industry, as seen in the table 9 below. Moreover, through interviews with automobile representatives and other experts, we have identified the key uncertainties in the below table. There are in particular uncertainties, associated to the degree of consumer acceptance, as well as whether the manufacturers are able to improve the technologies quality significantly or not.

Table 9: Final Key Uncertainties and Key Trends

<table>
<thead>
<tr>
<th>Key Trends</th>
<th>Key Uncertainties</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increasing focus on Electric Vehicles</td>
<td>• To what extent will consumer accept the emerging alternative vehicles?</td>
</tr>
<tr>
<td>• Rapid growth and rising incomes in Emerging Markets</td>
<td>• To what extent are manufacturers able to produce quality technology? Technological success or failure?</td>
</tr>
<tr>
<td>• Increasing Urbanization</td>
<td>• To what extent will fuel prices remain low and stable or will they be high and volatile? Oil to peak soon or later?</td>
</tr>
<tr>
<td>• The population in Emerging regions are growing, while the population in mature economies is ageing</td>
<td>• To what extent will environmental regulation become stricter?</td>
</tr>
<tr>
<td>• Technological shift is heating up competition in the automobile industry</td>
<td>• To what extent will governments across the world support with subsidies and promotion?</td>
</tr>
<tr>
<td>• Rising CO₂ emission</td>
<td>• To what extent will external sources raise capital?</td>
</tr>
<tr>
<td>• Increased focus on global warming</td>
<td>• To what extent will environmental awareness increase?</td>
</tr>
<tr>
<td>• Increasing number of strategic alliances &amp; untraditional technology sharing collaboration within the automobile sector, suppliers &amp; third parties</td>
<td>• How will the role of complementarily industries evolve?</td>
</tr>
<tr>
<td>• Cost pressure / capital pressure</td>
<td>• Whether there will be major improvements in technologies?</td>
</tr>
<tr>
<td>• Lack of qualified engineers and researchers in the mature economies</td>
<td>• What extent will new entrants or players emerge?</td>
</tr>
<tr>
<td></td>
<td>• To what extent will key suppliers experience profound changes in their industries and markets because of emerging fuel technologies?</td>
</tr>
<tr>
<td></td>
<td>• Who are the buyers / where are the markets?</td>
</tr>
<tr>
<td></td>
<td>• How will the emerging fuel technologies impact the rivalry?</td>
</tr>
<tr>
<td></td>
<td>• What will happen to the industry value chain?</td>
</tr>
</tbody>
</table>

In the following, we will make industry scenarios, spanning from 2010 until 2020 by selecting the two key uncertainties identified, as mentioned in chapter 2:

1. **Whether consumer acceptance will be high or low**

2. **Whether the manufacturers are able to produce the desired quality of technology or not**

These are then considered together in a scenario matrix. Four different scenarios will come out in the corners of the matrix, like in the figure below.
A look into the Future of the Global Automobile Industry with an emphasis on Emerging Fuel Technologies –
Rivalry Strategy Impact

Figure 6: Scenario Matrix

Next, the most important key trends and other key uncertainties identified through the PEST analysis, expert interviews (SEE APPENDIX 4A and 4B) and the assessment of the emerging fuel technologies, as seen in the above table, are then added to the resulting industry scenarios. In regards to the speed of commercialization and consumers acceptance we have identified governmental regulations and the volatility in the oil price to be the most influential factors.

To give a look into one specific future we will through scenario 2, “New Era of the Automobile Industry”, illustrate the impact of the emerging fuel technologies on the rest of the Porters 5 Forces; Internal Rivalry, Bargaining Power of Buyers, New Entrants and Suppliers in a given future scenario. Our choice of scenario is based on that the automobile manufacturers would be interested to have an understanding of how a future where the technology is readily available, and the consumer acceptance is high, will cause shifts in the
rivalry within the automobile industry. This however does not decrease the likelihood and impact of the other plausible scenarios to be realized in the future.

6.1 Future Scenarios of the Automobile Industry

In the following the four final scenarios are presented. Firstly, “Where is the Electric Car?”, “Business as Usual” and “Cheap Fuel” are briefly presented to show the given changes in the industry. Finally, the “New Era of the Automobile Industry” is more comprehensively analyzed through the remaining forces in the Porters 5 forces model.

6.1.1 Where is the Electric Car?

Over the decade, demand for alternative propelled cars and “breakthroughs” has become extremely high. Unfortunately, manufacturers have been slow to deliver, despite strong consumer pressure and ambitious government R&D initiatives. Promises of electric and plug-in hybrid vehicles in particular have not fulfilled their early promise after years of R&D in battery technology, causing the consumers to demand: “Where is the Electric Car?” The lack of further advances in the electrification technologies has meant that investments from important stakeholders dried up. Despite the various partnerships and collaborations, manufacturers were slow to implement the technological know-how to make the technologies competitive at a sustainable level. Partly, based on the inconsistency of governments to promote one specific technology, but also due to that other governments across the world did not follow the strict EU environmental policy for CO₂ reduction. This eased some of the pressure on the automobile industry to produce these vehicles. Also failure to locate the best suppliers to deliver quality technology has affected the manufacturer’s capability to improve the alternative vehicles sufficiently. Barriers to enter the industry are consequently lowered and new entrants and start-up companies specialized in PHEVs and EV’s have entered the industry and are pressuring the incumbents for market shares, hence increasing the rivalry.

Complementary industries have on the other hand aided with setting up the necessary infrastructure, and are providing financing options for consumers, which means that the initial price of the alternative vehicles are going down even though they are at a disadvantage

compared to the conventional car in terms of convenience and performance. Furthermore, as the oil is expected to peak anytime soon, there are serious concerns about the future supply of oil, which has skyrocketed the oil price to $200 a barrel over the decade. Consequently fuel prices at the local gas stations across the world are very high, causing consumers to demand alternative vehicles. Simultaneously, fears of climate changes have also intensified over the decade, and people are increasingly concerned about their cars CO₂ emissions. Governments worldwide have extensively promoted the benefits of the different alternative vehicle options through educational and marketing campaigns and also subsidized and set tax initiatives for buyers of green cars. The consumers are benefitting from this by using their bargaining power to lower prices, which have intensified the competition among incumbents further.

In this scenario, the most successful automobile companies are not necessarily the best providers of quality technology. Rather, they are the ones who most readily anticipate their customers’ needs and adapt their product offering to these changing needs on a regular basis, using the best technologies available.

6.1.2 Business as Usual

The world has not evolved as many industry observers predicted back in 2010. Notwithstanding the early promising developments of the new fuel technologies, largely backed by R&D investments from governments across the world. Manufacturers have not been able to improve the quality sufficiently from status quo 2010. In spite of the early promises and the vast collaboration and alliances with suppliers, other manufacturers and other players to gain technical know-how, the incumbents were slow to make the technologies competitive for the mainstream consumers. Mainly due to the cost pressure related to the diversification approach they followed, as well as the lack of capable supply in form of skilled employees. The competition in the industry has not evolved much over the decade, with features like price, product and technology still being the biggest differentiation factors. The low demand for alternative vehicles has upheld the high barriers like achievement of scale economies, sufficient capital investments, and other costs and resource advantages which makes it very difficult for new entrants to enter the industry.

Concerns from the public about climate changes have diminished over the decade, and there is no longer intense scrutiny of the automobile industry as a root cause of global warming,
despite rising CO₂ emission levels in the world. EU commission’s 20-20-20 policy is the only CO₂ restricting environmental regulation for the auto sector in the world, as other governments have not followed, easing some of the pressure on the industry to produce alternative propulsion vehicles. The access to funding from other stakeholders, private persons, venture firms have also remained low, due to their little confidence in the new technologies. At the same time the peak of oil is believed to be at distance, giving to the stabilized oil price around $ 50 a barrel over the decade. The combination of appealing conventional fuel prices and not any significant improvements in the technologies has meant that consumer demand for alternative vehicles has stayed low. Although, governments support with subsidies and promotion started off well, the low consumer acceptance dried it. Seeing the low consumer demand, complementarily industries such as energy providers and power utilities have not aided with the necessary recharging infrastructure. Even though these vehicles are market available as an option to the petrol or diesel driven cars, they are more expensive and have shortcomings in terms of quality. With stable fuel prices, the average consumers are not willing to trade the convenience and comfort of driving a conventional car with a “greener” and more expensive option, especially when the overall performance and infrastructure are at a disadvantage to the conventional car, despite significantly reduced emission levels.

All in all, manufactures have taken a wait-and-see attitude, and have continued the “business as usual” within the boundaries of existing expertise and skills.

6.1.3 Cheap Fuel

With governmental aid through subsidies and investments in R&D schemes, significant developments and breakthroughs have fully developed and commercialized quality alternative vehicles akin to the conventional car. Given the automobile sector’s role as the main source of global warming, it has made governments of large automobile producing nations introduce stricter regulations for CO₂ emissions and conventional emissions control. These follow the EU’s 20-20-20 policy, to accelerate the development in the emerging fuel technologies, as the future mobility is believed to be away from petroleum. The consumer acceptance is, however, low. Several factors in play are a root cause to that. Over the period the oil prices have stabilized around $50 a barrel. Experts believe that the oil peak is at a distance, and there is

low anxiousness about further oil security. Consumers are taking advantage of the low conventional fuel prices, and see no need in changing cheaper vehicles for the more expensive hybrid, plug-in hybrid or electric vehicle options. Given that also concerns about climate changes have diminished over the decade, these vehicles appeal to only a few customer segments. Simultaneously the growing urbanization has created other means of travel patterns. For which reason consumers are also becoming less dependent on their own vehicles in areas with comprehensive public transportation like high-speed trains and other transit systems. Although, complementary industries have been encouraged to set up the infrastructure, they have taken a reluctant approach as they have seen that the demand for alternative vehicles is low.

Since all of the established manufacturers are able to produce quality alternative vehicles, the dominant economic features of the industry have been upheld, hence increasing the rivalry. This competition to gain technological know-how has increased the number of consolidation among incumbents and suppliers over the years. New suppliers specializing in the new parts and components required are competing for contracts from incumbent manufacturers. Accordingly, suppliers bargaining power towards the manufacturers are low. Although new entrants and new players have emerged, few have been able to establish themselves in the industry, as the entry barriers have remained high. The lack of demand for alternative vehicles has further enhanced the overcapacity challenges meaning that manufacturers cannot engage in price competition as profit margins are much squeezed. This has created a buyer’s market meaning that buyers have higher bargaining power towards dealerships.

6.1.4 New Era of the Automobile Industry

Over the past 10 years, emerging fuel technologies achieves unprecedented breakthroughs that are sustainable, economical, environmental friendly and appealing to consumers; increasing the demand for alternative vehicles in all customer segments. High volatility in the oil price over the decade, with the oil predicted to peak soon, has surged the oil price to a record high $200 a barrel. This has raised the conventional fuels prices to a point, where the economics of driving the ICE car is not appealing anymore. The high oil price is a strong incentive for consumers to shift to alternative vehicles. These now provide similar convenience of driving as with the ICE versions in terms of performance and the fuel

economy is likeable. A positive image endorsed by governmental campaigns and support the past ten years is another reason for the high consumer acceptance. Through the extensive education, global consumers are more aware of the different alternative vehicles and their benefits and are awarded incentives and subsidies such as high-tax reductions to shift to these. Furthermore, growing concerns about global warming from governments, the private- and public sector has created an urgent need to reduce CO₂ emissions. Governments of large automobile producing nations worldwide introduce over the decade, stricter regulations for CO₂ emissions and conventional emissions, following the successful implementation by the EU to lower the automobile sector’s carbon footprint to 95g/km by 2020 and comparatively lenient threshold of 250g/km CO₂ (new CAFÉ standard) in the US, accelerating the development in the emerging fuel technologies. High confidence from external financing sources in the emerging hybrid and electric solutions have facilitated the necessary capital to the auto sector to further acquire the desired technical know-how to improve, develop and produce quality technology. Contemporarily industries like the energy sector and power utilities play a more important role than ever by aiding with the infrastructure, which now fully supports electric vehicles and plug-in hybrids, starting a new era for the automobile industry.

6.1.4.1 Rivalry within the Automobile Industry

In the “New Era of the Automobile scenario”, manufacturers are making vehicles which comply with the strict regulations. Although manufacturers are characterized by high fixed costs and compete on the traditional features as brand identity, diversity, product differentiation, the means of competition has increasingly been around technology and innovation. As an increasing number of manufacturers are now able to produce quality natural gas, hybrid, plug-in hybrid and electric vehicles, the competition for market shares has become fiercer. This has heated up the competition, pushing the prices of these vehicles down. Manufacturers have over the decade experienced growing overall demand for automobiles, primarily from emerging markets. However, the high demand for alternative vehicles has decreased the opposite demand for traditional ICE vehicles, especially in the Triad markets. Saturation and maturity in Triad markets have grown severe over the decade, with the competition to capture new market segments stronger, while rivalry is somewhat weaker in the fast growing emerging markets.
Even though, the challenge of overcapacity has diminished over the years; there is still some excess capacity left, which is pushing the profits of the manufacturers down and preventing them to engage in strategic moves like price cuts. Competing on lower prices is not possible for most of the manufactures, even those with financial strength, as there are constant cost pressures. To get rid of the excess inventory, manufacturers have to sell these vehicles with very low profits, which have created a buyer’s market, further increasing the competition among the incumbents.

Established manufacturers who moved early and made extensive investments to develop natural gas, hybrid, or electrification technologies are those that have gained first-mover advantages and are among the market leaders in this scenario e.g. Toyota and Renault-Nissan. Here the access to intellectual property, as well as the financial and branding strength determines, whether an automobile manufacturer is among the early or late movers in alternative vehicles. Manufacturers who did not prioritize alternative propulsion technologies over the years are at a disadvantage, while those firms who are among the late movers have taken a follower position. To stay competitive it is a prerequisite that manufactures implement alternative vehicles like hybrids, plug-in hybrids and electric vehicles in their product offering, or be at a major competitive disadvantage. Vertically integrated technology sharing strategic alliances and joint ventures, to get access to technological know-how and gain competencies has increased over the years. The many consolidations, has decreased the numbers of competitors as many small scale manufacturers have been acquired to be a part of a larger manufacturer group or merged together with other small scale manufacturers to form larger alliances. As global players have become more equal in size and capability, that has increased the rivalry further. The high capital bounded in assets, means that few exits from the industry have been apparent over the decade as there is still a tangible demand for pure ICE cars, albeit decreasing. Those manufacturers who still only produce ICE cars are among the weakest players, losing market shares and experience lower profitability. On the other hand, alliance building processes of collaborations and partnerships between manufacturers, energy providers, and even governments to set up the necessary stage for the introduction of plug-in hybrids and electric vehicles have also been observable, diminishing some of the competition.

To ensure a competitive advantage in the “New Era of the Automobile Industry”, manufacturers who are able to cut the lead time through optimized development and production techniques to rapidly introduce alternative vehicles into different product segments
at the right timing to meet the consumers are the ones with a market edge. Such a move can intensify the already heightened rivalry further, as those manufacturers who lack strong product innovation capabilities are left behind or have to introduce alternative vehicles, even if these are not cost-efficient, to not lose the competitive battle.

Since the different incumbents have closed in on each other regarding technical know-how, differentiation based primarily on the quality of the technology and the ability to provide alternative vehicle models in all product segments are what distinguish manufacturers from each other, hence where revenues are secured. Manufacturers that offer alternative vehicles with better performance and higher quality than rivals in all of the product segments have a competitive edge and can influence the path the industry will take further into the future from 2020. Strongly differentiated products means that the brand-driven buyers stay with the company’s offering, as the switching cost to other brands will be high. This renders the opportunity for the manufacturers to build strong value propositions towards its existing consumers to prevent them to shop around. The manufacturers with already a stronger brand image and appeal have substantial advantage over less-known manufacturers, provided they are able to reposition them with the “green” label, as the automobile consumers are brand driven. Other areas where there are differentiating opportunities for the incumbents are within marketing and branding of the firms image as “green”. Manufacturers who engage in innovative marketing tactics (Thompson, Strickland III and Gamble, 2008) like special sales promotions, heavy advertising through various channels, rebates, low interest rate financing or drum up additional sales to attract customers have the chance to improve their market position. Focus on having more efficient and better customer service capabilities, and stronger capabilities to provide buyers with custom made vehicles are also likely to improve the market position. The growing urbanization opens up opportunities to introduce new mobility or car sharing solutions like DriveNow, car2go and Mu. These are likely to give manufacturers a competitive edge as people are constant on the move, hence an increased access to customers.

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63 BMWblog.com, 2011
64 Car2go.com, 2011
65 Just-auto.com, 2011
Overall, the rivalry in the “New Era of the Automobile Industry” is very strong, which renders opportunities and threats for the manufacturers managing the global automobile industry.

6.1.4.2 New Entrants

An increasing number of start-up firms e.g. Fisker Automotive, Bright Automotive, specializing in electric and plug-in hybrid vehicles have over the years attempted to enter the industry, seeing the high demand for alternative vehicles as their opportunity to gain market shares. However, as the automobile industry has remained capital intensive, meaning that these new entrants must be financially strong enough to meet the high capital requirements to enter on a large scale or enter at a cost disadvantage. In particular, the presence of significant economies of scale in manufacturing and other cost and resource advantages stemming from strong learning and experience curve effects in every level, proprietary technology, and vertically integrated alliances the incumbent manufacturers are in possession of, gives them a significant cost advantage over the start-up firms. Although, some of these start-up firms are backed up by large private investors who have invested enormous sums in R&D and production facilities, they still have higher fixed costs and lack behind on several features like access to a network of distribution channels, favourable locations, and access to the best and cheapest suppliers. These also come short on customer knowledge and simply do not have the same powerful brand image/experience as existing players. Others are relying entirely on an outsourcing model, like Fisker Automotive. The incapability to alone produce a large number of vehicles in order to reach the economies of scale needed to reduce battery costs significantly enough to compete in the markets, have meant that few have been able to survive in the industry. Therefore, their market share capture has been very marginal. On the other hand, however start-up firms e.g. Tesla Motors, which are engaged in vertically integrated JV’s with established manufacturers, provided that they offer something to the partnership, like new technology or can redefine the existing, have been able to enter successfully the industry.

6.1.4.2.1 Emergence of new players

Besides electric and plug-in hybrid manufacturers, there are also new players from other industries who have emerged to be a part of the “New Era of the Automobile Industry”. Rather than being manufacturers or assemblers, these are third parties like mobility service

66 Ambwashington.um.dk, 2011
providers and energy providers for instance. Entirely new business models e.g. electric vehicle network and infrastructure providers Better Place, innovative wireless charging solutions for plug-in hybrids and electric vehicles e.g. Witricity\textsuperscript{67}, and utilities e.g. EDF\textsuperscript{68} that provide recharging stations for electric mobility have entered the industry.

The fundamental economic features of the automobile industry has not changed significantly over the past ten years, meaning the industry is still mature and very capital intensive, for which reason entry barriers are high. Concluding wise, in our view in “New Era of the Automobile Industry” the competitive pressures from new entrants to the incumbent automobile manufacturers are to be regarded as moderate to low.

\subsection{6.1.4.3 Buyers}

Even though, research in the world’s largest automobile markets identified more than 10 years ago the demographic profile of early adopters of hybrid, plug-in hybrid and electric vehicles to occupy a niche; generally older, wealthy and highly educated individuals with special interest in technology (JD Power, 2010b; WEF, 2011a). Alternative vehicles today appeal to all the mainstream customer segments, especially in the Triad markets and China as more and more consumers are comfortable with using them in their daily life. Manufacturers are providing vehicles according to the driving behaviours of the consumers.

Consumers have a larger knowledge of alternative vehicles due to governmental promotional campaigns and subsidies offered to purchase these vehicles. Over the decade the access to information regarding alternative vehicles and the dealers is far easier to retrieve, and has been purveyed through media such as advertisements, the far-reaching press and most importantly through the increasing use of telematics e.g. internet and portable devices. Since alternative vehicles are now affordable for more and more customers, the demand is growing. In the regions where the access to natural gas is vast, like Asia Pacific, there the demand for NG vehicles is growing rapidly. However, these vehicles have not taken off in the Triads and China, as other solutions are pursued. Hybrids vehicles have a strong foothold in the US and Japanese markets, due to their prior experience with the technology as revealed in chapter 5. The European markets and China, on the other, have over the decade, embraced electric cars on a large scale. However, there is a tangible demand for electric cars both in the US and

\begin{thebibliography}{99}
\bibitem{67} Toyota.co.jp, 2011
\bibitem{68} Edf.com, 2011
\end{thebibliography}

Japan, like there is a tangible demand for hybrid vehicles in Europe. Although, typically consumers are brand loyal towards one specific firm which they have consistently been satisfied by, and learned to trust through prior purchases (Cole and Flynn, 2009). The increasingly convenience of shopping around and to get more or less complete information about prices, brands, product features and discounts means that the buyer’s switching costs of shifting to competing brands or substitutes are relatively low.

Over the decade, these alternative vehicles are increasingly equipped with innovations like intelligent communication due to the growing use of telematics in the vehicles. People are more than ever connected through devices such as mobile phones, laptops and intelligent navigation systems. For example, when arriving at your destination your GPS will communicate with sensors to find the first available parking space according to your vehicle and let you know, if other vehicles are in the area. These systems also communicate with other cars to ensure a better traffic flow, but as well to avoid dangerous situations. Moreover, growing urbanization has moved people to urban areas, which has meant that these areas have become more populated and motorization has increased. To lower the carbon footprint, an increasing number of urban cities now have low carbon or carbon free zones e.g. like in London. Entirely carbon free cities such as Masdar City are also in emergence. To make commuting more sustainable and ensure a continued and fast flow of traffic, car sharing and other types of mobility services have gained popularity for commuting in urban areas.

Although private consumers are the main profit generators for the automobile manufacturers, they are to a large extent very responsive to prices. Furthermore, as private consumers do not have the capabilities to setup their own production of vehicles the threat of backward integration is non-existing. Accordingly, in the “New Era of Automobile Industry” pressures from buyers are low, as they never purchase large volumes of cars and neither have the power to backward integrate.

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69 London.gov.uk, 2011
70 Masdarcity.com, 2011
6.1.4.4 Suppliers

6.1.4.4.1 Components and parts

Changes have been incurring in the suppliers industries which deliver to the automobile sector. In order to develop quality alternative vehicles, manufacturers have over the decade searched for new suppliers as the manufacturing of alternative vehicles requires new components and technologies like drive trains and batteries (Pilkington and Dyerson, 2004), especially for the hybrid, plug-in hybrid and electric vehicles. This suggests that many of the tier 1, tier 2 and tier 3 suppliers’ competences may over the years become obsolete. Especially tier 1 suppliers have to diversify their product portfolios by expanding into the new parts e.g. batteries, electric motors, electronic controllers, drive trains, inverters / converters, range extender generators and electrified components needed, or risk losing contracts to new emerging suppliers specializing in these parts and components like Quantum technologies\textsuperscript{71}, NEC and Sony for example. Since automobile manufacturers face low switching costs and can control terms of supply and price, the bargaining power of suppliers is low. Yet, manufacturers are more than ever dependent on the suppliers industries, as only the financially strong have attained in-house development of key components like batteries and electric motors through partnerships. Especially the development and production stages of batteries from raw materials to the single cell (AT Kearney, 2009), are an entirely new field for most of the manufacturers. On the other hand, battery suppliers might forward vertically integrate to create an electric vehicle by themselves, given the simple mechanical technology used in electric vehicles. Similar threat is unlikely with the natural gas, hybrid and plug-in hybrid options, as those are build upon the more advance ICE power train.

Over the decade, given the increased use of intelligent telematics systems in vehicles like navigations, connectivity and information systems have opened up for the emergence of a new breed of suppliers, which are from previously “unusual” sectors such as telecommunications and information technology sectors (KPMG, 2011). Suppliers like computer software providers e.g. Apple and Google, network and connectivity providers e.g. Cisco and navigation system makers e.g. TomTom have increased over the decade and are an integral part of the automobile manufacturers supplier collaborations.

\textsuperscript{71} Qtww.com, 2011
6.1.4.4.2 Raw materials

Securing access to the best and cheapest suppliers to have influence over and sufficient supply at all time to raw materials and components related to the batteries is critically important to prevent a shortage of supply. As more and more responsibility is passed on to the suppliers, the many partnerships and vertically integrated alliances with battery makers to lower transaction costs and control costs in general, are the ones who have to secure the supply. That is achieved through backward integration and partnerships with their suppliers to prevent a shortage of supply. By securing the upstream value chain, it will be more punctual to meet the production commitments towards automobile manufacturers at contractual prices as volatility in commodity prices can drive the prices of raw materials up.

6.1.4.4.3 Human Capital

Even though many processes have been automated, the automobile and suppliers industries still requires human capital as one of the most needed inputs to their businesses. The shift to alternative vehicles has accelerated a demand for graduates with the new technological know-how and capabilities in engineering and research from the manufacturers. For most manufacturers the necessary engineering and research skills have to be acquired. To expand the range of technologies and to develop specific products for local markets will require additional capacity in R&D departments, for example, which creates the need for human capital. However, as the ageing population in the mature economies has been growing over the decade. That may have critical effects for the further development of the alternative vehicles in the regions with the highest demand, as more and more people that reach retiring age, have to be replaced. At the same time, the trend over the decade has been that not enough engineering graduates want to work in the automobile sector, due to negative perception as a low tech industry (Ernst & Young, 2010b). This indicates that at some point beyond 2020, there will be a shortage of supply of qualified personnel in engineering and research in the mature economies. Accordingly, many manufacturers will not be able to increase their engineering capacities, simply because there is a lack of skilled labour available, creating pressures for the industry.

See Williamson, 1979
6.1.5 Summary of the Porters 5 Forces in “New Era of the Automobile Industry”

In the “New Era of the Automobile Industry” the intensity of rivalry is fierce. The pressures stemming from the new entrants are moderate to low, while both the pressures from suppliers and the buyers are regarded to be low. Hence, the collective forces are moderate in power, which indicate that the global automobile industry in this future scenario is attractive and there are opportunities of gaining nice profits.

There are many opportunities arising in this future industry scenario, but also threats which need to be considered, to strategize accordingly. In the following there will be given a summary of the opportunities and threats arising from the industry scenario analysis of “New Era of the Automobile Industry”.

6.1.5.1 Opportunities

Several opportunities will arise in the “New Era of Automobile Industry” scenario. Emerging fuel technologies as revealed in chapter 5 represent vast market opportunities in the future. Offering products with higher quality and better performance faster than the competition render opportunities for competitive advantage. There will be opportunities in regards to the introduction of alternative vehicle models, in every product segment to reach more broadly. Other more product specific opportunities which are likely to differentiate one manufacturer from another are within incorporation of telematics within vehicles, have increased focus on marketing, customer services and introduction of new ways of reaching customers due to the rising urbanization e.g. car sharing and mobility concepts. The possibility of backward integration to take over steps from the production of electric vehicles also represents opportunities for some manufacturers. Present opportunities within M&A to share costs or gain access to technology or other resources, and other strategic alliances will stand for the majority of inorganic growth in the future. Collaborations and partnerships with new players such as governments and utilities represent also opportunities where first mover advantages within alternative vehicles can be achieved. Lastly, the vast opportunities which lie in the emerging markets can organically grow the businesses of automobile manufacturers further.
6.1.5.2 Threats

On the other hand the automobile manufacturers will face increasing rivalry which may squeeze the profit margins down. Present challenges like saturation in mature markets and overcapacity will continue to be a concern into the future. New entrants like start-up firms and third parties with new business models will emerge, and are likely to a certain degree pressure the industry players for profits and market shares. The likelihood of pressures stemming from suppliers who may forward integrate will increase, especially from battery makers given the simple technology of electric vehicles. Moreover, in the future a shortcoming of human capital in traditional markets is likely, due to the increasing ageing population and fewer engineering graduates. Furthermore, consolidation is also likely to increase in the future, creating more equal industry players. Finally, the increasing demand for alternative vehicles will decrease the sales of conventional ICE cars.

All these are challenges which a manufacturer has to take into account when strategizing in the “New Era of the Automobile Industry” scenario.
7. Strategic Implications (Impact on rivalry strategy)

In this chapter we will demonstrate the impact of the “New Era of the Automobile Industry” on the rivalry strategy. The purpose is to illustrate how automobile companies will possibly react, according to their individual resource capabilities and deficiencies to the arising market opportunities and threats in the future scenario. For that reason, we have deliberately chosen two major but distinct automobile manufacturers groups, PSA Peugeot Citroën and Toyota Motor Corporation. Firstly, because they originate from different continents; PSA is Europe’s second largest manufacturer and the leading European manufacturer in unit sales of low carbon vehicles (PSA annual report, 2009), while the world’s largest automobile manufacturer Toyota hails from Japan and is the market leader within hybrid technology. We will here illustrate how these firms have to strategize to be best possible ready for “New Era of the Automobile Industry”.

To get a comprehensive overview of whether PSA and Toyota’s overall situation is fundamentally healthy or unhealthy the SWOT analysis is applied. The SWOT analysis is a powerful tool to appraise a company’s resource Strengths and Weaknesses and its external Opportunities and Threats to its future well-being (Thompson, Strickland III and Gamble, 2008). We will draw the conclusions from the SWOT analysis into strategic actions to better match PSA’s and Toyota’s strategy to their resource strengths and future market opportunities, and to correct the important weaknesses, and to defend against future external threats.
7.1 PSA Peugeot Citroën

7.1.1 Overview of PSA Peugeot Citroën

The PSA Peugeot Citroën Group (PSA) saw its present day existence when two independent French manufacturers Citroën SA and Peugeot SA merged together in 1976\(^{73}\). Today, PSA is the third largest European automobile manufacturer after Volkswagen and the Fiat-Chrysler alliance, as referred in chapter 4. Headquartered in Paris, the PSA Group employs 186,200 people in 160 countries worldwide and has 15 production centres across the world, mostly in France\(^{74}\). The main markets served are in Europe, Latin America, Russia and China. The latter three accounted together for some 39 percent of the total sales in 2010 (PSA annual Report, 2010). The group is divided into five distinct divisions: Automotive Division, Banque PSA Finance, Faurecia, Gefco and other businesses. Through these divisions PSA manages vehicle production, vehicle financing, automotive equipment\(^{75}\), transportation and logistics and the operations of the Group’s holding company (PSA Sustainability Report, 2009). PSA manages two distinct brand groups; Peugeot brand group and the Citroën brand group.

7.1.2 Financial Performance

In 2010 PSA reported net revenues above 56 billion €, growth of 15.8 percent from 2009, of which € 41,405 billion were generated by the automotive division (Annual Result Report, 2010). With a strong financial recovery and a record more than 3.6 million vehicles sold in 2010, the PSA Group has turnaround the fragile financial conditions from the previous year. PSA experienced sales growth in all its key markets; in Europe the total share ended on 14.2 percent up from 13.5 percent in 2008, China had also a slightly increase from the previous year with 0.1 growth to total 3.4 percent share in 2010, while Latin America grew from 0.2

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\(^{73}\) PSA-Peugeot-Citroen.com, 2010a

\(^{74}\) PSA-Peugeot-Citroen.com, 2010b

\(^{75}\) From production of seats to exhaust systems

percent to 5.4 percent in 2010\textsuperscript{76}. Only Russia had a small contradiction of 0.1 percent to 2.8 percent total share in 2010\textsuperscript{77}. Although the company have on average had negative sales growth the past 5 years, as seen in the table below, the above mentioned numbers indicates that PSA have good sales growth prospects in the future, especially as the company has strong focus on emerging markets.

The table below shows how well PSA has performed in comparison to its main competitors. PSA has for the past 5 years on average had a poor profitability, 1.01, in terms of how much profit it generated from shareholders investments (ROE) compared to the industry average of 10.06. In addition PSA has also performed less than the industry average regarding how much returns it have generated on its investments (ROI), with -0.04 compared to the industry average of 6.95. The same goes for ROA, with PSA’s profitability relative to its total assets on -0.01 is negative, in comparison to the industry performance of 3.64.

Table 10: Key Financial Ratios – Comparison of Industry (last 5 years average)

<table>
<thead>
<tr>
<th>Automobile Manufacturers</th>
<th>ROE</th>
<th>ROI</th>
<th>ROA</th>
<th>Sales growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honda</td>
<td>10.47</td>
<td>4.82</td>
<td>3.08</td>
<td>-0.16</td>
</tr>
<tr>
<td>Nissan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-2.6</td>
</tr>
<tr>
<td>PSA Peugeot Citroën</td>
<td>1.01</td>
<td>-0.04</td>
<td>-0.01</td>
<td>-0.07</td>
</tr>
<tr>
<td>Fiat</td>
<td>8.75</td>
<td>2.81</td>
<td>1.52</td>
<td>-5.07</td>
</tr>
<tr>
<td>Hyundai</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>13.86</td>
</tr>
<tr>
<td>Industry</td>
<td>10.06</td>
<td>6.95</td>
<td>3.64</td>
<td>11.64</td>
</tr>
</tbody>
</table>

Source: numbers taken separately from [http://www.reuters.com/finance/stocks](http://www.reuters.com/finance/stocks), authors own compilation

The capital structure has total debt-to-equity of 239.83 in the most recent quarter, and thus much higher than the industry average of 22.42\textsuperscript{78}. PSA have a solid capital structure mix of long-term debt and equity that it uses to finance its operation. The automotive division has no

\textsuperscript{76} PSA-Peugeot-Citroen.com, 2011b

\textsuperscript{77} Ibid.


net debt, while the gross debt of the group is targeted to decrease from 1,524 million Euros today to reach as low as 254 million Euros in the 2018 - 2025 periods included the full repayment of French State loan by April 2011. The financial leverage of PSA is very low, with a gearing of 8.6 percent in 2010. It implies that PSA activities are mainly funded by its own equity, and have very little debt, which means that the company has a high level of financial security. PSA’s ability to meet short-term obligations are mirrored in the current ratio of 1.09 in the most recent quarter, compared to the industry average of 0.23, while the quick ratio of 0.95 in the most recent quarter is well above the industry average of 0.20. This indicates that PSA have the necessary financial strength to meet its short term obligations in general, but also without relying on the sales of inventories. Moreover, the PSA Group has recovered strongly from the financial crisis, with all its entities contributing to the turnaround. Recurring operating income went from a loss of 689 million Euros in 2009 to a positive gain of 1,796 million Euros in 2010 of 621 million Euros were from the automotive division. This indicates that PSA has recovered its operations and sales. The net income of the PSA Group ended on 1,134 million Euros opposed to negative 1,161 million Euros in 2009.

Although, the PSA group has recovered strongly from the financial recession, key financial ratios the past 5 years show that the company is very little profitable as it is has performed well below the industry average. Given that the financial leverage of PSA is very low, on the other hand, it implies that the company has access to equity to finance its operations, at least in the short term. Hence, the PSA’s financial conditions for now are secure, but further business growth in the future depends on how well the company are able to perform in terms of operation and sales (See Performance Plan).

79 PSA-Peugeot-Citroen.com, 2011b
80 Ibid.
82 PSA-Peugeot-Citroen.com, 2011b
83 Ibid.
A change in the managing board in 2009 formed a new corporate strategy for PSA which is based upon four main pillars included strengthening the company’s environmental performance, and have a strong presence in emerging markets (PSA Annual Report, 2009). With core competency lying in how an automobile should function; a combined effort of different departments joining together and building a car, PSA has consecutively for three years won the prestigious “The International Engine of the Year Award” on engines which have been built in co-operation with BMW. PSA’s two brand groups Peugeot and Citroën are clearly differentiated through distinct vehicle design (PSA Annual Report, 2009), which in our view is one of PSA’s main distinctive competencies too. PSA acknowledge that to increase their presence in the emerging markets, strong brand awareness and a global image is necessary to compete with the top (Ibid.).

To lower GHG, it is important for PSA to incorporate the alternative propulsion technologies into their program, but also to improve the existing engine technologies (PSA Annual Report, 2009; PSA Sustainability Report 2009). As a European leader in low carbon vehicles with more than 750,000 vehicles emitting less than 120 g/km CO₂ sold in 2009 (PSA Annual Report, 2009), PSA’s effort to stay in this position is also mirrored in their production which has an increased focus on improving the existing ICE. The aim is to increase this number to 1 million by 2012 (Ibid.). The latter shows that PSA believes that European consumers are interested in fuel efficient cars, and if it is beneficial for the environment, it is also an advantage. Furthermore, PSA’s approach is into the whole array of emerging technologies, as they believe the offering will depend on regional demand. For example, in Europe, the focus will be on selling electric vehicles and hybrids which are planned to be marketed from 2011 (Ibid.). Unlike the Toyota Prius, PSA’s hybrid, the Peugeot 3008 Hybrid4 will be a diesel hybrid, which according to environmental manager Jens Andersen (2010), is a more fuel efficient solution and will be able to perform better than the Prius. The reason for choosing a diesel hybrid is related to that the company has a technological know-how within diesel engines. Further, the company is working on launching different variants of hybrid technologies to the market such as the e-HDI micro hybrid in the Citroën C4 model. Most recently, PSA have also launched two full electric models in collaboration with Mitsubishi;

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84 PSA-Peugeot-Citroen.com, 2009a
Peugeot iOn and the Citroën C-Zero, as mentioned in chapter 4, which indicates that electric vehicles are also regarded highly. Overall, it is clear that PSA are very competent in regards to developing new vehicles, which are environmental friendly, and that they are increasing the number of car launches into the market. Another effort from PSA to attract new customers is through e-commerce, as the company is working on the idea of selling cars online. However, it will not be marketed under the Peugeot or Citroën brand, since the company is not interested in losing the image they have created around the two brands. Instead PSA will create a new brand to outcompete the used car sales market and its regular competitors.

The company foresees a shift in consumer travel patterns due to the growing urbanization (PSA Sustainability Report, 2009). Therefore, PSA have introduced “Mu by Peugeot”, a mobility concept which offers consumers the possibility to rent different types of transportation like bicycles, scooter and cars for shorter or longer distances (PSA Sustainability Report, 2009; Peugeot Press Release, 2009). This solution can offer a competitive advantage to PSA, but competitors have already started to offer similar services e.g. BMW DriveNow and Daimler AG have car2go, although not as extensive as the one PSA is offering.

During 2010-2012, PSA plans to improve its operating efficiency by investing 3.3 billion Euros into a performance plan, of which 55 percent will be used to ensure cost reductions. The remaining 45 percent will be used on a marketing strategy, which will help improve PSA’s overall performance and improve their sales numbers (PSA Sustainability Report 2009). One of the first steps in their cost reduction plan is to cut the numbers of media providers from three to two. By doing this PSA can cut costs and streamline their efforts.

Over the years PSA has invested in several partnerships around the world. PSA has, for instance, a JV with Toyota in Czech Republic, to produce small cars for the European market. PSA joined Toyota due to the intense rivalry the two companies were experiencing from Korean manufacturers who had begun launching A-segment cars into Europe (Andersen Interview 1+2, 2010). This partnership produces the same vehicle at one factory under different names, namely the Citroën C1, Peugeot 107 and the Toyota Aygo.

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85 Online.wsj.com, 2011
86 Autonews.com, 2011
87 Car2go.com, 2011
88 PSA-Peugeot-Citroen.com, 2009b
89 Mediaweek.co.uk, 2009
90 Tpca.cz, 2011

Interview 1+2, 2010). Other major partnerships the French manufacturer is involved in are a co-operation with BMW on the development of efficient petrol engines and components for hybrids. In addition, PSA has a joint venture with Mitsubishi Motors regarding the production of the Citroën C-Zero and the Peugeot iOn. The benefits of these partnerships are the possibility to share information on battery technology, achieve technological know-how, EV competencies, and gain economies of scale; it also means that PSA save on R&D and costs in general.

One of the biggest reasons for why Japanese car manufacturers have a competitive advantage over their rivals is due to lean production. PSA are aware of the possibilities that come along by improving their own lean production in their factories to lowering capacity and improving their production performance (PSA Annual Report, 2009). Presently, they are focusing on reducing the floor space used during production and removing all complicated or unnecessary movements to save time (Ibid.). PSA acknowledges that they are behind their competitors in this field, but their investment of 3.3 billion Euros in the performance plan in the coming years can have a very positive effect on PSA.

At present PSA is rolling out a new model named Peugeot “508”, and for the first time PSA is introducing variable night shifts to increase output with 60 percent as demand for this model will be high. By introducing variable night shifts to the plants PSA can e.g., also increase the number of diesel hybrids to the market and beat their competitors simply by focusing on delivering before time and scooping up the consumers which are considering of purchasing an environmental vehicle.

PSA have a special emphasis on delivering the right service to the customer during purchase, delivery, maintenance and repairs, this is a main focus for the company. Paying attention to it has meant that warranty claims have gone down with 58 percent, and the costs related to these have decreased with more than 66 percent (PSA Annual Report, 2009). This shows that PSA regard their reputation and consumers highly.

91 PSA-Peugeot-Citroen.com, 2010c
92 PSA-Peugeot-Citroen.com, 2011a
7.1.3.2 Potential Resource Weaknesses and Competitive Deficiencies of PSA

Being a volume manufacturer PSA is competing with the likes of Toyota, GM, Ford and VW, and is present in all product segments. The competition for market share is fierce, which has placed PSA currently behind the top five manufacturers. As mentioned earlier, PSA are engaged in several partnerships in regards to production. These partnerships confirm the fact that PSA does not have the required skills in-house to produce their own engines; (Andersen Interview 1+2, 2010). Compared to other major players PSA’s Production System is not as fine-tuned. Therefore the company has been working on reducing costs and development time by re-using more components among different vehicles, to help decrease lead time on production (PSA Annual Report, 2009). Not having a fine tuned production is not only costly it can also decrease the company’s market shares if they e.g. cannot follow the demand.

Selling cars is becoming increasingly more difficult, with many players with different offerings, therefore to attract new customers, PSA needs to improve the overall quality of their services provided, as it has been deemed too weak (PSA Annual Report, 2009).

7.1.4 Conclusion of SWOT

PSA have a core competency within diesel hybrid technology and they are continuously striving to be the leader in low carbon vehicles in Europe. Furthermore, the company’s hard work in differentiating their vehicles through a distinctive design has become a distinctive competency for PSA. The automobile industry is entering a new era, and the fact that PSA have a competency within diesel hybrids can in the future help to increase their market shares. However, electrification is also an important asset which PSA acquire through collaboration with Mitsubishi; on the other hand if PSA can produce this technology in-house they can strengthen their position towards the incumbents. However, the company’s deficiencies are extremely critical for PSA’s business, firstly the Production System is the heart within every automobile manufacturer’s operational process, which PSA acknowledge and are working on as improving the production system can help to decrease their costs. Secondly PSA have been struggling with decreasing sales, this PSA is currently trying to solve by implementing the

performance plan. Hence, PSA do have issues which are being dealt with to ensure market growth, on the basis of this the company’s overall situation is rated as being healthy.

7.1.4.1 PSA’s strengths and weakness summarized

**Strengths**
- Powerful Corporate Strategy with clear focus on environmental challenges backed up by a Board which is not afraid of taking chances
- Leaders within Diesel hybrid technology
- Strong focus on R&D; leaders in diesel engines
- Strong line up of cars in every technology
- Offering of a Mobility Service to the market “Mu by Peugeot”
- Strong partnerships and joint ventures around the world
- Gaining market shares outside Europe, especially China and Latin America
- Collaborations with Mitsubishi on EV’s & BMW on engines
- European leaders within low carbon vehicles
- Distinct vehicle Design
- Solid capital structure mix

**Weaknesses**
- Losing market share in Europe
- Weakness in Production System
- Weakness in regards to after sales/repairs
- Recovering from Financial Crisis
- Negative profitability
- Operation and sales

**Opportunities**
- Emerging technologies / Alternative vehicles
- Emerging markets
- Differentiation
- Car Sharing / Mobility Service /Urbanization
- Strategic alliances and collaborations
- Backward integration /Make or Buy

**Threats**
- Saturation in mature markets / Slowdown in market growth
- Increasing rivalry/competitors close in / may squeeze profit margins
- Overcapacity – cost pressures - buyers markets
- New entrants / new players New business models
- Threat of forward integration of suppliers
- Lack of human capital
- Decrease in ICE sales
- Consolidation
7.1.5 PSA Generic Strategy

Using the expanded concept of generic strategies as pioneered by M.E. Porter (1980) in Strickland III, Thompson & Gamble (2008), we have identified that PSA is following a broad differentiation strategy. Today PSA are represented within every product segment, and over the years they have acquired a distinctive competence in vehicle design. This comes especially to expression through PSA’s two newly market launches mainly the Peugeot RCZ Coupe\textsuperscript{93} and the Citroën DS3\textsuperscript{94}, which both are luxury vehicles. For this reason PSA also act according to a best cost provider strategy.

7.1.6 Strategic Actions for PSA

PSA is currently outside the top five automobile manufacturers. Given that, we base PSA to be a typical runner-up firm, which strives to better its industry position. In regard to this, we will in the following analyze what position PSA is likely to have in the “New Era of the Automobile Industry”. Thompson, Strickland III & Gamble (2008) suggest that runner-up firms are often advancing market challengers who strive to improve their market positions. That fits well with PSA’s current standing. The latter authors highlight among offensive strategies for runner-up firms who aim to improve their market positions; growth via acquisition of smaller firms, finding innovative ways to drive down costs, crafting an attractive differentiation strategy, pioneering a leapfrog technological breakthrough or being first-to-market with new or better products. Thompson, Strickland III & Gamble (2008) also mentions five other strategic approaches runner-up firms can employ, as follows:

1. **Vacant Niche Strategy**: This strategy implies that PSA concentrate on customer groups which have been neglected by market leaders.

2. **Specialist Strategy**: This strategy implies that PSA focus on one specific technology, product or market segment.

\textsuperscript{93} Peugeot.dk, 2011  
\textsuperscript{94} DS3.citroen.com, 2011

3. **Superior Product Strategy:** This strategy implies that PSA focus on selling superior quality products to the luxury segment.

4. **Distinctive Image Strategy:** This strategy implies that PSA differentiate themselves from their competitors by focusing on a distinctive design.

5. **Content Follower Strategy:** This strategy implies that PSA copy the competitor’s products, but do not try to steal shares from the market leader, they take a defensive position rather than offensive.

From the SWOT analysis we have gained valuable information concerning PSA, this knowledge will be used to adjust the strategy of PSA as a runner-up firm with decent profits, to make the company more competitive in the “New Era of the Automobile Industry”. As a leader within distinctive vehicle design, PSA should pursue a “Distinctive-Image Strategy” (Thompson, Strickland III & Gamble, 2008), besides focusing on growth via acquisition. Accordingly, PSA should emphasize on its capabilities like being the leader within low carbon vehicles and diesel hybrids, which are competitive strengths which PSA should continue to build on. Furthermore, offering a distinctive design to their portfolio of vehicles is also crucial, as it is what differentiates them from their competitors. In the following this will be elaborated.

7.1.6.1 **Diesel Hybrid and Electric Vehicles: Growth through Acquisition and Strategic Alliances**

For PSA it is hard to increase their sales numbers from current standings of approx 3 million vehicles annually, over the last three years (PSA Sustainability Report, 2009) as it does not have the financial strength of an industry leader like Toyota. For PSA to increase this requires either; huge financial intakes or the acquisition of a smaller firm, possibly a new entrant. To be competitive in the “New Era of the Automobile Industry” scenario PSA will benefit from acquiring a start-up electric vehicle manufacturer. Such an acquisition can strengthen their image as the leading low carbon manufacturer in Europe and can facilitate for PSA, to produce in-house its own electric vehicles. Hereby, PSA can lower transaction costs, gain
intellectual property rights (IP), and earn valuable technical transfer. Another strategic move for PSA is to take advantage of its partnership with Mitsubishi Motors on electric vehicles. By expanding the partnership, both companies can share development and manufacturing costs, while PSA can take advantage from the technology transfer. Since PSA already now, has market launched electric vehicles through the partnership, an increased focus on the collaboration is likely to increase its competitiveness in the industry. The future goal of the alliance must be, to produce new and innovative electric cars for the mass-market, while PSA is staying true to the overall strategy of excelling within distinctive design and low carbon vehicles.

Another impetus for PSA in the “New Era of the Automobile Industry” is to cement its position as the leader within diesel hybrids. This will ensure that the company achieve a first-mover advantage in that aspect and can enhance its competitiveness further.

7.1.6.2 Increase market share in Europe

In Europe, PSA must regain their lost markets shares; one possibility is for PSA to decrease their production costs. To achieve this PSA must improve their Production System, as low costs can lead to a deduction in the sales price of their cars, which can draw back the customers, but also help to win customers from other manufacturers.

7.1.6.3 New mobility services

New mobility concepts build on the new travel patterns due to increasing urbanization gives rivals a competitive advantage in the “New Era of the Automobile Industry”. This is a solution PSA already has a first-mover advantage in, as they launched “Mu by Peugeot” in 2010. In the forthcoming years PSA can expand this to gain valuable experience and cement its competitive edge and gain a larger customer base.

PSA have for many years been a runner up firm in the industry. However, if PSA can take advantage of their strengths and opportunities in the “New Era of the Automobile Industry”,
then PSA can move market shares, even though not necessarily becoming the industry leader, but increasing their sales numbers and their presence in Europe yet again.

In the following years to come for PSA to successfully compete in the “New Era of the Automobile Industry”, as mentioned above, we recommend PSA to implement the following strategic actions over the next decade:

- Focus on the alliance with Mitsubishi motors
- Acquisition of a startup electric manufacturer
- Cement its position as a leader within diesel hybrids
- Increase market shares in Europe
- Continue to improve the Mu by Peugeot

PSA have many opportunities ahead in the future provided that they take advantage of those, to prevail in the future scenario.

7.2 Toyota Motor Corporation

7.2.1 Overview of Toyota Motor Corporation

Toyota Motor Corporation (Toyota) was founded in 1937 in Japan\(^{95}\) as a venture firm. Headquartered in Toyota City, Toyota is the world’s largest automobile manufacturer both in terms of volume and amount of sold vehicles and employees 320,808 people (Toyota Annual Report, 2010). The company is represented in more than 170 countries and has 51 overseas manufacturing plants in 26 countries\(^{96}\). Its main markets are Japan, North America, Europe and Asia. In 2009, Toyota achieved a record high market share in Japan of 44.3 percent (Ibid.). Moreover, Toyota’s businesses can be divided in two main divisions; the automotive and financial services sectors (Ibid.). The financial services division is for instance providing leasing, insurance, dealer and customer financing. The company had a total vehicle

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\(^{95}\) Toyota.co.jp: 2011a  
\(^{96}\) Toyota-global.com, 2010a
production of 6,809,000 units in 2010 (Ibid.), which is a decline of 3.4 percent compared to 2009 volume.

7.2.2 Financial Performance

The company reported net revenues of $203,687 million and more than 7.23 million sold vehicles in 2010, which is a decline in sales growth of 7.7 percent compared to previous year (Toyota Annual Report, 2010). Mainly due to financial recession, negative publicity due to break jam with recalls of more than 12 million vehicles globally\(^2\) and overcapacity issues.

The table below shows how well Toyota has performed in comparison to its main competitors. We can see that Toyota has for the past 5 years on average had a slightly less profitability, 8.34, in terms of how much profit it generated from shareholders investments (ROE) compared to the industry average of 10.06, while 2010 ended on 2.1 percent\(^3\). In addition Toyota has also performed less than the industry average regarding how much returns it have generated on its investments (ROI), with 0.55 compared to the industry average of 6.95. Although, Toyota reported a ROA of 0.7 percent in 2010\(^4\), Toyotas profitability relative to its total assets has on average been 2.66 over the 5 year period, which is better than that of today, but a bit lower than the industry performance of 3.64.

<table>
<thead>
<tr>
<th>Automobile manufacturers</th>
<th>ROE</th>
<th>ROI</th>
<th>ROA</th>
<th>Sales Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford</td>
<td>-</td>
<td>-2.47</td>
<td>-1.76</td>
<td>-6.12</td>
</tr>
<tr>
<td>Toyota</td>
<td>8.34</td>
<td>0.55</td>
<td>2.66</td>
<td>0.43</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>11.37</td>
<td>3.95</td>
<td>2.38</td>
<td>6.41</td>
</tr>
<tr>
<td>GM (no data after re-Organization)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Industry</td>
<td>10.06</td>
<td>6.95</td>
<td>3.64</td>
<td>11.64</td>
</tr>
</tbody>
</table>

Source: numbers taken separately from [http://www.reuters.com/finance/stocks](http://www.reuters.com/finance/stocks), authors own compilation

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\(^2\) Businessweek.com, 2011  
\(^3\) Toyota-global.com, 2011  
\(^4\) Ibid.

The capital structure has total debt-to-equity of 117.65 in the most recent quarter, and thus much higher than the industry average of 21.87. The debt-to-equity-ratio in 2010 was about 64 percent, slightly higher than 59 percent in 2009, indicating that Toyota is using more debt to finance its activities than equity. Toyota’s ability to meet short-term obligations are good as mirrored by the high current ratio in the most recent quarter of 1.18 compared to the industry average of 0.23, while the quick ratio of 1.04 compared to industry average of 0.20 indicates that the company are able to pay off its short-term obligations without relying on sales of inventory. That indicates that Toyota is financially strong. Like the rest of the automobile sector, Toyota is recovering strongly from the economic crisis, with a reported net income of $2,251 million in fiscal year (FY)2010, as compared to the net loss of $4,369.4 million in FY2009 (Toyota Annual report, 2010). Operating profit of $1,586 million during FY2010 showed that the company has recovered some of it sales, as compared to an operating loss of $4,610.1 million in FY2009 (Ibid.). These numbers shows that Toyota is financially secure, albeit declining sales, the many automobile recalls during 2009, and overcapacity issues have affected Toyota’s overall performance for the past 5 years. Toyota is financially strong and has ample financial resources to grow its business, meaning that is does not need to engage in strategic alliances or partnership for the cause of finances.

7.2.3 SWOT Analysis of Toyota

7.2.3.1 Resource Strengths and Competitive Capabilities of Toyota

To ensure a leading position in the market place, Toyota acknowledges that in the future, alternative fuels or power trains with renewable energy sources will co-exist with the conventional petroleum derived fuels (Eriksen Interview, 2010). Therefore, Toyota’s long term goal is to create the ultimate eco car, that produces zero tailpipe emissions and at the same time does not have a negative impact on the environment. To reach this goal the long-term strategy of the company, is to work simultaneously on a range of technologies such as the plug-in hybrid, battery electric, hydrogen fuel cell and bio-fuels, by implementing the hybrid technology at the core (Toyota Annual report 2010). Electrification is also seen as very

101 Authors own estimates substantiated by the consolidated balance sheet 2010
102 Ibid.
103 Toyota.com, 2010
104 Toyota.eu, 2010
vital, for this reason Toyota recently made a joint venture with electric vehicle manufacturer Tesla Motors\textsuperscript{105}, as previously mentioned in chapter 4. This will give Toyota access to valuable battery technology and Tesla’s core competencies in electric car power train technology manufacturing. The expected outcome of this partnership is an electric car made by Toyota which can be priced lower than Tesla’s Model-S and the Roadster model\textsuperscript{106}. The production of an EV is an integral part of the company’s growth strategy. To ensure future organic growth Toyota focuses on having a presence in the emerging markets to be a vital part of the company’s growth strategy (Ibid.).

For the past three decades Toyota has had a sustainable competitive advantage over its rivals, due to the development of lean manufacturing techniques, resulting from years with continual learning experience. The TPS is a role model for automobile manufacturers, and proven to be a distinctive competency for Toyota as it has helped to reduce costs significantly (Teresko, 2007; Takeuchi et al, 2008). TPS ensures that Toyota can reduce stock balance and errors everywhere in Toyota’s global activities, and gives the company a flexibility which is still unmatched to this day\textsuperscript{107} as well as a major cost advantage over its rivals.

Being an innovation based company, Toyota is in possession of substantial product innovation capabilities through the “Toyota Product Development System”, based on the same lean values as TPS, and can regularly develop higher quality automobile faster than the rivals at lower unit costs and higher profits (Liker and Morgan, 2006). Accordingly Toyota is among the leaders in the development of products and new models and manages more new vehicle launches than most of the American and European competitors (Culpan, 2002; Liker and Morgan, 2006).

In 1997, Toyota launched the world’s first mass produced hybrid vehicle, the Prius. The move was seen as a radical innovation in the industry, but by 2010 the sales numbers had reached 2 million sold units worldwide\textsuperscript{108}. The innovative and great technological development of the Prius has given Toyota a fantastic market opportunity and shifted Toyota’s profile towards being the leading manufacturer of sustainable mobility (Zapata and Nieuwenhuis, 2010). The company’s core competency lies in their patented hybrid technology; in which Toyota also have first-mover advantage according to Toyota Norway’s Marketing director, Håkon Tveten

\textsuperscript{105} Triplepundit.com, 2010
\textsuperscript{106} Teslamotors.com, 2011
\textsuperscript{107} Toyota.dk, 2010
\textsuperscript{108} Toyota-Global.com, 2010b
Eriksen (2010). However, at the same time he admits that “Yet, in my view the advantages are primarily on the reputation side...as we are aware of that the lead can be quickly detached [...] Toyota has patented the (hybrid) technology to several competitors and is spending more than 40 billion NKR annually in R&D of next generations technology”. Given Toyota’s patents in its proprietary hybrid technology and also to gain widespread adoption, the technology is today also licensed out to several rivals (Eriksen interview, 2010; Toyota Annual Report, 2010). Toyota’s hybrid vehicles are also strongly differentiated from those of its rivals, through the registered Hybrid Synergy Drive trademark.\(^{109}\)

With a worldwide presence covering all of the major automobile markets\(^{110}\) in the different continents in the world, Toyota enjoys a large and loyal customer base around the world. As a volume manufacturer Toyota’s automobiles are found in every product segment, and with their Lexus model line they also appeal to the luxury and sports-segments. Toyota has a very extensive dealer network in Japan; here they have 289 dealers which employ approx 36,000 sales personnel, while outside of Japan, 180 distributors are spread around 170 countries (Toyota Annual Report, 2010b). This extensive dealer network is one of the big drivers for the company’s success in the world in our view. Toyota acknowledges that if they lack in this field, it will decrease their sales and loss of market shares (Toyota Annual Report 2010).

Toyota focuses on a “Customer First” approach, which means that they develop products according to a wide variety of consumer needs, a part of Toyota’s global strategy is to put the “Customer First” this the company works on by delivering the best service, as they acknowledge that poor service can affect the company’s growth (Toyota Annual Report, 2010). The Japanese manufacturer is the industry leader, and this is simply because they have massive focus on their production and costs. Traditionally, Toyota has enjoyed a strong brand name due to the quality, durability and reliability related to their cars (Ibid.).

Toyota’s intellectual capital lies in their employees as they ensure that TPS functions optimally, as Toyota cannot perform without a skilled staff (Toyota Annual Report 2010). Accordingly, Toyota strengthens their employees through training and improvement in these

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\(^{109}\) Toyota.no, 2010
\(^{110}\) Toyota-Global.com, 2010c
practices (Ibid.). In addition Toyota uses two shift teams in their factories one in the morning and the other in the afternoon, after a week they switch shifts\textsuperscript{111}.

On the environmental side, Toyota wants to implement a sustainable production and cut CO\textsubscript{2} emissions (Toyota Sustainability Report, 2009), to ensure this Toyota has adjusted the TPS. This has resulted in cutting waste to a minimum, and recycling rainwater and waste water (Ibid.), during the production of cars. Toyota also acknowledge the fact that there is a need to look at the build of the vehicles, and try to change the existing designs, into designs which implement ecological and recycled plastic. This can cut 20 percent of the CO\textsubscript{2} emissions, during the products life cycle (Ibid.). This shows that Toyota is sincerely interested in taking on a green image, but also how innovative they are (Ibid.).

Toyota has 50 overseas operations in 26 countries, for which reason they procure parts and components from many different suppliers around the world (Toyota Annual Report, 2010b). To keep costs at a minimum, Toyota is working on optimizing every stage of the supply chain this is attained by standardized distribution and support of this at every stage (Ibid.). By doing this vehicle production is always on time, and supplier relationships are strengthened as unnecessary delays or problems are avoided (Ibid.).

\textit{7.2.3.2 Resource Weaknesses and Competitive Deficiencies of Toyota}

Following the economic recession with declining global sales, Toyota in addition went through a period of bad publicity due to brake failure on several models\textsuperscript{112}. Worldwide, the company had to recall almost 8 million vehicles. This tarnished their brand name considerably, and in early 2010 Toyota’s President and Director, Akio Toyoda, faced harsh questions from the US senate\textsuperscript{113}. Results from a 2010 J.D. Power Quality Survey\textsuperscript{114} show that consumers rate Toyota just “about average”\textsuperscript{115} compared to its competitors, while previous polls have shown higher ratings. The poorer ratings are mainly due to the weakened reputation as consumers perceive Toyota differently than before, due to the brake failure

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\textsuperscript{111} Toyota.co.jp, 2011b
\textsuperscript{112} Timesonline.co.uk, 2010
\textsuperscript{113} BusinessWeek.com, 2010
\textsuperscript{114} JDpower.com, 2010
\textsuperscript{115} The authors have compiled the ratings and found an average
incidents. These incidents resulted in calls for more transparency at Toyota (Chris and Guyette, 2010).

Even though Toyota is the leader in hybrid technology, its joint venture collaboration with Tesla Motors shows that it lacks the technological insights into battery electric technology. This move will definitely give access to much needed resources for Toyota, but it also shows that the company is vulnerable in this area, and given the technological shift, other manufacturers who act faster have the opportunity to overtake Toyota for instance.
7.2.3.3 Toyota SWOT summarized

**Strengths**
- Powerful Strategy backed up by a Board which is not afraid of taking chances
- Leaders within hybrid technology - Toyota Prius
- Strong distribution network
- Strong supplier network
- Strong focus on R&D
- Strong line up of cars in every segment and technology
- Joint venture with Tesla Motors on EV’s
- Financially robust
- Toyota Production System
- Toyota Production Development System
- Worldwide Presence
- Industry Leader
- Long term goal create an ultimate eco-car
- Strong focus on environment
- Strong Brand
- Large and loyal customer base

**Weaknesses**
- Recovering from the Financial Crisis
- Bad Publicity due to Brake Failure
- Competitors gaining in on technological expertise
- Absence of Small Car in Key Markets
- Decline in Financial Position
- Declining Growth Rate
- Lacks technological knowhow in EV’s

**Opportunities**
- Emerging technologies / Alternative vehicles
- Emerging markets
- Differentiation
- Car Sharing / Mobility Service / Urbanization
- Strategic alliances and collaborations
- Backward integration / Make or Buy

**Threats**
- Saturation in mature markets / Slowdown in market growth
- Increasing rivalry/competitors close in / may squeeze profit margins
- Overcapacity - cost pressures - buyers markets
- New entrants / new players New business models
- Threat of forward integration of suppliers
- Lack of human capital
- Decrease in ICE sales
- Consolidation
7.2.4 Conclusion of Toyota SWOT

Financially robust, Toyota is deemed an extremely strong industry leader with core competencies within hybrid technology and the TPS which is renowned in the industry. Toyota however, is weak within electrification technologies, for which reason they have entered a partnership with Tesla Motors, to gain the necessary technical knowhow as they cannot produce the desired technology in-house themselves. This move is part of Toyota’s long term strategy to make the ultimate eco-car. Toyota has to enter these partnerships, also because competitors are increasingly closing in on their technological knowhow. Furthermore, Toyota is lacking vehicles in the small car segment, which will play a major role in the emerging markets in the future. Therefore, it is crucial for Toyota to develop more vehicles to compete in this segment. On the basis of the above mentioned Toyota’s strengths are deemed to match the industry requirements in the “New Era of the Automobile Industry”. Hence, Toyota’s overall strength is deemed to be very strong as they by far are able to overcome their deficiencies.

7.2.5 Toyota Generic Strategy

Using the expanded concept of generic strategies as pioneered by M.E. Porter (1980) in Thompson, Strickland III & Gamble (2008), we have identified that Toyota is not following one particular strategy, but several. By having incorporated TPS in every facet of their business, Toyota has been able to lower its overall costs and thereby follow a low cost provider strategy. However, as Toyota possesses a distinctive competence through their assembly line production, they also follow a broad differentiation strategy, which is opted through studying buyers needs and behaviour carefully to learn what buyers see as important features in a car, what they believe adds value to their car and what they are willing to pay for. On the other hand Toyota’s, luxury brand Lexus is sold in line with a best cost provider strategy.
7.2.6 Strategic Actions for Toyota

Since Toyota is the industry leader, we will when crafting a strategy emphasize on Toyota cementing its position as industry leader in the “New Era of the Automobile Industry”. An industry leader’s main strategic concern revolves around how to defend its leadership position and even make it more dominant, according to Thompson, Strickland III & Gamble (2008). The latter authors highlight three contrasting strategic postures for an industry leader like Toyota, as follows:

1. *Stay-on-the-offensive strategy*: This strategy implies that Toyota continues to be an action-oriented first-mover, and set the standards for the remaining of the industry.

2. *Fortify-and-defend strategy*: This strategy implies that Toyota for example, make it harder for challengers to gain ground and for new firms to enter the industry by defending its present market shares, strengthen current market position and protect its competitive advantages.

3. *Muscle-flexing strategy*: This strategy implies that Toyota for example, as a dominant leader play competitive hardball when smaller firms make moves which threaten its market position.

From the previous analysis we have gained valuable information concerning Toyota, this knowledge will be used to build their future strategy, as Toyota today are industry leaders and are continuously front-runners in regards to innovation and technological developments. Therefore in our view, it is important that their future strategy continue in the same path and follows a “Stay-on-the-offensive strategy”, which Courtney, Kirkland and Viguerie (1997) in their article about “Strategy Under Uncertainty” refer to as “Shape the Future”. Accordingly, as an innovation and technology based company, Toyota must continue to pursue a first mover position and force rivals into catching up to them and always aim to have a competitive advantage over their rivals. In the following this will be elaborated.

Toyota is the world’s largest automobile manufacturer and is like the rest of the automobile industry also affected by the financial crisis, which is also mirrored in the decline in its
financial position and growth rate. To ensure future growth while holding on to their position as industry leaders Toyota will build their strategy upon the following strengths and weaknesses.

7.2.6.1 Alternative Vehicles: Focus on Electrification & Hybridization

To successfully be a leader in the “New Era of the Automobile Industry”, Toyota has to diversify their strategy to not only focus on the hybrid technology, but also electric cars. By taking advantage of its core capability in hybrid technology and the partnership with Tesla Motors on electric vehicles, Toyota should aim to be an early mover in both areas and implement these within every product segment of their portfolio. The JV with Tesla Motors will ensure Toyota to mass produce electric vehicles within a short time span. Given the “New Era of the Automobile Industry”, this can ensure immense first-mover advantages for Toyota, and will also push new entrants away. Also due to its TPDS system, Toyota is able to bring innovative hybrids and electric vehicle faster than competitors to the market. These moves will ensure that Toyota can set the path for which the global automobile industry have to take beyond 2020 in the “New Era of the Automobile Industry” and achieve extreme competitive advantage over the competition, given that they do not close in on Toyota.

7.2.6.2 Focus on reaching consumers in the Emerging Markets

Currently, Toyota is represented in every key market and product segment but they are still lacking behind in the small car segment. As previously revealed, in the future the small car segment will enjoy an increased share in the emerging markets as well as the established markets, as consumers will want more fuel efficient vehicles. Therefore, Toyota must also have increased focus on targeting these segments. The vehicles must however be customized according to the specific markets, to gain success. In the emerging markets there will not be a demand for small alternative vehicles instead they will want cars with an ICE, furthermore it will be more beneficial for Toyota to produce the vehicles in the respective markets to benefit from the local engineers in these markets.
7.2.6.3 Differentiation

According to Thompson, Strickland III & Gamble (2008), a differentiator who follows the “Stay-on-the-offensive Strategy” must constantly be innovative to keep its product apart from those of rivals. Toyota’s efforts to stand out in the “New Era of the Automobile Industry”, will be by revamping their vehicle design to be more daring and innovative, as automobiles have over the decade, come to resemble each other quite a lot in the different segments. A strategic move for Toyota is to incorporate telematics into their vehicles to make them more connected and also increase the safety of the customers ride.

7.2.6.4 New Business Models

Another means of differentiation for Toyota is to take into account the increased urbanization which will lead to new business models that can have an impact on the competition. To fortify against this Toyota must construct a global mobility service. Through this Toyota will offer consumers the possibility to rent Toyota vehicles at a reasonable price for a specific time period, anywhere in the world. A point system will keep track of the users and give special offers when applicable to ensure consumers continue using the service. These special offers will include discounts at restaurants, theatres, airplane tickets, car rental to name a few.

7.2.6.5 Marketing

Toyota have already seen in Japan, how the Gazoo website gained popularity, Toyota can study this and use it to launch a new marketing tactic, by offering consumers the possibility to purchase Toyota vehicles over the Internet. The option of purchasing the car directly from the dealer will still exist. Customers will still have access to showrooms where they will be able to see and “feel” the cars, but the difference will be that they will be ordered over the internet or online at the dealers, the point of using the internet will be to give the consumers the option of customizing their vehicles down to the last detail and making the purchasing experience more interactive. The possibility of following the whole process of production Toyota will try to sell as an “experience” and as no actual seller will convey the sale the automobile will be priced lower as the costs of the seller’s fee will disappear. If consumers embrace the idea of
using the internet, over time Toyota can remove the sales personnel from the equation which will lead to even lowered costs and an increase in revenues.

### 7.2.6.6 Human Capital

In the future there will be a lack of human capital especially within engineers. This Toyota can solve by offering scholarships to students to make the field of engineering within automobiles intriguing again. Those who accept the scholarship will have the possibility of joining Toyota’s vast teams of engineers. Furthermore, to boost the field automobile engineering, Toyota will host an annual competition where students can compete on building new and innovative automobiles. The group which wins the contest will have their car exhibited at Toyota’s stand at the Detroit Motor Show the following year. These steps will ensure that Toyota attract the finest engineers whilst breathing new life into the field of automobile engineering.

If Toyota pursues the above mentioned strategic steps, it is able to utilize its strengths to take advantage from the opportunities in the “New Era of the Automobile Industry”. At the same time, Toyota can defend against existing rivals and the threats arising from new entrants and thereby manifesting their position as in industry leader. Hence, we recommend Toyota to implement the following strategic actions over the next decade:

- Focus on acquiring new engineers to the company
- New marketing tactics
- Focus on mobility services
- Focus on electrification & hybridization
- Reach consumers in emerging markets
- Differentiation of their vehicles

Since Toyota is both financially secure and have vast access to resources, by following these strategic actions, Toyota are able to secure a sustainable competitive advantage over the rivalry, and manifest its position as an industry leader.
8. Conclusion and Summary

8.1 Conclusion
Through the paper, we have showed how to utilize scenario thinking in connection with Porters Five Forces, to create plausible future industry scenario(s) for an industry which is experiencing technological change. In chapter 4, we commenced with giving an overview of the present situation of the global automobile industry emphasizing on the technological shift. Through PEST analysis in the chapter, we identified key trends which are likely to shape the future of the automobile industry. Among the key trends, our findings suggest that strict environmental regulations and volatility in oil prices are the major factors which can influence the global automobile industry’s profitability on one hand, and on the other hand which technologies they will pursue. During the research process we also identified through expert interviews, that there are several key uncertainties related to the technological shift in the industry which can possibly shape the future in one or another direction. Furthermore, from the assessment of the new fuel technologies on technical readiness and consumers perceptions, we identified in chapter 5 that the technologies which are most likely to have an impact over the next 10 year are hybrids, plug-in hybrid and electric cars. Given that some of these are currently at a pre-commercialization stage, we incorporated scenario thinking to create plausible future industry scenarios will remain low or become high versus automobile manufacturers ability to improve the technologies significantly. From the scenarios we chose one, the “New Era of the Automobile Industry”, which was analyzed through the remaining Porters 5 Forces to identify future market opportunities and potential threats. This scenario has been used as a reference throughout the remaining of the paper. Finally, through two distinct firm examples Toyota and PSA, we have shown that different automobile companies have to react differently to the opportunities and threats arising, based on their financial strength and resource capabilities.

8.2 Answering the Research Questions
The research questions in this thesis are answered primarily answered covering chapter 4 to 7. In chapter 4, the first research question is answered by giving an overview of the current situation of the global automobile industry regarding the technological shift. The chapter also identified environmental regulations and volatility in oil price to be the major driving forces behind the technological transformation. The findings show that governments have
substantial power over the automobile industry mainly through rules and regulations. This was also substantiated through our interviews, where industry representatives many times pointed out that they were quite driven by what the governments around the world were deciding on behalf of the automobile sector. Consumers’ are driven by their bank balance, meaning that times with high oil price push them to consider alternative solutions.

The second research question is primarily answered through chapter 5 to 7. From the former chapter we assessed hybrids and electric cars to have most likelihood for impact on the future of the global automobile industry. These technologies were then used in a scenario building process where two key uncertainties, as mentioned above, were crossed to get four plausible futures. Out of the four equally plausible scenarios we chose the “New Era for the Automobile Industry”. The reason for choosing this particular scenario was that in the authors view this was the most intriguing scenario. Furthermore it is also the scenario which has the best possible outcome for consumers and the automobile industry. Nonetheless, we acknowledge that by choosing another future scenario the outcome might be different. Moreover, we also acknowledge the fact that typically in scenario planning all the four scenarios are equally analyzed. The impact of the “New Era of the Automobile Industry” on the incumbent manufacturer’s rivalry strategy, we illustrated through PSA and Toyota. In our view, the former should pursue a runner-up strategy to be best match its capabilities to the competitive surroundings in the future industry scenario. Toyota, on the other we recommended that should pursue an action oriented stay on-the- offensive strategy to continue in its position as an industry leader in the future scenario too. Our main finding from this exercise is that different automobile manufacturers will have to react differently to arising opportunities and threats in the future scenario.

8.3 Recommendations for Further Research

We have worked on one particular future scenario, even though we have touched upon the other scenarios, it is quite likely that if a more in depth analysis is performed. This might give rise to further questions, in regards to the plausible future industry scenario.
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9.1 Interviews

Andersen Interview I, 2010: Interview with Jens Andersen, Environmental Manager at Peugeot Denmark, conducted 29. January 2010 at PSA HQ in Glostrup, Denmark

Andersen Interview II, 2010: Interview with Jens Andersen, Environmental Manager at Peugeot Denmark, conducted 15. April 2010 at PSA HQ in Glostrup, Denmark

Eis Interview, 2010: Telephone Interview with Volker Eis, Sustainability Manager at Ford Europe, conducted 30. March 2010.

Eriksen Interview, 2010: Email Interview with Håkon Tveten Eriksen, Marketing Director at Toyota Norway, conducted 4. August 2010.

Kampmann Interview, 2010: Interview with Christian Erik Kampmann, Associate Professor at CBS, conducted 17. March 2010 at Copenhagen Business School

Morsing Interview, 2010: Interview with Erik Morsing, Communication Manager at GM Denmark, conducted 20. April 2010 at GM HQ in Charlottenlund, Denmark

Rask Interview, 2010: Interview with Morten Rask, Associate Professor at ASB, conducted 23 February 2010 at Århus Business School
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APPENDIX 1: European Commission – A major driver

A major driver towards more environmental cars in Europe is the European Commission (EC)’s 20-20-20 plan\textsuperscript{116}. The aim of this treaty is to reduce 1) CO\textsubscript{2} emissions in EU on average by 20 percent, 2) Ensure that 20 percent of the energy consumption is derived from renewable resources by 2020, and 3) Political ambition of that the EU to overall become 20 percent more energy efficient by 2020. It is worth to mention that the latter one is not a binding target. This has set high expectations to the EU countries, and for the automobile industry the EC has specific targets\textsuperscript{117}. These targets requires that by 2015 CO\textsubscript{2} emissions

\textsuperscript{116} EC. Europa.eu, 2010
\textsuperscript{117} ACEA.be, 2010b

must be no more than 130g/km CO₂ for a car manufactures entire fleet. Furthermore, the fleet average must not exceed 95 g/km CO₂ by 2020. However this will be assessed continuously to evaluate whether the goal is achievable for the industry. This 20-20-20 strategy will be a major improvement in CO₂ emissions from 1995, where the average was 186g/km.\textsuperscript{118}

In addition, to ensure and put pressure on the industry the EC has imposed some penalties; for the first 3 grams there will be penalties between 5 to 25 Euros, and for every gram beyond this there is a fine of 95 Euro per gram. Furthermore, the penalty will from 2019 be fixed to 95 Euros for every excess gram of CO₂ emissions by the automobile manufacturer. For niche manufactures there are special rulings.

APPENDIX 2:

\textsuperscript{118} EC. Europa.eu, 2010b
APPENDIX 3A: Biofuels: 2nd generation biofuels

2nd generation biofuels are produced from starch from different non-food sources\textsuperscript{119} which can be converted into automobile fuels (DB Research, 2009). This technology is currently at a researching stage with firms in the energy sector investing in R&D to make the production processes sustainable enough for market penetration (KPMG, 2010a). When ready, the 2nd generation biofuels are likely to offer promising technical benefits. Certainly the technology offers a lower carbon footprint and green house gas (GHG) emissions than both the conventional fuels as well today’s 1st generation biofuels (KPMG, 2010a, BCG, 2009). The attractiveness from an environmental perspective, accordingly, seems to be very high, but the market acceptance will also depend on how consumers perceive them. Another major technical advantage is that 2nd generation biofuels are expected to be better compatible to use in conventional ICE automobiles as well as produced more sustainably (KPMG, 2010a; BCG, 2009). The latter have been an issue with the 1st generation biofuels, and have hampered their impact on the markets.

On the other hand, however, due to the nascent stage of development, 2nd generation biofuels are not expected to be commercially available before earliest in 2015 (DB Research, 2009). That entails that at present from a technical point of view, the technology is not readily available, but with enormous potential. Accordingly there is no data on the price level either; however it is widely believed that the prices will remain on an equivalent level to the conventional automobile fuels (DB Research, 2009). Since the fuel technology is compatible with conventional gasoline or diesel ICE automobiles, there is not much R&D related costs for the automobile manufacturers. Overall, all these factors suggest that 2nd generation biofuels poses a threat to the conventional fuels of today. Still our research suggests the competitiveness of biofuels compared to the conventional petroleum derived fuels will also be heavily determined by the surges in oil prices and governmental regulations.

Despite the actual good fuel economy offering, biofuel vehicles are poorly perceived in the European markets (Frost & Sullivan, 2008a). In the authors view, that can stem from the negative publicity biofuels have received with being labeled as being harmful for the

\textsuperscript{119} Such as waste biomass, the stalks of wheat, corn stover, wood, and special energy or biomass crops and plants, household waste, and even used/old tires

agricultural land. Furthermore, the Frost & Sullivan (2008a) study revealed that European consumers have high expectation toward the improvements in fuel consumption by the alternative fuelled vehicles such as bio-fuels. The majority of the respondents perceive minimum acceptable improvements in fuel consumption from these in the range of 20 – 60 percent compared to conventional vehicles (Frost & Sullivan, 2008a). The latter numbers are much greater than some of these alternative fuelled vehicles advantages and offering, which clearly indicates a misinterpreted image and lack of information about the different fuel types among the European consumers. European consumers perceive as having the lowest emission levels, followed by CNG, biofuels and LPG on the next places (Frost & Sullivan, 2008a). For the overall performance, the respondents ranked biofuels as the best alternative fuel technology (Frost & Sullivan, 2008a). Almost a fifth of consumers’ think that biofuels and biodiesel would be more expensive to run.

**APPENDIX 3B: Liquid Petroleum Gas**

LPG or Autogas, a by-product of the oil refinery, is another readily available alternative to the existing automobile fuels. Its main technical benefits are akin to CNG that it burns relatively cleanly and produces less pollutant emissions and GHG than the conventional automobile fuels. CO₂ emissions are reduced with up to 15 percent compared to gasoline or diesel (Morsing Interview, 2010). Likewise to CNG, the price at the pump for Autogas is lower than gasoline and diesel. The average cost savings for the consumer can be up to 50 percent, according to Frost & Sullivan (2010b). The drawbacks of this technology is similar to CNG, in the means of that lower energy density than gasoline and diesel, requires higher fuel consumption to drive same distances.

**APPENDIX 4: Blueprint of the Scenarios**

<table>
<thead>
<tr>
<th>Key Uncertainties</th>
<th>Experts</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>To what extent will consumers accept the emerging technologies?</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Able</td>
<td>Able</td>
</tr>
<tr>
<td>To what extent are automobile manufacturers able to produce quality technology?</td>
<td>Not able</td>
<td>Able</td>
<td>Not able</td>
<td>Able</td>
<td>Able</td>
</tr>
</tbody>
</table>

**APPENDIX 3B: Liquid Petroleum Gas**

LPG or Autogas, a by-product of the oil refinery, is another readily available alternative to the existing automobile fuels. Its main technical benefits are akin to CNG that it burns relatively cleanly and produces less pollutant emissions and GHG than the conventional automobile fuels. CO₂ emissions are reduced with up to 15 percent compared to gasoline or diesel (Morsing Interview, 2010). Likewise to CNG, the price at the pump for Autogas is lower than gasoline and diesel. The average cost savings for the consumer can be up to 50 percent, according to Frost & Sullivan (2010b). The drawbacks of this technology is similar to CNG, in the means of that lower energy density than gasoline and diesel, requires higher fuel consumption to drive same distances.

<table>
<thead>
<tr>
<th>Question</th>
<th>Jens Andersen/Erik Morsing</th>
<th>High and volatile</th>
<th>Stricter</th>
<th>Not stricter</th>
<th>High support</th>
<th>Stricter</th>
<th>Low and stable</th>
<th>Stricter</th>
</tr>
</thead>
<tbody>
<tr>
<td>To what extent will the fuel prices remain low and stable or will be high and volatile?</td>
<td>High and volatile</td>
<td>Stricter</td>
<td>Not stricter</td>
<td>High support</td>
<td>Stricter</td>
<td>Low and stable</td>
<td>Stricter</td>
<td></td>
</tr>
<tr>
<td>To what extent will environmental regulation become stricter?</td>
<td>All of them</td>
<td>Not stricter</td>
<td>Stricter</td>
<td>Not stricter</td>
<td>Stricter</td>
<td>Not stricter</td>
<td>Stricter</td>
<td></td>
</tr>
<tr>
<td>To what extent will governments across the world support with subsidies and promotion?</td>
<td>High support</td>
<td>High support</td>
<td>Stricter</td>
<td>Not stricter</td>
<td>High support</td>
<td>Stricter</td>
<td>Low and stable</td>
<td>Stricter</td>
</tr>
<tr>
<td>To what extent will external sources raise capital?</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>To what extent will complementarily industries aid?</td>
<td>Jens Andersen</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>To what extent will environmental awareness increase or is it just hype?</td>
<td>Increase</td>
<td>Incase</td>
<td>Same as now</td>
<td>Same as now</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
</tr>
<tr>
<td>Is the peak of oil sooner or later? – Oil prices fluctuations</td>
<td>Soon</td>
<td>Soon</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
<td>Later</td>
</tr>
<tr>
<td>To what extent will governments across the world support with subsidies and promotion?</td>
<td>Jens Andersen/Erik Morsing</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Whether there will be major improvements in technologies, technology readiness, access to funding, inconsistent governmental efforts</td>
<td>Erik Morsing</td>
<td>Low</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>What will happen to the industry value chain?</td>
<td>Christian Erik Kampmann</td>
<td>It will move new suppliers/players</td>
<td>Nothing it will remain the same</td>
<td>Diversification will still exist, but the new players will not make an effect on the market</td>
<td>It will create overcapacity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>How will the emergence affect the incumbents strategies?</td>
<td>Volker Eis / Erik Morsing</td>
<td>It will move new suppliers/players</td>
<td>Nothing it will remain the same</td>
<td>Diversification will still exist, but the new players will not make an effect on the market</td>
<td>It will create overcapacity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Will the suppliers change?</td>
<td>Christian Erik Kampmann / Morten Rask</td>
<td>It will move new suppliers/players</td>
<td>Nothing it will remain the same</td>
<td>Diversification will still exist, but the new players will not make an effect on the market</td>
<td>It will create overcapacity</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Will new supplier emerge? What happens to the bargaining power? to what extent will key suppliers experience profound changes in their industries and markets because of the emerging technologies?</td>
<td>Christian Erik Kampmann / Morten Rask</td>
<td>Yes - better bargaining power towards suppliers</td>
<td>Yes</td>
<td>Yes but they will not be able to push the industry</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>What about the buyers market? Who are the buyers?</td>
<td>Jens Andersen</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Technological knowhow/access to technological knowhow</td>
<td>Christian Erik Kampmann / Morten Rask</td>
<td>Very likely, but difficult to challenge the established as they also can produce the quality</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Will new entrants emerge / What new entrants will emerge?</td>
<td>Morten Rask / Christian Erik Kampmann</td>
<td>Very Likely</td>
<td>Very Likely</td>
<td>Very Likely</td>
<td>Very Likely</td>
<td>Very Likely</td>
<td>Very Likely</td>
<td>Very Likely</td>
</tr>
</tbody>
</table>