Alexander Pointner, BSc

Pilot Project for the Market Launch of E-Mobility in Austria

Master Thesis

Production Science and Management

Graz University of Technology

Faculty of Mechanical Engineering and Economic Sciences

Institute of Industrial Management and Innovation Research

o.Univ.-Prof. Dipl.-Ing. Dr.techn. Christian Ramsauer

Graz, 2012

Statutory Declaration

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

....

Date Signature

Abstract

The master thesis deals with the market launch of electric mobility in Austria. The topic is gaining more importance worldwide especially for the automotive industry and there are many reasons why e-mobility is more attractive nowadays. For example, climate change, growing megacities, peak oil prices and also customer demand is now focusing on e-mobility. There are already original equipment manufacturers which have electric vehicles on the market and in the next few years more electric vehicles will follow.

The basis of the thesis was a nine month project at Porsche Austria. Porsche Austria is an international automotive dealer with its headquarters in Salzburg, Austria. They are general importer for the brands of the Volkswagen Group in twenty countries. The task was to organize a test fleet with fifteen battery electric vehicles in Austria and to prepare the market launch for Porsche Austria. An important issue was the interaction of the electric vehicle, the charging infrastructure and the mobile online services.

The objective of the master thesis was to compare the market launch in the automotive industry of conventional vehicles and electric vehicles. On the one hand, the implications for Porsche Austria have been elaborated and on the other hand the relevant stakeholders for Porsche Austria have been defined. Also important were the new fields of activity for Porsche Austria arising from e-mobility.

The results of the thesis are important for Porsche Austria to fully consider all relevant aspects of e-mobility and to cooperate with key stakeholders in order to be prepared for the market launch of electric vehicles.

Kurzfassung

An Elektromobilität führt kein Weg mehr vorbei! Verschiedene Parameter begünstigen den Aufschwung: allen voran der Klimawandel, wachsende Großstädte, die Verknappung des Erdöls und damit einhergehend eine Änderung der Kundenbedürfnisse.

Die Volkswagen Gruppe startet 2013 mit der Markteinführung ihrer Elektrofahrzeuge. Diese Markteinführung muss, um den Ansprüchen von Volkswagen gerecht zu werden, gut geplant und vorbereitet sein.

Grundlage dieser Diplomarbeit war ein neunmonatiges Projekt bei Porsche Austria, einem internationalen Automobilhändler mit Hauptsitz in Salzburg, Österreich. Porsche Austria ist Generalimporteur aller Volkswagen Marken in 20 Ländern. Aufgabe war es, eine Testflotte mit fünfzehn rein elektrischen Golf Blue-e-Motion in Österreich zu organisieren und im Zuge dieses Projekts die Markteinführung aller Elektrofahrzeuge des Volkswagen Konzerns in Österreich vorzubereiten. Besonderes Augenmerk galt der Analyse des Zusammenspiels von Elektrofahrzeug, Ladeinfrastruktur und Mobilen Online Diensten.

Aufbauend auf diesem Projekt war es das Ziel der Diplomarbeit, den Unterschied in der Markteinführung zwischen konventionellen Fahrzeugen einerseits und elektrischen Fahrzeugen andererseits zu vergleichen. Hierbei werden die Auswirkungen für Porsche Austria aufgezeigt und auch die relevanten Interessensvertreter definiert.

Die Arbeit gliedert sich in einen theoretischen und in einen praktischen Abschnitt. Der theoretische Teil beschäftigt sich mit dem Begriff der Innovation und dem Innovationsmanagement, der praktische Teil mit dem oben genannten Projekt.

Das Ergebnis der Diplomarbeit hilft Porsche Austria, alle Aspekte der Elektromobilität zu verstehen und auch die wichtigsten Interessensvertreter zu kennen, um dann bestmöglich für die Markteinführung vorbereitet zu sein.

Acknowledgement

I would like to thank all persons who were supporting me to write my master thesis and to complete my study program in Graz at the University of Technology.

Especially I want to thank Porsche Austria to give me the opportunity to write my master thesis at their company in a really interesting topic, where I loved to work on.

At Porsche Austria I want to thank Wilfried Weitgasser, Josef Frauscher, Eric Buchleitner, Gerhard Welsch and Volker Amann for their support during writing my master thesis and for the support to develop the topic. I will also thank all the other colleagues at Porsche Austria, who are not named here, for their support.

Furthermore, I want to thank the Institute of Industrial Management and Innovation Research for the supervision, especially Univ.-Prof. Dipl.-Ing. Dr.techn. Christian Ramsauer and the Scientific Assistants Dipl.-Ing. Elisabeth Plankenauer and Dipl.-Ing. Hans Peter Schnöll. I also want to use the opportunity to thank em.Univ.-Prof. Dipl.-Ing. Dr.techn. Josef W. Wohinz for his support during my study program.

Of course, I also want to thank my parents, who have enabled a successful completion of my study program. Finally, I really want to thank my girlfriend Rosmarie for her support, especially during writing my master thesis.

Table of Contents

1 Introduction

This Master Thesis deals with the market launch of e-mobility in Austria. In this first chapter the company Porsche Austria is described, including their business operations and their locations, followed by an assessment of the initial situation of e-mobility in Austria in general and at Porsche Austria in detail, as well as the objectives of this master thesis. Finally the approach of the master thesis is presented in the last part of this chapter.

1.1 About Porsche Austria

Porsche Holding GmbH is an international active automotive dealer with its headquarters in Salzburg, Austria. Since 2009 the enterprise is a 100 percent subsidiary of the Volkswagen AG in Germany because the company founders and shareholders, the families Porsche and Piëch, decided to sell the company to the Volkswagen Group. On the 1st of March 2011 the Volkswagen Group paid approximately 3,3 billion Euros for the acquisition of the Porsche Holding.[1]

Porsche Holding has three major pillars:[2]

- Automotive wholesaling,
- Automotive retailing,
- and financial services.

Porsche Holding is mainly focused on the brands of the Volkswagen Group including Volkswagen, Audi, Porsche, Seat, Skoda, Lamborghini, Bugatti and Bentley. However, they also work in retailing with other brands abroad. The structure is shown in figure 1.[3]

[1] Cf. Porsche Mitarbeiter ABC (2011), pp. 3

[2] http://www.porsche-holding.com/de/unternehmen/geschaeftsfelder [30.07.2012]

[3] Cf. Porsche Mitarbeiter ABC (2011), pp. 5

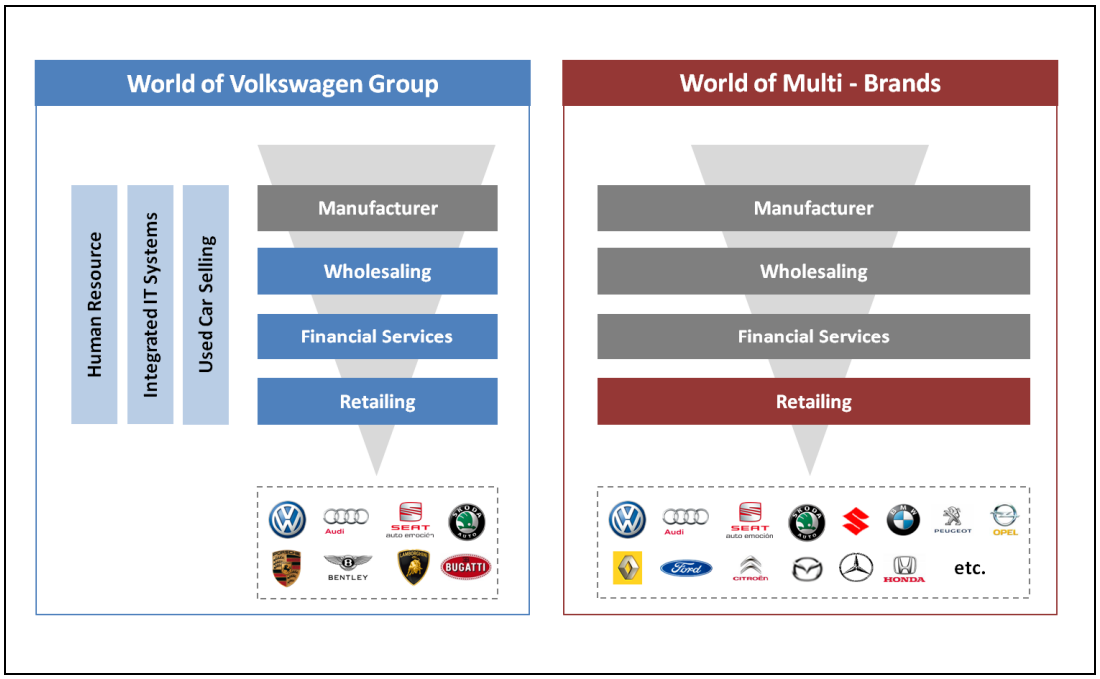

Figure 1: Structure of the Porsche Holding[4]

In 2011 about 21.000 employees worked for Porsche Holding all over the world. In that year the company's turnovers were around 11,3 billion Euros and they sold about 432.000 vehicles.[5]

Porsche Austria is the automotive wholesaling company of the Porsche Holding in Austria. They are responsible for wholesale in thirteen countries including Austria, Czech Republic, Slovenia, Croatia, Slovakia, Hungary, Ukraine, Romania, Serbia, Bulgaria, Albania and Macedonia. Porsche Austria is integrated in the Porsche Holding GmbH as a 100% subsidiary. They are focused on the brands of Volkswagen and Audi.[6] In this master thesis´ project the focus was on Volkswagen.

For Skoda, Seat, Porsche and other Volkswagen Group brands own wholesaling companies exist and they are working in nearly all the same countries as Porsche Austria. Evidently, these other wholesaling companies are also part of Porsche Holding.[7]

[4] Referring to Internal Presentation of Porsche Holding

[5] http://www.porsche-holding.com/de/unternehmen/zahlen_fakten [30.04.2012]

[6] http://www.porsche-holding.com/de/unternehmen/standorte [01.05.2012]

[7] Internal Presentation of Porsche Holding

1.2 Initial Situation

The topic of e-mobility is gaining more importance worldwide. There are many reasons why e-mobility is an emerging topic:[8]

- *Climate Change:* A lowering of the CO_2 emissions on a global scale is important for the climate.
- *Less fossil energy resources*: The prices for diesel and gasoline are rising every year.
- *Urbanization*: More and more people are living in cities. These megacities have problems with air pollution.
- *Technological requirements*: Technological requirements are now available and a serial production is possible. And for that reason, e-mobility is becoming cheaper.
- *Customer demand*: The number of early adopters, which are interested in e-mobility, is growing, but also general discussion about e-mobility has started.

In Austria it is already possible to buy certain battery electric vehicles (BEV) and some plug-in hybrid electric vehicles (PHEV). But there are still some problems with the technology and the charging infrastructure. The technologies are still not sophisticated enough.[9]

In the Volkswagen Group different models are developed as a BEV or a PHEV. In the following figure these models of the Volkswagen Group brands and their market launches are shown.

[8] Internal Presentation of Volkswagen Group

[9] Internal Presentation of Volkswagen Group

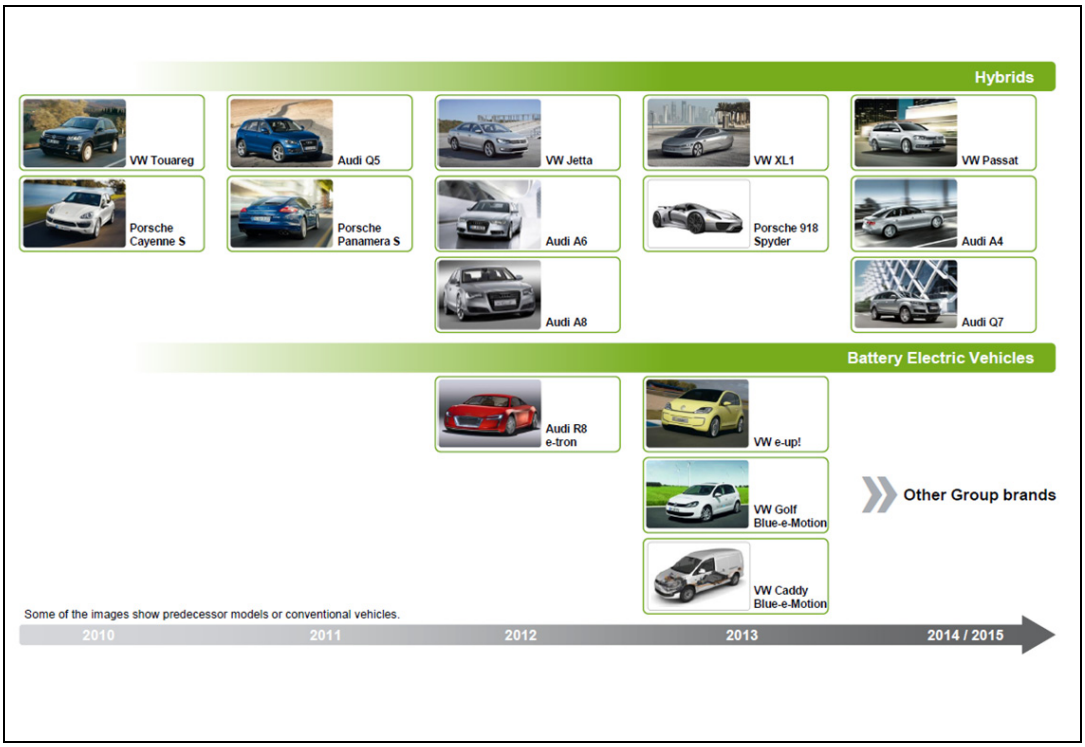

Figure 2: Volkswagen Group BEV and PHEV[10]

There are already some Volkswagen Group full-hybrids (HEV) on the market, but no PHEVs. The first higher volume of electric vehicles is coming in 2013. For this reason the Volkswagen Group has to prepare the market launch to be long term successful. This master thesis describes the preparation for the market launch of e-mobility in Austria with the focus on Porsche Austria and the implications for the company. The market launch is supported by a test fleet of BEVs in Austria.

[10] Referring to Internal Presentation of Volkswagen Group

1.3 Objectives of the Master Thesis

The objectives of this master thesis are concerned with the market launch of e-mobility in Austria by Porsche Austria. The basis for this launch was a test fleet of BEVs. The different objectives of the master thesis are described in this section:

- *Different market launches conditions in the automotive industry for conventional vehicles and electric vehicles*: For the market launch of conventional cars the process at Porsche Austria is described. In the end the differences for Porsche Austria concerning the market launches should be defined.
- *Definition of the stakeholders of Porsche Austria in e-mobility:* It is important to define the relevant stakeholders for Porsche Austria and the relevant stakeholders for e-mobility in general. Also a definition of their roles in e-mobility is important.
- *Classification of the new fields of activity*: New fields of activity which occur in e-mobility should be described.
- *Identification of critical activities*: Regarding the fields of activity the critical ones should be defined. For Porsche Austria it is important to know where to focus on.
- *Implications for Porsche Austria due to the differences in e-mobility*: Ultimately, the implications for Porsche Austria regarding e-mobility are described. These implications should help Porsche Austria to prepare the market launch of e-mobility in Austria.

1.4 Approach of the Master Thesis

In the next chapter this master thesis deals with the market launch in the innovation process. This is the first theoretical chapter and covers innovation in general and the innovation management, followed by a definition of the innovation process. Two innovation processes are described to get an overview, however, the focus is on the last stage, i.e. is the market launch. Afterwards, the system innovation is described in more detail. The last part of the second chapter is a description of the management of innovation projects regarding the organizational structure of an innovation project and the differences to other projects.

The third chapter deals on the one hand with the market launch in the automotive industry in general and on the other hand with the specific characteristics in e-mobility. The market launch part is focusing on marketing in the automotive industry, the innovation process at Volkswagen and the market launch process at Porsche Austria. It is described how they launch a new car in the market and which different departments are affected. The specific characteristics are concerning the differences of the market launch in e-mobility in comparison to a conventional car, such as the different aspects in e-mobility, new stakeholders, challenges, legal aspects, battery issues, charging infrastructure and renewable energy.

The fourth chapter discusses the pilot project at Porsche Austria. The objectives of the project were to organize a test fleet with fifteen BEVs in Austria and then to investigate the interaction of the electric vehicle, the charging infrastructure and the mobile online services. In this chapter the project is defined, authorities and their functions as well as processes with all important stages are determined in order to get a chronological overview. Finally, the fields of activity are indicated. These fields are divided in the sections fleet user, fleet activities, data collection, qualification, electric vehicle, charging infrastructure, and mobile online services.

In the fifth chapter the results of the master thesis are presented, starting with important issues in e-mobility, key stakeholders in e-mobility for Porsche Austria and finally a comparison of the market launches of conventional cars and electric cars at Porsche Austria.

The master thesis concludes with a summary of the results and an outlook on the next steps for Porsche Austria, including their focus and the direction in which e-mobility is developing.

2 Market Launch in the Innovation Process

This chapter deals with the basics of innovation. First, the meaning of innovation, the different dimensions and the types of innovation are explained. The second part is about innovation management and followed by a closer look on system innovation. Two innovation processes are described in the next part; these are the stage gate process of Cooper and the process of Thom. In the last part of this chapter the management of innovation projects is discussed.

2.1 Innovation

Innovation can be defined as follows: that is the process of finding economic application for the inventions. Invention is the obvious first step towards any new product or process.[11] Another definition is that innovation is concerned with the commercial and practical application of ideas or inventions.[12]

The term innovation is used to denote something new. It means a difference in its kind, not only in its grade. It is about new products, operations, distribution ways, or corporate identities. Innovation is more than a gradual improvement and more than a technical problem.[13] Just a new means to an end combination is not enough to call something an innovation. This combination has to prove itself on the market or for internal applications.[14]

It is important to distinguish between innovation, invention, modification and imitation. An idea itself is not enough to call something an innovation, the utilization or sales distinguishes between innovation and invention.[15] A modification is described as a marginal change of a product or process, where the basic function is still the same. The imitation is just a simply copy of an existing product or process.[16]

[11] Schumpeter (1911), pp.100

[12] Trott (2005), p.15

[13] Cf. Hauschildt (2011), p.4

[14] Cf. Baker et al. (1967), p.160

[15] Cf. Hauschildt (2011), p.5

[16] Cf. Limberg (2008), pp.11

2.1.1 Dimensions of Innovation

There are different dimensions of innovation. To clear up the dimensions it is distinguished between five criteria. These criteria are listed below:[17]

- The content-related dimension: What is new?
- The intensity dimension: How new?
- The subjective dimension: New to whom?
- The processual dimension: Starting and ending where?
- The normative dimension: Is new equal to success?

The Content-Related Dimension: What is New?

This dimension considers the different types of innovation and answers the question: "what is new?". Literature distinguishes between product innovation, process innovation, system innovation, innovation beyond technology and postindustrial system innovation.[18] The different types of innovation are described in more detail in the next subchapter.

The Intensity Dimension: How New?

The scope of innovation can be defined in two different ways. First, the intensity is based on facts and secondly, the intensity is based on a grade. Referring to the later, there are different categories to grade the innovation:

- Dichotomy, i.e. major or minor, radical or incremental[19]
- Ordinal scale, i.e. totally new or distinct improved product[20]
- Scoring, i.e. multilevel ordinal scales[21]
- Multidimensional approaches, i.e. changed environment of the company[22]

[17] Cf. Hauschildt (2011), pp.5

[18] ibidem

[19] Cf. Hauschildt (2011), pp.11

[20] Cf. Kleinknecht et al. (1993), pp.44

[21] Cf. Dahlin/Behrens (2005), pp.727

[22] Cf. Hauschildt (2011), p.13

The Subjective Dimension: New to Whom?

The assessment of the qualitative differences of an innovation compared to the initial situation is subjective. Therefore, innovation is what it is taken for. There are different groups who are estimating the innovation, these could be an expert or it could be declared by the top management. Furthermore, it is also possible that it is estimated by the competitors or the suppliers. Other examples are the national-economic opinion or what is found by mankind for the first time.[23]

The Processual Dimension: Starting and Ending where?

Innovation is more than an invention, but the invention is also not always the first step of the innovation process. The first steps can be an idea, discoveries or observations, research, developments, the application approach or an ongoing monitoring.[24] In the end, the innovation project has to be forwarded to a daily routine work and at this moment the work of the innovation manager is done.[25]

The Normative Dimension: Is New Equal to Success?

The transformation of money into knowledge is research; the transformation of knowledge into money is innovation.[26] Sometimes it is just called innovation if the process led to an improvement compared to the initial situation, then it would be objective oriented. The scale for such judgments is the realized profit. However, it should be noted that innovation managers are working with an estimated innovation success and not with the realized innovation success.[27]

[23] Cf. Hausschild (2011), pp.18

[24] Cf. Albach (1994), pp.80

[25] Cf. Hausschild (2011), p.21

[26] Cf. Mirow (1998), p.485

[27] Cf. Hauschildt (2011), pp.21

2.1.2 Types of Innovation

Like already mentioned in the last subchapter, there are different types of innovation. These different types are listed in the following paragraphs.

Product Innovation

Product innovation is the development of a new or improved product. [28] It is focused on the benefit for the customer. The objective of this innovation is the increase of the effectiveness.[29] It is a market oriented usage of the product innovation. In industry the product innovation progressively requires the process innovation.[30]

Process Innovation

Process innovation is the development of a new manufacturing process.[31] It is focusing on faster, high quality, safer and more cost-effective manufacturing. The objective of this innovation is the increase of the efficiency.[32] Concerning the implementation aspect, it is mainly an internal usage of the process innovation.[33]

System Innovation

The coverage of the innovation content can be expanded through considering the number and correlation of product and process innovation in a system theoretical way. There are three different parts in the system innovation: the innovative system components, the innovative system itself and the innovative system linkage.[34]

The system oriented view on the innovation allows the definition of position and object in a more differentiated way than the classical distinction of

[28] Trott (2005), p.17

[29] Cf. Hauschildt (2011), pp.5

[30] Cf. Hauschildt (2011), p.8

[31] Trott (2005), p.17

[32] Cf. Hauschildt (2011), pp.5

[33] Cf. Hauschildt (2011), p.8

[34] ibidem

product and process innovation.[35] The system innovation is described more detailed in the next chapter because of its particular relevance for e-mobility.

Innovation beyond Technology

SCHUMPETER[36] is seeing the essence of the innovation in the enforcement of new combinations which are not occurring continuously but rather discontinuously.

Innovation is not only a problem of science and technology, but also a problem of economy and management. It is possible to distinguish between sales, procurement, logistic, manufacturing, financial, human resource, and social innovation.[37]

Postindustrial System Innovation

Innovation is not only focused on industrial companies or internal decision problems. It is also about innovation in banks and insurances. Some examples are credit cards, leasing, bar codes or e-business.[38]

Summary

There are many different types of innovation. The mentioned innovation can also be separated in the following levels:[39]

- *The technical innovation*: Products, processes and technical knowledge
- *The organizational innovation*: Structures, cultures, systems, management innovation
- *Related to business innovation*: Reformation of the business model, the structure of the industry branch, the market structures, or market borders

[35] Cf. Shenhar (1998), pp.36

[36] Cf. Schumpeter (1939)

[37] Cf. Hauschildt (2011), p.9

[38] Cf. Hauschildt (2011), pp.10

[39] Cf. Zahn/Weidler (1995), pp. 362

In conclusion, the system innovation considers different numbers of innovation in a system theoretical way. Innovation beyond technology covers all other innovation in industry besides the well-known product and process innovation, which is not connected to technology. Finally, the postindustrial system innovation includes innovation which is not connected to industry, like in banks or insurances.

2.1.3 Driving Forces of Innovation

There are driving forces which often lead to innovation. They are listed below:[40]

- *Technological progress:* On the base of technological and knowledge-based rates of growth problems can be solved, which have been unsolvable ten years ago
- *Changed customer demands*: Consumer markets are changing all the time. The requests of customers are changing fast
- *Shorter life spans of products*: Products have a shorter life span on the market. New products of competitors are replacing products of the companies.
- *Global competition*: Foreign markets can be more widely accessed than ever in the history of economy. On the other side the domestic market is under more pressure because of foreign competitors. But the chance to become international market leader is given.

2.2 Innovation Management

There are two perspectives on innovation management in literature. On the one hand innovation management means to define and follow a strategy and objectives, to arrive at a decision, to determine and influence information flows, to create social relationships and to realize these decisions. This view is mainly process oriented. It is placing the decisions and enforcement aspects in the middle of consideration. Therefore,

[40] Cf. Cooper (2010), pp. 8

innovation management is a dispositive configuration of innovation processes.[41]

On the other hand there exists a system theoretical view.[42] This means, that innovation management is a distinct configuration of the innovation system, but not only certain processes, but also the institutions, wherein the processes are running.[43]

Innovation management has to be clearly distinguished from management of research and development.[44] Evidently, research and development are parts of innovation management, not the other way around. Research and development projects refer to science and technology, but innovation management also includes administrative processes.[45]

2.2.1 Innovation System

When talking about the innovation system, it refers to the position and competence structure as well as the communication and interaction structure of innovation management. The result is a company's innovation system. A system is an amount of elements, which are connected in a certain way. In innovation this elements are primary persons, and secondary materials and machines. The innovation system captures all persons who contribute actively to the accomplishment of an innovation, but also all persons, who are affected passively.[46]

2.2.2 Resistance against Innovation

In case of doubt, innovation is not welcomed. Willingness for innovation is not a reality because innovation means a significant change in the existing way of work. Innovation is often perceived as a nuisance, a radical change or a senseless turbulence. Therefore, innovation has to consider resistance

[41] Cf. Hausschild (2011), p.29

[42] Cf. Uhlmann (1978), p.82

[43] Cf. Hausschild (2011), p.29

[44] Cf. Geschka (1970), pp.54

[45] Cf. Hausschild (2011), p.30

[46] Cf. Hausschild (2011), p.57

and this is not only true for older companies, but for modern companies as well. The history of innovation is an endless story of resistance against it.[47]

There are three ways in which resistance affects an innovation project. This can either be prevention, i.e. a radical resistance to stop the innovation; delay, a reason to stop the project later on, and deformation, i.e. a last effort for resistance to at least change the innovation project.[48]

2.2.3 Actors in Innovation

In literature there are different promoter models for innovation. In innovation a special combination of entrepreneurial, managerial, and technological roles is required.[49]

WITTE[50] describes three promoters to achieve this objectives, technology promoters, power promoters, and process promoters. The technology promoters have the knowledge to solve a problem; they are procuring or creating the required information. The power promoters have the influence to promote the innovation, they use leadership instruments to overcome the resistance and they allocate tangible and intangible incentives for the innovation. The process promoters are responsible for the administration and the organization; they establish relevant connections and support the interaction of the participants.[51]

[47] Cf. Hausschild (2011), p.99

[48] Cf. Hausschild (2011), pp.101

[49] Maidique (1980), p.59

[50] Cf. Witte (1973), pp.15

[51] ibidem

2.3 System Innovation

System innovation is about a profound change in the economy or society. Often the attribute post-industrial is added to underline that technology has just a supplementary role. The organizational and informational performances are dominating the technical one. Also the new media is supporting system innovation. The time range for system innovation is normally within some decades.[52]

2.3.1 Characteristics of System Innovation

There are some points which are important to characterize system innovation. System innovation exists if: [53]

- Innovation-specific partial activities,
- of legally and economically independent innovators (enablers),
- in an inter-organizational arrangement (governance),
- an innovative combination of purpose and means arises,
- which leads to a sustainable change in behavior.

So system innovation differs in respect to the innovators, also called enablers, and the users from the classic innovation. For the users it is the sustainability and the range of the change of the user behavior. This means it leads to a change of the game. [54]

2.3.2 Involved Groups in System Innovation

System innovation consists of two main groups of characters. Like mentioned, these are the enablers and the users. [55]

Enabler is a term for the system provider, which initiates, develops and performs the system innovation and so enables to use it. The term enablers

[52] Cf. Grün, Hauschildt, Jonasch (2008), pp.177

[53] Cf. Grün, Hauschildt, Jonasch (2008), p.178

[54] ibidem

[55] Cf. Grün, Hauschildt, Jonasch (2008), pp.178

contains the variety of institutions, which differ in their size, their branch affiliation cross industry and their specific interests.

For system innovation it is the same as for “Multi-Organization Enterprises” - it presents an inter-organizational arrangement. This is the reason why the term “Multi-Organization Innovation” is often used in this context. [56]

The following figure shows the interaction of innovation systems of particular enablers in a multi-organizational arrangement.

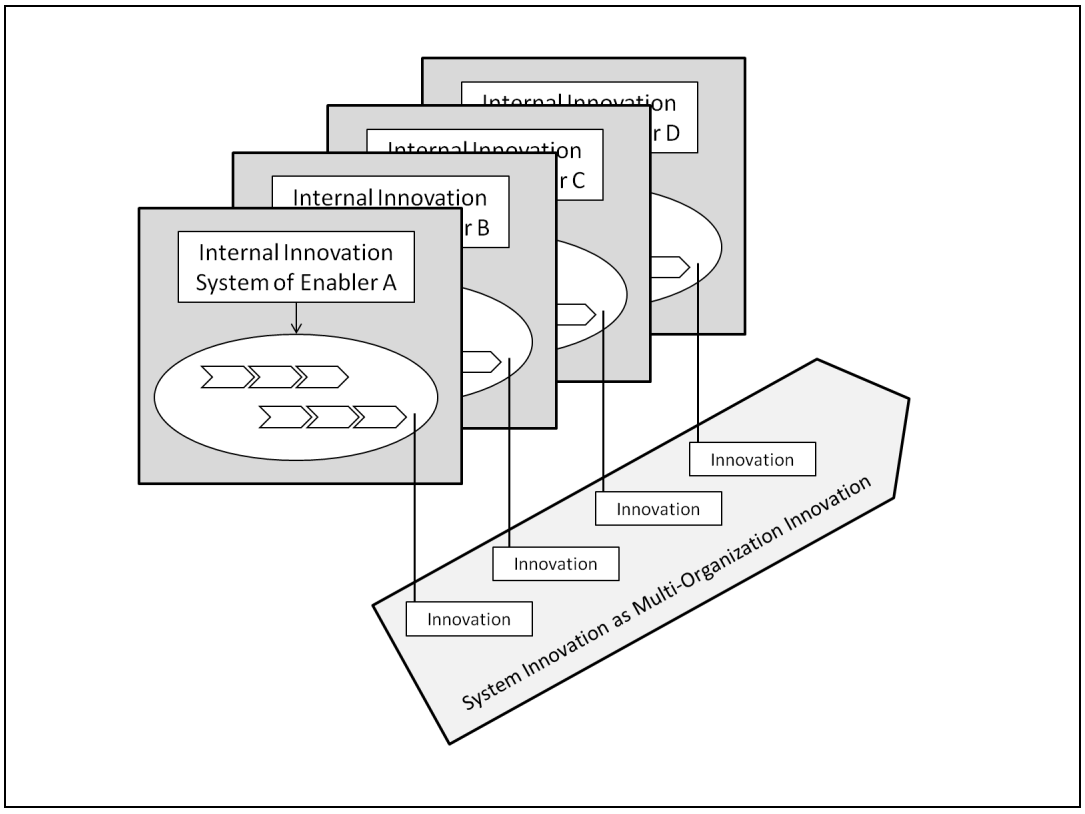

Figure 3: Interaction of Innovation Systems as Part of the System Innovation[57]

The second distinction between system innovation and classic innovation is the behavior of users. This group has, compared to the small number of enablers, a high number of users. The generation of user-communities is crucial, especially for enacted system innovation. This is usually easier for business customers than for private customers.[58]

[56] Cf. Grün, Hauschildt, Jonasch (2008), pp.178

[57] Referring to Grün, Hauschildt, Jonasch (2008), p.179

[58] ibidem

2.4 Innovation Processes

In the next two subchapters two well-established innovation processes are described. On the one hand it is the Stage Gate Process of Cooper and on the other hand the process of Thom.

2.4.1 Innovation Process by Thom

A really general illustration of an innovation process is provided by Thom. This model consists of three phases: the idea generation, the idea acceptance and the idea realization phase. The first phase contains the definition of the target field and the idea itself. The second phase contains the rating of the idea and the creation of an implementation plan. Last but not least, the third phase covers the implementation of the plan as well as the success monitoring. This structure of the innovation process is the basis for many other descriptions of innovation processes. These three main phases are used to separate the sub phases. [59]

Following the three main phases of the innovation process of Thom are listed:[60]

- Idea generation
    a. Target field definition
    b. Idea finding
    c. Idea proposal
- Idea acceptance
    a. Rating of the idea
    b. Creation of an implementation plan
    c. Decision for one implementation plan

[59] Cf. Thom (1980), p.53

[60] ibidem

- Idea realization
    a. Concrete implementation of the plan
    b. Forwarding the new idea to the initiator
    c. Acceptance monitoring

The following figure shows the three main phases of the innovation process of Thom:

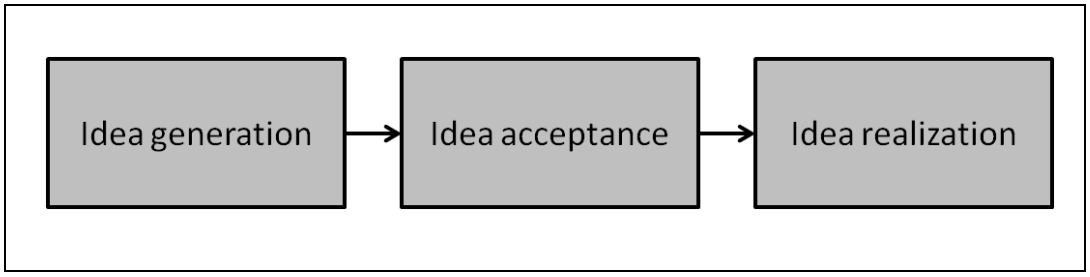

Figure 4: Innovation Process by Thom[61]

2.4.2 Stage Gate Process

The Stage Gate Process separates the innovation process into different segments, which are defined in advance. Each segment is entered through a gate, which monitor the process and are used as a checkpoint for the quality control and the termination or continuation of the project. And exactly this structure of stages and gates leads to the name Stage Gate Process. [62]

The stages and gates of this process are as follows:[63]

- *Discoveries at the beginning*: Ideas are the trigger for the process and they define the following process course. In this phase engineering research can be done to find new technical opportunities. To make a summary of the discovery phase is essential for innovation.

[61] Referring to Thom (1980), p.53

[62] Cf. Cooper (2010), pp.145

[63] ibidem

- *1. Gate - Idea screen*: The first gate is used to sort out ideas. It has to be decided if resources are invested in this idea or not. The idea has to fit into the company´s strategy, the market has to be attractive enough, and the idea has to be technically feasible.
- *1. Stage - Scoping*: The objective of this stage is to define the technical and market-based advantages of the project. Important factors are the market assessment and a concept for the first steps. Another important factor is the technical evaluation, regarding the production line, the feasibility, the time and cost estimation as well as national laws and regulations.
- *2. Gate - Second screen*: The second gate contains another screening of the project. Basically, it is a repetition of the first gate but with more strict criteria.
- *2. Stage - Build Business Case*: The second stage is about the definition project's framework. It is the very beginning of the product development. It covers market assessment and market research in order to clarify requirements, wishes and preferences of the customer. The analysis of the competition is also part of it. Finally, a detailed entrepreneurial and financial analysis has to be done.
- *3. Gate - Go to development*: This gate is the last one before the development of the product with expensive investments starts. This is the last exit point without making a considerable financial loss.
- *3. Stage - Development*: This is the development stage of the product. Tests are also part of this stage. The focus lies on the technical work, but also the management activities are done.
- *4. Gate - Go to testing*: This gate works as control unit for the progress of the project. The quality is checked and the project is compared with the definitions of the third gate.
- *4. Stage - Testing and validation*: In this phase the complete project is tested and validated, i.e. the product, the process, the customer acceptance and the financial side. This phase includes product tests, customer tests, testing of the production line, working with test markets and a revision of the business and financial analysis.

- *5. Gate - Go to launch*: The last gate opens the door for marketing, the market launch and the manufacturing of the product. This is the last chance to stop the project.
- *5. Stage - Launch*: The manufacturing plans and marketing plans are realized. If there are enough resources in the background and the pre-work is done with a high quality, the product is now ready to be launched on the market.

2.4.3 Testing and Validation Phase

Because this master thesis is focusing on the back end of the innovation process the testing and validation phase is explained in more detail. In this phase a prototype is already developed. The next step is the testing and validation of the product, in order to confirm the project. As to this, typical activities are product testing, field tests and tests with customers.[64]

Testing of the Product

The product has not only to be tested in the development department; it should also be tested if the customer is using it. The customer needs to accept the product to generate a buying intention. [65]

Field Tests and Internal Tests

Extended consumer test or field tests enable the customer to test the product for a longer time period. The reaction and the buying intention are then based on more detailed and better information. Extended consumer tests are especially appropriate for complex products where it needs a longer time to see advantages and disadvantages. Furthermore, they explore more product deficits, which would be unseen in shorter tests.[66]

For the implementation of a consumer test a sample of potential customer is defined and qualified. The next step is to handover the product to the customer. The customer is then using the product at home or at work. Afterwards a follow-up meeting is done in form of a personal interview or

[64] Cf. Cooper (2010), pp.305

[65] Cf. Cooper (2010), pp.306

[66] Cf. Cooper (2010), pp.305

another survey. Important for the interview is the interest for the product, the preferences, the buying intention, the advantages and disadvantages, and potential improvements.[67]

2.4.4 Market Launch in the Innovation Process

The marketing plan, which is the basis for market entry, is a central element of the product strategy. It is an action plan for the market launch of new products and it contains three major points, which are the marketing objectives, the marketing strategy and the marketing program.[68]

The marketing objectives have to provide criteria to decide between alternatives, which have to be quantitative and measureable in the amount of time required. The marketing objective should at least contain the sales figures and market share for the next year, based on a defined market segment. Major points of the marketing strategy are a market analysis, an environmental analysis and an internal valuation.[69]

There are four main fields in the market analysis:[70]

- *The market overview:* How big is the market? How fast is it growing? What are the trends?
- *The market segments:* Which market segments are there? How fast are they growing?
- *The buying behavior:* How is the buying behavior? Who is buying? Where, when and why does the customer buy a product?
- *The competition:* Who are the competitors? What are their strengths and weaknesses? What are their strategies?

[67] Cf. Cooper (2010), pp.307

[68] Cf. Cooper (2010), p.321

[69] Cf. Cooper (2010), pp.323

[70] Cooper (2010), p.327

2.5 Management of Innovation Projects

This chapter contains the management of innovation projects. The explained methods can be used to develop new services or new products. The main stages of the management of innovation projects are described in the following paragraphs.

Innovations can be seen as isolated processes and are organized and lead like a project. Innovation management is project management, however, in a special way. Innovations are strategic projects, often connected with high costs and long-term impacts for companies.[71] These projects differ substantially from operative projects as described in the project management literature.[72]

The innovation project can be split into four main stages. These are: [73]

- The project definition
- The project planning
- The project monitoring
- The project closure

2.5.1 Project Definition

The first process step is the project definition. It is building the base for the innovation project. Important parts of the definition phase are the setting of targets and the definition of the project organization and an appropriate process organization. [74]

[71] Cf. Lechler (1997), pp.233

[72] Cf. Hauschildt (2011), p.143

[73] Burghardt (2002), pp.12

[74] Cf. Friesenbichler (2002), p.10

Project Targets

The targets are defining the condition after the innovation project and can be split into three parts. The performance and quality targets describe the final outcome of the projects. The targets in terms of costs limit the available budget and therefore the applicable resources for the achievement of the targets. Last but not least the target in terms of deadlines defines the time until the closure of the project and often also the time until the achievement of intermediate targets. [75]

Organization of Innovation Projects

Past experience shows that large and complex projects will be successful if appropriate organizational provisions are made. There are two main issues for the organizational structure. First, the project has to be implemented in the organization, where different organizational forms are available. Secondly, within the innovation project the different roles have to be clear and the acting persons have to be defined. Therefore, the competences and the areas of responsibility have to be defined. [76]

For the involvement of the project management in an existing structure four variants are distinguished:[77]

- Functionally based organization: The mainly affected department assumes the steering of the decision and enforcement process. Project leader is the management of the affected department. It has to be aimed for cooperation with other departments for overlapping topics.
- Pure project based organization: There are two variants of this organization model. The first one is the project oriented line organization. The whole company is working on different projects, which are developed simultaneously or successively. For each project an own project team with a project leader is temporary defined. After finishing the project a new task has to be supervised.

[75] Cf. Friesenbichler (2002), pp.10

[76] Cf. Friesenbichler (2002), pp. 11

[77] Cf. Hauschildt (2011), pp. 72

The second variant is the task force model. It consists of a project team which is independently of the functional organization and has to supervise a special task for the company. The project team works just for this project as long it is not officially completed or just ended. This concept is often used for innovation projects where time is playing a major role.

- Matrix based organization: In this organization a project team exists which is working separately, but not independent of the functional structure. For the running task the line manager and for the innovation project the project leader is responsible. In this case the conflict between two superiors over the work capacities is accepted. However, the acceptance of the line manager for the project has to be received. Experience shows that a reduced influence of the line managers and higher influence of the project manager improves the efficiency and effectiveness of the project.

Project Order

At the project's beginning a project order is necessary. Only with this document, that contains the most important milestones and the targets of the project, a development intention is going to become a project.

2.5.2 Project Planning

A major aspect for a project is accurate planning. Planning is used to reduce the complexity of a project for the project team. After successful project planning it is defined which work packages have to be created, who is doing what and which resources are required. Furthermore, the costs, the time schedule and the chronological sequence of the work packages are determined.[78]

2.5.3 Project Monitoring

Project monitoring is necessary because of the unpredictable events that influence the project, like customer´s requirements; disturbances, absence

[78] Cf. Friesenbichler (2002), p.10

of team members; planning failures, forgotten work packages or a wrong estimation. The actual project parameters are compared with the target parameters. It is important to control all relevant parameters including costs, time and performance. The project manager has to know the performance progress at all times. The time schedule has to be adapted during the project. The cost controlling is often important for the top management, therefore the target costs and the actual costs have to be compared and the variance has to be analyzed. [79]

2.5.4 Project Closure

For successful closure of the project there are some points which have to be considered. First, the product or performance acceptance is done by the project team itself but also by the top management. The exact time for the project closure has to be defined. Secondly, the project closure analysis, which documents the variance of the actual costs, time and performance. It is important to analyze the reasons for the variation to gain experience for the next project. This leads to the third point, which is the protection of the gained experiences. Negative and positive experiences are valuable for the next projects. In the end project closure is necessary, because each innovation project needs a defined starting and end point. Tools for the knowledge management are project closure reports or lessons learned workshops.[80]

[79] Cf. Posch (2003), pp.211

[80] Cf. Friesenbichler (2002), p. 22

3 Market Launch

This chapter is separated into two different parts. Firstly, the market launch in the automotive industry is described and secondly the specific characteristics in e-mobility are explained.

3.1 Market Launch in the Automotive Industry

This chapter deals with the marketing in automotive industry, the innovation process in the automotive industry with the example of Volkswagen and furthermore offers a closer look on the market launch in the automotive wholesaling with the example of Porsche Austria.

3.1.1 Marketing in the Automotive Industry

Marketing is not equal to selling, because it begins before a company product is on the market. Marketing is the task that has to be done to evaluate needs and requirements of customers, to analyze them and determine if there is a profitable opportunity. Moreover, it is about customer loyalty, finding new customers and the after sales. The marketing process is transferable to different fields like goods, services or politics.[81] Another description in a more precise way is defined here: marketing is the management process responsible for identifying, anticipating and satisfying customer requirements profitably.[82]

The market-oriented process for the marking is defined below:[83]

- *Analysis:* It is important to analyze factors which are important for the company. The analysis contains the market analysis, which includes market size and market trends, the competitor analysis, the customer analysis, but also the company analysis, which considers the market share, portfolio analysis and profitability analysis.

[81] Cf. Kotler (1999), p.19

[82] Adcock/Halborg/Ross (1995), p.3

[83] Lancaster/Massingham (2011), p.14

- *Planning:* The planning is important for the preparation of decision making. The most important marketing decisions are the marketing objectives, product and market scope with the segments and targets, the company target, the marketing strategy and finally the marketing mix decisions, which include product, price, place and promotion.
- *Implementation:* Important is also the implementation, which needs staff and financial resources.
- *Control:* The last point is about the monitoring and controlling of the activities.

There are some methods define in literature for a winning marketing practice. These practices are listed here:[84]

- Win through higher quality
- Win through better service
- Win through lower prices
- Win through high market share
- Win through adaptation and customization
- Win through continuous product improvement
- Win through product innovation
- Win through entering high-growth markets
- Win through exceeding customer expectations

It is not enough to be just a bit better than competition, it is important to have its own robust strategy to win a market in the long-term. [85]

3.1.2 Innovation Process at Volkswagen

The innovation process of Volkswagen is an important part of the organization. The process is based on the Stage Gate Process of Cooper. In the following figure the different stages of this process are shown.

[84] Kotler (1999), p.5

[85] Kotler (1999), p.9

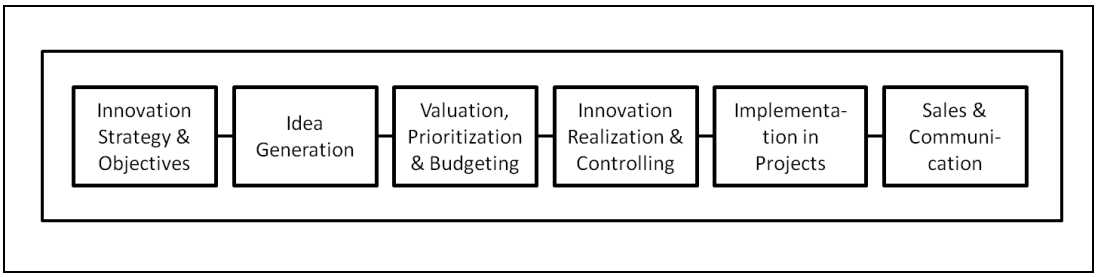

Figure 5: Innovation Process of Volkswagen[86]

The main focus of the master thesis lies on the last stage of the innovation process, i.e. sales and communication. Yet this master thesis deals with innovation, so the first stage with the innovation strategy and objectives is described briefly as well in the following paragraphs.[87]

Innovation Strategy and Objectives

Innovation is crucial for Volkswagen. This is the reason why they defined a strategy how to handle innovation in their company. The basics of the Volkswagen Innovation Strategy are as follows: [88]

- Innovation is seen as key success factor
- Clear defined innovation objectives are necessary
- Business unit comprehensive innovation processes are existing
- Set innovation fields have to be defined
- Central control mechanism are necessary
- Early consideration of trends has to be done

Sales and Communication

There are three main parts in the sales and communication process at Volkswagen, which are the framework for the sales and communication:[89]

[86] Internal Information of the Volkswagen Group

[87] ibidem

[88] Referring to Internal Information of the Volkswagen Group

[89] ibidem

- *Market positioning:* Is about the early definition of the market-relevant innovations, the long-term direction of the communication strategy and the anticipation of market-relevant innovation communication.
- *Brand and technology communication*: Is about the steady adjustment of prospective innovations with the communication strategy, the positioning of the brand through prospective innovations.
- *Product communication*: Is about the transition of the brand promises in concrete product communication and about the determination of a campaign-worthy innovation at an early stage.

The previous described issues are most crucial for the framework of the sales and communication. More in detail, communication means the production of television spots, radio spots, and other activities. Additionally, launch events have to be organized, like exhibitions and fairs, press, fleet and VIP events, and events at the dealerships. Finally, the training for the sales men and the dates for the first orders have to be defined.

At Volkswagen the main focus in the sales and communication stage is the external communication, as described before. The detailed sales steps are not described in the Volkswagen innovation process. Innovation is a major issue especially in the beginning during research and development. In conclusion, at Volkswagen the focus lies on product innovation and a modified stage gate process is used. The detailed sales process in Austria on the example of Porsche Austria is described in the next subchapter. [90]

3.1.3 Market Launch at Porsche Austria

The last chapter described an overview of the innovation process of Volkswagen in general. This chapter will cover the last stages of the innovation process, which is mainly the sales process of the market launch. In this chapter the standard market launch for a new model of Volkswagen

[90] Internal Information of the Volkswagen Group

in Austria is explained. First it will be about the definitions, then the sales planning and in the end about the market launch itself. [91]

Definitions

On one side, there is Volkswagen in Wolfsburg, Germany which is the manufacturer of the vehicles. A manufacturer is producing industrial goods.[92]

On the other side there is the trader, who is only or mainly procuring goods and, without substantial changes, sells it again. There are different types of trade, for example the retail sector and the wholesale sector. The retail and wholesale sector are in this case taking the part between the manufacturer and the end consumer. Porsche Austria is the wholesale company, also called importer for brands of the Volkswagen Group in Austria.[93]

Sales Planning

The sales planning contains the market research, sales political instruments and the sales plan. After the collection of information about potential customers and competitors through the market research a sales political activity plan can be created.[94]

- Through the product policy a demand-based offer is created
- Through the price policy a profit-maximized price is searched
- Through the communication policy the promotion and the public relations is optimized
- Through the distribution policy the best sales channel is chosen

The optimization of these four policies is called the marketing mix. When the activity plan is defined, a sales plan can be created. The sales plan contains the sales program, the sales volume and the sales price. Basically the whole planning is about the determination of a competitive advantage. The

[91] Internal Information of Porsche Holding

[92] Cf. Baumgartner/Schölling (2000), p.4

[93] Cf. Müller-Hagedorn (1993), p.17

[94] Cf. Wöhe/Döring (2008), pp.385

target is to occupy a business field, where a competitive advantage is given and to overtake the market leadership in this field.[95]

Market Launch at Porsche Austria

Requirement for the release of the market launch process in the field of sales planning is an official message of Volkswagen to the importer with information about market launch date, product concept, technical information, and price. Through this information the processes in the different departments are starting. There are four involved departments, the product management, the disposition, the price management and the homologation. [96]

The product managers are informed by means of the new product information folder of Volkswagen and through so called Open Days, where new models are shown. A product concept has to be created by them with the following information:[97]

- Overview of the market and the segment of the model
- Overview of the competition of the model
- Objectives
- Target customers
- Positioning
- Price positioning of the basic model
- Time scheduling

Further points for the product managers are the creation of a price list for the retail organizations, creation of an information brochure, update of the website and the creation of a product catalogue. Furthermore, product training is organized for the sales staff of the dealers.[98]

The disposition department, in cooperation with the product management and the price management, is responsible for the equipment in Austria.

[95] Internal Information of Porsche Austria

[96] ibidem

[97] ibidem

[98] ibidem

Further important points for the disposition department are the market launch volumes, volumes for the training, the press and other events. The market launch date, optional equipment for the market launch, painting for the market launch and seat covers. Through the volume planning the disposition department is able to define the exact market launch time, events for the press, and the congresses. [99]

The price management department is responsible for the maintenance of the prices for all models, equipment and paintings. The homologation has just one important point for the market launch. They have to allocate the technical information of all different motorizations to the appropriate model code. This has to be done to calculate the registration tax for example. [100]

Another topic is the after sales, here are also preparations necessary. The after sales staff is trained to be able to work with the new model. Spare parts are stored in order to be able to react fast to repairs and finally after sales offers are created to ensure customers´ loyalty. [101]

In conclusion, the focus at Porsche Austria lies on a marketing mix with product, price, promotion and place policies. Furthermore the after sales organization prepares to be ready for the launch. In the end, the market launch is ready to start. This includes events for journalists, conferences for dealers and external communication. [102]

[99] Internal information of Porsche Austria

[100] ibidem

[101] ibidem

[102] ibidem

3.2 Specific Characteristics in E-Mobility

There are many reasons why e-mobility is an emerging topic. One reason is that the reduction of greenhouse gases is becoming more and more important. The smog in megacities is increasing and it reduces the living quality of people in the cities. Another problem is the finite nature of fossil fuels which leads the automotive industry to invest in new. Additionally, energy consumption in the world is rising annually; therefore new and more efficient technologies are necessary. Another reason is that politicians are now more interested in e-mobility.[103]

Concerning the further development of e-mobility in Austria it is generally considered that the e-mobility will prevail in the long run. But of course the speed of the market penetration is strongly depending on the framework conditions, like for example government incentives, regulations, high oil prices or technological leaps.[104]

3.2.1 Current Situation in E-Mobility

This chapter should give an overview of the current situation in e-mobility. The regulation of the European Union is described and also the first customers in e-mobility in literature are listed. Finally, the sales figures of the automotive industry from the last years, listed by the powertrain technology are shown.

CO_2 Emission Targets of the European Union

The European Union released a regulation for all automotive manufacturers in the European Union countries. It is about the CO_2 emission of all new passenger cars in the European Union. In this regulation the target CO_2-fleet emission is 95 Gramm per kilometer. The automotive manufacturers have to pay a fee for each Gramm of CO_2 that exceeds the regulation in their fleet of passenger cars. This regulation is important for all automotive

[103] Internal Presentation of Volkswagen Group

[104] Cf. E-connected (2010), p.18

manufacturers and a reason to invest in the electrification of the powertrain.[105]

First Customers of E-Mobility

For new technologies it is important to define potential customers. The potential customers for e-mobility are defined in literature as follows: [106]

- Commuters
- Taxi Service Providers
- Public Fleets
- Company Car Pools
- Model Regions

Sales Figures

In the following table the sales figures of BEVs, hybrid electric vehicles, gasoline and diesel vehicles, others and the whole automotive market in Austria are demonstrated:

[105] Cf. European Parliament and Council (2009), p.5

[106] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.11

	2009		2010		2011	
	#	%	#	%	#	%
Battery Electric Vehicles	39	0,01	112	0,03	631	0,18
Hybrid Electric Vehicles (BEV+PHEV)	1055	0,33	1248	0,37	1310	0,37
Gasoline and Diesel	317.809	99,50	325.048	98,93	352.272	98,91
Others	500	0,16	2155	0,67	1932	0,54
Whole automotive market in Austria	319.403	100	328.563	100	356.145	100

Table 1: Sales Figures of Electric Vehicles and the Whole Market in Austria[107]

3.2.2 Advantages and Challenges in E-Mobility

There are specific advantages for the environment, for the economy and the users themselves. The specific advantages are listed in this chapter. Afterwards, the technical challenges and challenges for the customer acceptance are described.

Specific Advantages

The specific advantages of e-mobility are:[108]

- Local zero emission in urban centers with strong pollution
- The usage of renewable energy in the oil-dependent road traffic
- A higher energy efficiency of the electric motor compared to a conventional motor

[107] Internal Information: Market Research Department, Porsche Austria

[108] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.13

- A higher durability and less maintenance costs of the electric motor because of no internal combustion engine (ICE) and less moving parts

Technical Challenges

The technical challenges in e-mobility are:[109]

- High battery costs
- Low range because of the energy-density in the batteries
- Possible safety issues for accidents because of the changed weight distribution or the released pollutants of the battery
- Changed perception of electric vehicle because of the missing engine sounds
- Challenges for customer acceptance

The costs, range and infrastructure are very important criteria for the customers. Currently, the purchase costs of electric vehicles are higher than for conventional vehicles. Low purchase costs strongly influence the purchase decision of most customers. How the automotive manufacturer reaches lower purchase costs is not relevant for the customer. One possibility would be with government incentives and a second would be through further technological developments. The purchase costs are high for BEVs but also for hybrid electric vehicles. For electric vehicles it is important to calculate the total costs of ownership, because of the higher purchase costs but the lower energy costs and maintenance costs.[110]

The low range is another important criterion for the customers. The customer's trust in the mobility and range of electric vehicles is not very high; meaning that customers are not always sure how far they can go anymore. This lack of trust leads to a request for higher range and a better infrastructure. Of course, the range problem just applies to the BEVs; hybrid

[109] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.14

[110] Cf. Fraunhofer ISI (2012), p.16

electric vehicles have a higher range. The differences are described in chapter 3.2.4.[111]

Another problem is the lack of appropriate public charging infrastructure. This infrastructure is needed to charge the vehicles during the day, for example in city centers or at the working place. Yet in different model regions it was also shown that the public infrastructure was used on a seldom basis. This topic is of course also a psychological issue. Furthermore, this topic is closely connected to the range issue. If there are electric vehicles with higher ranges, the public infrastructure isn´t very important anymore. If the public charging infrastructure is rising, the range anxiety of customers is getting lower.[112]

3.2.3 Stakeholders in E-Mobility

In this chapter the stakeholders which are described in studies are shown. Furthermore their role in the system of e-mobility is described shortly.

The stakeholders in e-mobility are: [113]

- *Original equipment manufacturer (OEM):* The OEMs have realized the interest in this topic and invested a lot of money. Furthermore the green image is very important for them and they need to have a long-term strategy for alternative vehicle concepts when running out of fossil fuels. Furthermore, the OEMs are enforced to invest in e-mobility by politics due to CO_2-fleet emission limits. There are new business fields for the OEMs, like the battery technology, the charging infrastructure, financial models and other services. But there are also new OEMs on the market like Think. The automotive supplier industry has to react on the new fields in e-mobility, but basically there is no change in the business model for automotive suppliers.

[111] Cf. Fraunhofer ISI (2012), p.16

[112] ibidem

[113] Cf. E-connected (2010), pp.18

- *Fleets:* There are a lot of companies with a high number of cars in their carpool. There are big fleets of company vehicles, but also big fleets of logistics and transport vehicles. These groups are seen as a potential customer group for e-mobility in future. For them, incentives also play a major role.
- *Specialists and mobility service provider*: This group has a clear focus on offering mobility services or parts of it. Currently, they offer car-sharing concepts for example. In the future they will play a more important role for multimodal mobility concepts.
- *Energy provider and grid operators*: There is a high interest of energy providers and connectivity providers in the context of e-mobility. The expected additional revenues are estimated rather small. However, better customer loyalty and the chance for cross-selling are the main drive for their commitment to e-mobility.
- *Tourism:* The tourism industry will be able to be a core area for the distribution of e-mobility. Tourism is in a position to bring e-mobility to life and to introduce the user groups to e-mobility. An example would be a touristic overall plan involving organizers, hotels, local authorities and tourists associations.
- *Area provider*: The public sector as area provider has the opportunity to benefit from electric vehicles. There are already cities with a city toll, like London. For private area providers there is the potential to attract new customers by providing charging stations for electric vehicles, but there is also the potential for new services, like park and charge.
- *Infrastructure providers:* There are three fields of infrastructure providers. Firstly, companies which are focusing on components for the charging infrastructure, secondly, companies which are focusing on systems, and thirdly companies which are focusing on services in the field of charging infrastructure. The challenge is to identify a potential market niche and to enter it with a differentiated product. But there is still an uncertainty for investments, because political decision can change the complete situation really fast.

- *Politics:* Politics plays a major role in e-mobility, because politics is in the position to quickly change the framework of e-mobility. For example, new incentives demand-sided would strongly supports the penetration of the market with electric vehicles.
- *Customers:* The customers are crucial because they decide if e-mobility gains acceptance or not. Therefore, customer requirements are important for the market launch of e-mobility.
- *Research:* E-mobility is also a new topic in research. There are a lot of institutions working on this field. In order to be up-to-date it is important to consider research institutions as important stakeholders.

In this list of e-mobility stakeholders it has been proven that there are new stakeholders, which are usually not of importance in the automotive industry. In the fifth chapter the list of stakeholders in e-mobility suggested by literature are confirmed and even extended. Furthermore, the relevant stakeholders for Porsche Austria are defined.

3.2.4 Electric Vehicles

This chapter illustrates the history of electric vehicles and the different powertrains from the mild-hybrid to the BEV. Also the battery, which is part of the electric vehicle, is described.

History

At the beginning of the automotive age there have been more electric vehicles than ICE vehicles. But after some time the conventional vehicles started their triumph for a long time. Reasons for that has been the electric starter for ICEs, the lower purchase price compared to pure electric vehicles and the higher number of gas stations.

At the beginning of the 1980s e-mobility was making a return because of environmentally actions. The French automotive industry saw a realistic economic chance with the support of the French government. Prototypes and low volume production were created by Peugeot, Citroen and Renault in 1985. Also Volkswagen was developing an electric vehicle, the Volkswagen City-Stromer. During the early 2000s a second hype for e-

mobility started. This was especially enforced by Toyota with their hybrid vehicles in 2000.[114]

Different Powertrains

There are different vehicles concepts based on an electric powertrain. This includes electric bikes, electric scooters, electric mopeds, the electric motorcycles and the electric cars. Electric cars can be separated in pure BEVs and hybrid electric vehicles. This thesis focused on electric vehicles including BEVs. Therefore the different electrifications of the powertrain for cars are described in this chapter.[115]

The different electrifications of vehicles are:[116]

- *Micro-Hybrid Electric Vehicle*: The Micro-Hybrid is a conventional vehicle with a start/stop function. The start/stop function stops the engine while the vehicle halts at a junction.
- *Mild-Hybrid Electric Vehicle*: The Mild-Hybrid supports the ICE with some electricity with a maximum electric power of 6 to 14 kW.
- *Full-Hybrid Electric Vehicle (HEV):* The full-hybrid already has an electric motor which is supporting the ICE during the acceleration phase. It is also possible to drive for certain duration with the electric motor only.
- *Plug-In Hybrid Electric Vehicle (PHEV):* The PHEV has an electric motor and an ICE. It is possible to drive between 20 and 80 kilometers with the electric motor. Plug-in means that it is possible to charge at a charging station with a plug. The powertrain is powered by the ICE or the electric motor, but it is also possible to drive with both at the same time to support acceleration.

[114] Cf. Federal Ministry for Transport, Innovation and Technology (2009), p. 39

[115] Internal Information of the Volkswagen Group

[116] ibidem

- *Range Extender Electric Vehicle (REX):* The REX is also a PHEV because it is also possible to charge the vehicle at a charging station. The difference is the powertrain. The PHEV is powered by the ICE or the electric motor. The REX is always powered by the electric motor and the ICE is just charging the battery for a longer range.
- *Battery Electric Vehicle (BEV):* The battery electric vehicle only has an electric motor and no ICE. Currently it is possible to drive between 80 and 200 kilometer with the battery. The powertrain is only powered by electricity.
- *Fuel Cell Electric Vehicle (FCEV):* This technology is powered by an electric motor. The fuel cell is used to produce electricity. The FCEV uses, for example, hydrogen and oxygen from the air.

When electric vehicles in this master thesis are mentioned it refers to the BEV, the PHEV and the REX. The following figure illustrates an overview of the different electrifications of the powertrain.

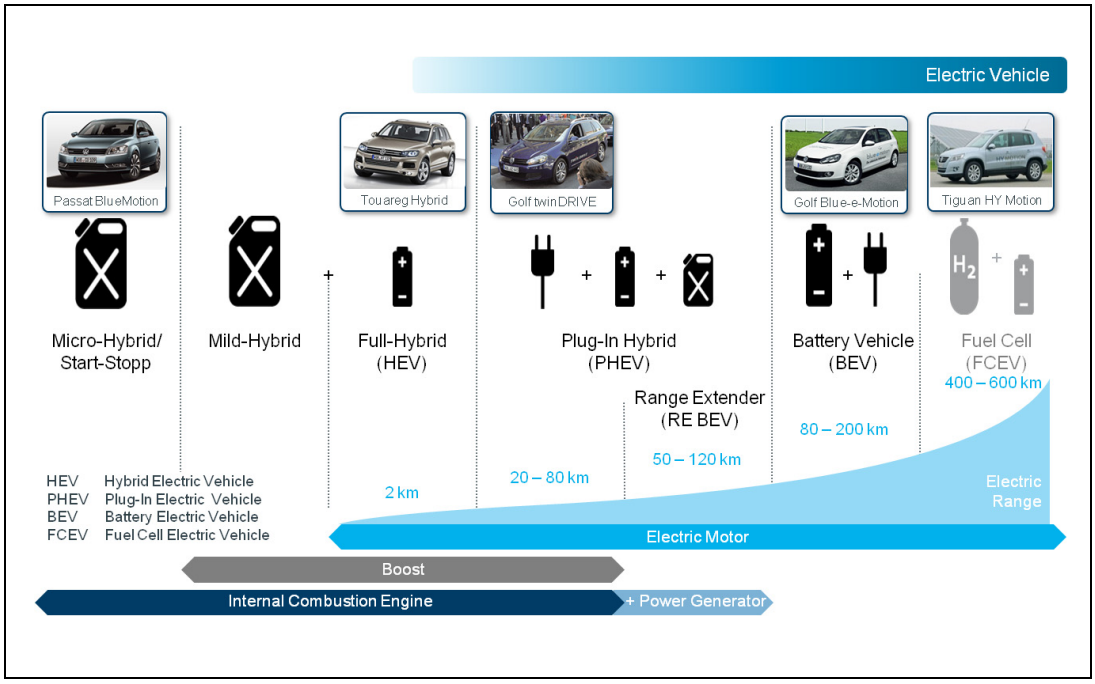

Figure 6: Electrifications of Vehicles[117]

[117] Referring to Nationale Plattform Elektromobilität (2012), p.44

Battery Technology

The battery technology is a critical issue for e-mobility in the future. There is a lot of research in the field of battery technology for electric vehicles; because of this it is difficult to see which battery technologies will come in future.[118]

The latest battery technology on the market is the Lithium-Ion technology. This will be the leading technology for the next years. However in the future other combinations with Lithium are possible or complete different combinations of materials like Silicon.[119] The worldwide deposits of Lithium are estimated with 160 million tons. This will lead to a problem with Lithium supply in the near future.[120]

BEVs and PHEVs have different requirements on battery technology. For BEV high energy storage ability, low weight, low volume and low costs are the most important factors.[121] For PHEV the most important factor is the power for the acceleration.[122]

The battery technology cannot be separated from its environment. It is important to see the battery technology in the overall context from the production of raw material to the electric vehicle.[123] This context is shown in figure 7.

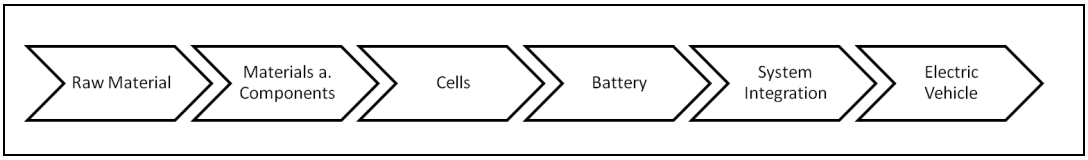

Figure 7: Battery Technology in the Overall Context[124]

[118] Cf. CE Delft (2011), p.11

[119] Cf. CE Delft (2011), pp.11

[120] Cf. Roland Berger Strategy Consultants (2009), p.27

[121] Cf. Federal Ministry for Transport, Innovation and Technology (2009), p.17

[122] Cf. Köhler (2004), p.34

[123] Cf. Federal Ministry for Transport, Innovation and Technology (2009), p.24

[124] Referring to Federal Ministry for Transport, Innovation and Technology (2009), p.24

3.2.5 Legal Aspects

There are three important differences in regards to legal aspects that distinguish electric vehicles from conventional vehicles. Currently, none of them has a deadline, but there is no information about the legal aspects in some years.

The three differences are: [125]

- Electric vehicles do not have to pay registration tax in Austria. This tax has to be paid once for the first registration of a vehicle in Austria. The maximum tax is 16 percent of the purchase price.
- Electric vehicles do not have to pay the annual tax. This tax is depending on the power of the engine and has to be paid annually.
- An electric vehicle is allowed to drive at a higher maximum speed in certain areas. These areas are covered by the Emission Control Act – Air. Electric vehicles do not emit CO_2 and are therefore not covered by this law.

3.2.6 Charging Infrastructure

A requirement for e-mobility is an appropriate public charging infrastructure. If there are more charging stations, it is possible to have more electric vehicles on the road.[126]

Challenges

Challenges for the public infrastructure are:[127]

- The awareness of Europe-wide and industry-wide standards for the interface of electric vehicles and charging stations.
- The standard exchange of information between the electric vehicle, the charging station and the user.

[125] Cf. Federal Ministry for Transport, Innovation and Technology (2009), p.24

[126] Cf. Arbeitsgruppe 2: Bedarfsgerechte Infrastruktur des Ladens Endbericht (2011), p.4

[127] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.61

- Easy and standardized billing of the energy costs with the electricity providers.

The first point has already been decided in Europe. Starting in 2017 the Combined Charging System will be the standard public charging infrastructure in Europe. The second and third point is not yet decided and the outcome will depend on developments regarding the electricity providers, the charging stations provider and other stakeholders.[128]

Charging Possibilities

Experience with model regions showed that users charge their vehicles during longer standing times at home or their working place. It was discovered that more than 80 percent were using one of these charging possibilities. Public charging infrastructure was playing a minor role, but it is important for raising the awareness of e-mobility. Strategic placed charging stations are able to minimize the range anxiety for example.[129] A third possibility is charging at semi-public places like shopping centers or on the street. [130]

Charging at home is allowed with one phase and three phases. For an electric fuse protection with 16 Ampere (A) maximum electric power of 3,7 kWh with one phase or 11,1 kWh with three phases is possible.[131]

For charging at semi-public places there is the possibility to provide energy for free to the customers to a certain place, like a shopping center or a restaurant. Here it is important to use the official standards and to comply with legislation.[132]

A public charging infrastructure is necessary to give the user the feeling of a sufficient number of charging points. In fact, just a small number of public charging stations are necessary, because of the predominant charging at home and at the working place. Of course, the standardization of the

[128] Internal Information of the Volkswagen Group

[129] Cf. Arbeitsgruppe 2: Bedarfsgerechte Infrastruktur des Ladens Endbericht (2011), pp. 4

[130] Cf. E-connected (2010), p.27

[131] Cf. E-connected (2010), p.26

[132] Cf. E-connected (2010), p.27

charging system is really important as well. Currently also the long charging times are making the public charging not really attractive. [133]

Public Charging Spots

It is sound strategy to build up a charging infrastructure at places where a mobility change is possible, like park and ride spots or rail stations, or places where a longer stay is normal, like rest places on the highway, restaurants, hotels, hospital, but also recreational facilities, public swimming pools and shopping centers.[134]

Charging Technology

Nowadays, there are four possibilities to get energy for an electric vehicle. The first one is the alternating current (AC) charging, the second the direct current (DC) charging, third the inductive charging and fourth the battery swapping.[135]

AC charging is an easy and cheap way to charge the vehicle in comparison to the other charging possibilities. With AC charging it is possible to charge with one phase or with three phases. More phases lead to more electric power.[136]

DC charging is more attractive to the public charging infrastructure, because charging with higher electric power is possible and this leads to a shorter charging duration.[137]

Inductive charging is a contact free charging. The occurring field strength is so low that they are no health risks involved. This is a really comfortable way to charge the vehicle but the technology has to be further developed.[138]

Battery swapping is also a possibility. The charging time would just include the duration of swapping batteries. The problem is the very sensitive battery.[139]

---

[133] Cf. E-connected (2010), p.27

[134] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.60

[135] Cf. Nationale Plattform Elektromobilität (2012), p.41

[136] ibidem

[137] Cf. Nationale Plattform Elektromobilität (2012), p.43

[138] ibidem

Figure 8 illustrates an overview of the mentioned charging technologies.

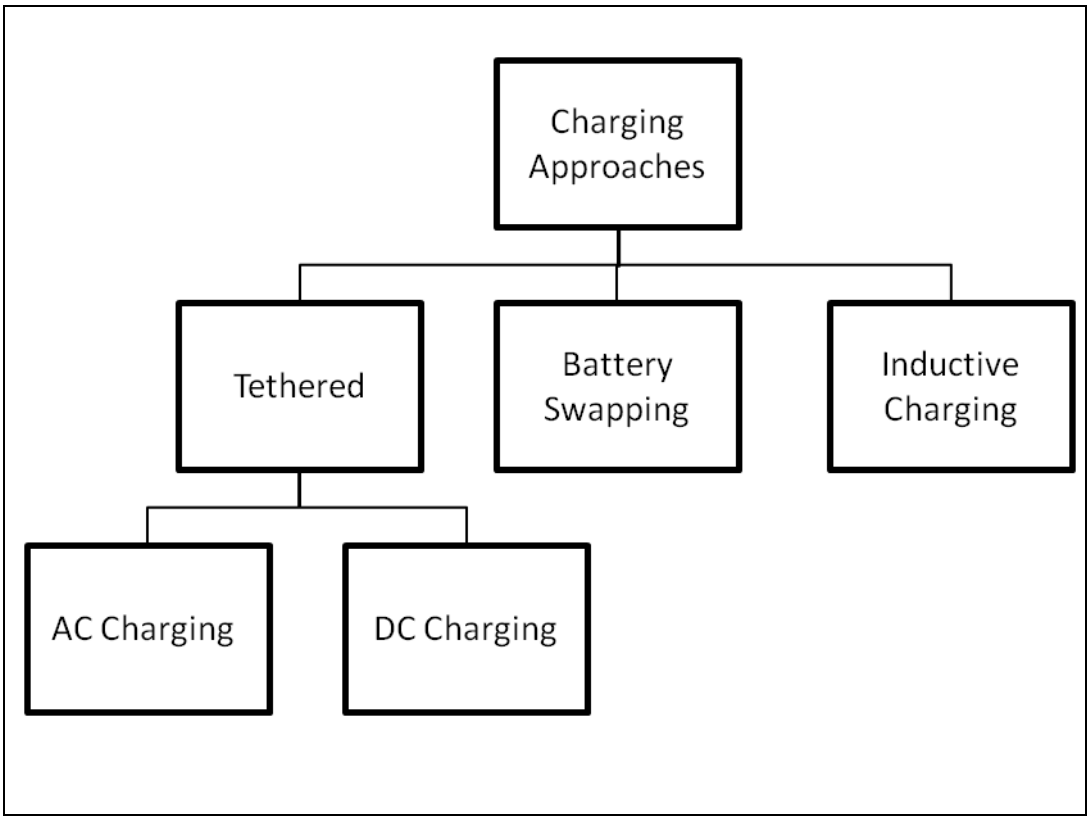

Figure 8: Charging Possibilities of Electric Vehicle[140]

Charging Plugs

For AC charging there are three different types of plugs. The first one is the Type 1 plug, shown on the left side of the following figure; it was developed in Japan and is working with one phase of up to 32 Ampere. The second is the Type 2 plug; shown in the middle of the figure, this one was developed in Germany and is working with one or three phases of up to 63 Ampere. The Type 2 is the most common one. The last one is the Type 3 plug from Italy and it is also working with one or three phases of up to 63 Ampere and is shown on the right side of the following figure. [141]

[139] Cf. Nationale Plattform Elektromobilität (2012), p.44

[140] Referring to Nationale Plattform Elektromobilität (2012), p.44

[141] Cf. Nationale Plattform Elektromobilität (2012), p.45

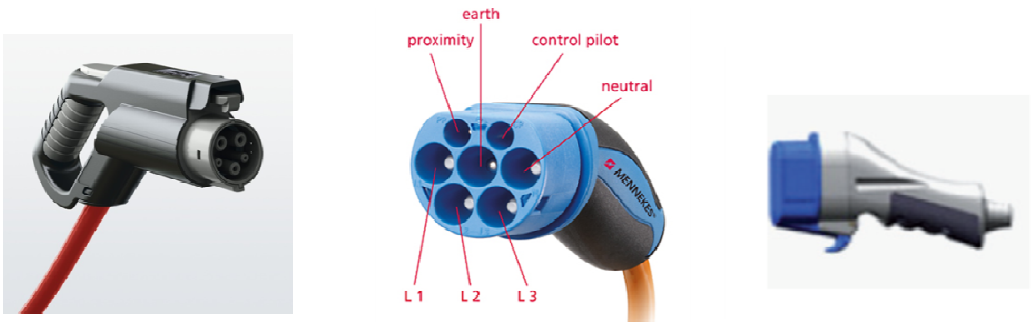

Figure 9: Charging Plugs for AC Charging[142]

For DC charging there is the Combined Charging System which is compatible with all AC charging possibilities. The Combined Charging system is able to charge an electric vehicle with up to 200 Ampere and is shown in figure 10. This System is also called Combo 2. On the other hand there exists the CHAdeMO plug, which was developed in Japan. The name stands for “Charge de Move” which means charge for moving.[143]

Figure 10: Combined Charging System Plug (Combo 2) for AC and DC Charging[144]

[142] Referring to Nationale Plattform Elektromobilität (2012), p.45

[143] Cf. Nationale Plattform Elektromobilität (2012), p.46

[144] Referring to Nationale Plattform Elektromobilität (2012), p.46

Charging Costs

The costs for a charging station between public and private charging stations differ. Furthermore the costs are depending on the grid admission charge and the grid provision fee. These costs are depending on the provided electric power, especially for quick charging stations where it can be more expensive.[145]

For a rough calculation the following example assumes a private charging station with a separate grid connection for the electric vehicle. Evidently, there are fewer costs for using an already existing grid connection. At home an electric power of 3,7 kWh is assumed. The costs for the grid admission charge are about 2.000 Euros, the grid provision fee is about 1.000 Euros and the costs for the charging stations are about 500 Euros. All in all, costs of about 3.500 Euros have to be paid. For a higher electric power connection costs of about 6.500 have to be paid. These calculations are fully in line with the experience from model regions in Austria.

The question is if the costs for a charging infrastructure at home have then to be calculated in the total costs of ownership for electric vehicles or not? On the one hand, these costs are needed in e-mobility, but not for ICEs. Therefore, these costs should be a part of the total costs of ownership. On the other hand, it is a onetime investment in a charging infrastructure for electric vehicles and can be used for future cars as well. If the costs for charging infrastructure have to be calculated in the total costs of ownership or not has to be decided in future to be able to compare electric and conventional vehicles.[146]

3.2.7 Electricity Provider

Electric vehicles are not only affecting vehicles manufacturers, but the electricity sector as well.[147]

For BEVs the energy source of the electricity is an important factor. If for example the Chinese electricity mix is used for driving an electric vehicle, the CO_2 emission is higher than the emission of a conventional ICE vehicle.

[145] Cf. Arbeitsgruppe 2: Bedarfsgerechte Infrastruktur des Ladens Endbericht (2011), p.7

[146] ibidem

[147] Cf. CE Delft (2011), p.13

This results from the fact that China is focusing mainly on the production of electricity with coal. In Europe this situation is better, although e-mobility is only reasonable where renewable energy is used. The basis of renewable energy is for example electricity from water, the sun or wind energy. Still, it will take some time to change the world's energy production to renewable energy. It is important to analyze the CO_2 emissions from well to wheel, otherwise a comparison is not legitimate.[148]

In the following figure the different CO_2 emissions of a conventional vehicle are compared to an electric vehicle. For the electric vehicle the emissions depend on the given energy source. The emissions are calculated from well to wheel.

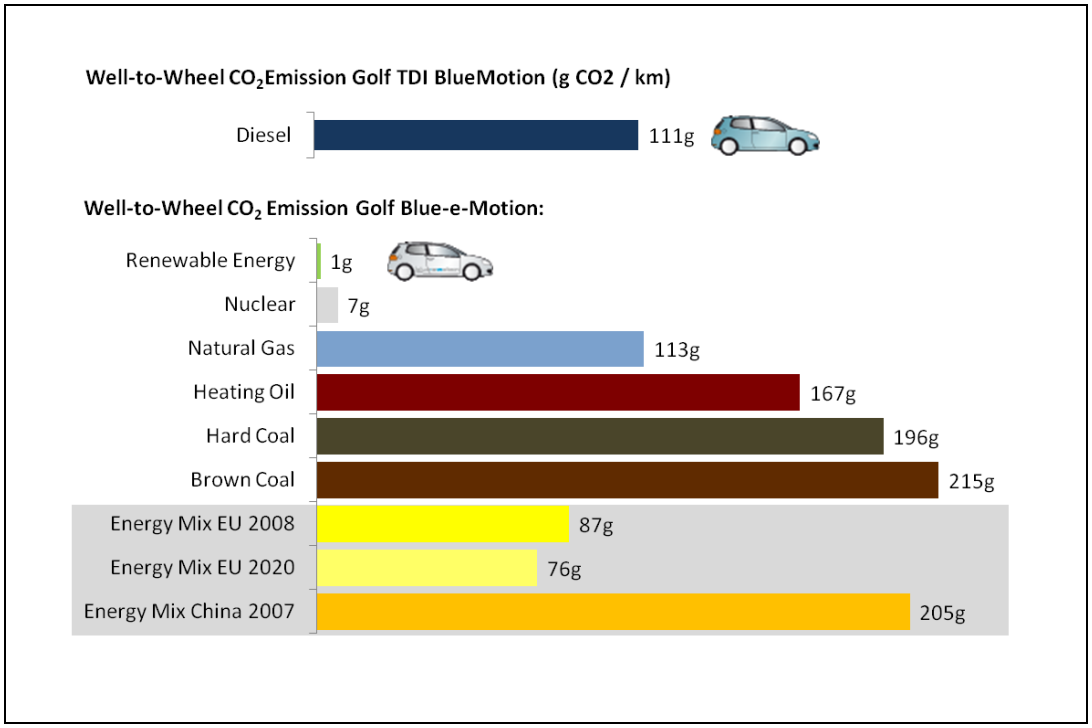

Figure 11: Well-to-Wheel CO2 Emission149

If today there would be just electric vehicles in Europe, it would result in an additional need for energy of about 10 to 15 percent, which is in fact not a very high increase. It is very likely that there will be enough energy for all

[148] Cf. Österreichischer Verein für Kraftfahrzeugtechnik (2012), p.5

[149] Internal Presentation Volkswagen

electric vehicles, but of course it is important to consider the origin of the electric energy.[150]

Cooperation between the automotive manufacturing sector, the energy providing sector and the research facilities will be of great importance for the future of e-mobility. Examples are the smart home, smart grid and vehicle-to-grid. The smart grid is a term which describes the intelligent electricity grid, which is connected with the smart home, which efficiently and effectively consumes energy at home. The term vehicle-to-grid describes the possibility of using the battery of an electric vehicle as a reserve battery or as an energy supply during times in which energy is expensive.[151]

For e-mobility it is important to consider renewable energy for charging. This is necessary if electric vehicles want to make a contribution to lower CO_2 emissions in a well-to-wheel approach.[152]

3.2.8 Conclusion

There are many reasons why e-mobility is an emerging topic for customers, but also OEMs are forced to invest in e-mobility because of the CO_2 emission target of the European Union.

For the market launch it is important to define the target customer group. In e-mobility there are groups for the first phase which are describe in literature. Regarding the customer groups, there are also different electrifications of the powertrain in e-mobility. Therefore, it has to be figured out, which kind of electric vehicles are relevant for which customer group.

Sales figures are showing just small numbers of electric vehicles sold in the last years, but it is generally considered that the e-mobility will prevail in the long run. However, the speed of the market penetration is strongly depending on the framework conditions, not only from government incentives or high oil prices, but also from the acting of the OEMs. They have to prepare the market launch and have to consider all aspects of e-mobility.

---

[150] Cf. CE Delft (2011), p.14

[151] Cf. Nationale Plattform Elektromobilität (2012), p.24

[152] Cf. Österreichischer Verein für Kraftfahrzeugtechnik (2012), p.6

The costs, range and infrastructure are very important criteria for the customers. Currently, these criteria do not support the sales of electric vehicles. For the market launch it is important to find solution for these problems, or to find other ways to convince customers to buy an electric vehicle. An example would be to show customers a total costs of ownership calculation where electric vehicles have chances to challenge conventional vehicles. Another advantage of electric vehicles are the legal aspects. They don´t have to pay registration or annual tax like conventional vehicles and additionally they don´t have to consider the Emission Control Act – Air.

E-mobility is not only the electric vehicle, but it is also about charging infrastructure, renewable energy and mobile online services. For the market launch all aspects have to be considered and therefore it is also important to know relevant stakeholders in e-mobility. For example, for the charging infrastructure it is important to find infrastructure providers for cooperation. Furthermore, for the market launch in e-mobility a solution to combine electric vehicles with renewable energy is necessary.

In the following chapter the project at Porsche Austria concerning e-mobility is described. Afterwards, the differences in the market launch of electric vehicles and conventional vehicles is shown and compared with the results of the project. The project was necessary for Porsche Austria to gain experience in the topic of e-mobility and to confirm and to specify the important issues.

4 Pilot Project

In this chapter Porsche Austria's project is described. It starts off with a subchapter that covers innovation and e-mobility, followed by the project definition and the project planning. These three chapters provide an overview of the project at Porsche Austria. Afterwards, the project's different fields of activity are described in more detail.

4.1 Innovation and E-Mobility

This chapter is about the connection between innovation and e-mobility. Firstly, the dimensions of innovation for e-mobility are explained. Then, the driving forces for an innovation like e-mobility are described. In the next part e-mobility is defined as system innovation. Afterwards, the current situation at Porsche Austria regarding innovation and resistance against innovation in e-mobility is explained.

4.1.1 Dimension of Innovation

There are different dimensions of innovation. To clarify these different dimensions with respect to e-mobility it is distinguished between five criteria. These criteria are listed below as well as an approach to answer how this applies to e-mobility: [153]

- *The content-related dimension*: What is new? The electric vehicle itself is not a new product idea; there have been already some in history. But because of a leap in technology and an increasing support of the OEMs, the electric vehicle can still be defined as a new product.[154] But besides the electric vehicle, there are many more new aspects such as the charging infrastructure, renewable energy, mobile online service and others. If the focus is on the electric vehicle alone or just on one other aspect of e-mobility it could be defined as product innovation. But if e-mobility is seen from a higher level with

[153] Cf. Hauschildt (2011), pp.5

[154] Porsche Austria Internal Information based on Expert Interviews

all the different aspects and the different stakeholders it can be defined as system innovation. A detailed definition of e-mobility as system innovation follows in the chapter 4.1.3.

- *The intensity dimension*: How new? For research and development, but also for manufacturing of electric vehicles it is a major and radical step to develop and produce such a vehicle. Also from the perspective of the sales department it is not a conventional vehicle anymore. Additionally to the new vehicle, there are other aspects of e-mobility which have to be considered as well; therefore it is a major step in innovation.
- *The subjective dimension:* New to whom? E-mobility is new to the most of the stakeholders in e-mobility. It is, among others, new for manufacturers, suppliers, sales, banks, energy provider, but also for the management in the automotive industry.
- *The processual dimension*: Starting and ending where? E-mobility is starting with research and development. The first electric vehicles existed already in the 19 century. Therefore, it is difficult to say when e-mobility started but since the beginning of the 21 century the topic is of greater interest for the automotive industry. It will take more time until e-mobility is a daily routine in the automotive industry and in the automotive retailing.
- *The normative dimension*: Is new equal to success? This is an important question: will companies, which deal with e-mobility, be successful in the future? Currently there is no assurance that e-mobility will recover its investments.

4.1.2 Driving Forces in E-Mobility

Some of the described driving forces of innovation in the second chapter can also be applied to e-mobility. First, there is technological progress regarding e-mobility in the automotive industry. Companies are investing a lot of money in this field and the technology is already well-developed, but of course a lot of more research and development has to be done. [155]

[155] Porsche Austria Internal Information based on Expert Interviews

Secondly, the customer demands changed. E-mobility is nowadays a viable option for many customers, who are seriously considering the purchase of an electric vehicle.

Thirdly, there is a global competition in e-mobility. Especially in China the government and the automotive industry are investing in e-mobility. Therefore, also in Europe the automotive sector has to invest in e-mobility.

Fourthly, the ecological issue which is a really important one. On the one hand, the ecological issues is becoming more important for customers and on the other hand, OEMs have to pay a fee if they don´t reach the target CO_2-fleet emission value of 95 Gramm per kilometer of the European Union.[156]

Fifthly, politics which is able to influence the market penetration of e-mobility in a strong way.

Another driving factor of e-mobility are growing megacities, where less CO_2 emissions are necessary because of air pollution and the resulting worse living quality in cities.

4.1.3 E-Mobility as System Innovation

In this chapter it will be shown that e-mobility can be defined as system innovation. The definition of a system innovation is described in chapter 2.3. The characteristics of system innovation are listed and followed by an explanation of the connection to e-mobility.

The points to characterize system innovation are:[157]

- *Innovation-specific partial activities:* In e-mobility innovation exists in different parts. E-mobility is not only about electric vehicles including the battery; it is also for example about charging infrastructures at home and in public, mobile online services and energy provision. In each of these fields innovation is important and can be defined as product innovation, which drives development.

[156] Cf. European Parliament and Council (2009), p.5

[157] Cf. Grün, Hauschildt, Jonasch (2008), p.178

- *Legally and economically independent innovators (enablers):* The big players in e-mobility such as the original equipment manufacturers, the energy providers, the battery industry, the wallbox manufacturers and the installation providers are playing a major role. They are all legally and economically independent from each other, but they are innovators in their fields of business.
- *In an inter-organizational arrangement (governance):* The different organizations in e-mobility are working independently, but of course they have to cooperate. Arrangements in the field of e-mobility are necessary to adapt competences.
- *An innovative combination of purpose and means arises:* There are some new means in e-mobility. For example, new technology for powertrains of electric vehicles and new technology for charging infrastructure. But there is also a new combination of purpose and means. Electric energy is used to drive vehicles, the charging infrastructure is used to get energy for mobility at home or at parking areas, and smart phones are used to communicate with the cars. The smart phones will also be used for conventional cars, but it is starting with electric vehicles.
- *Which leads to a sustainable change in behavior:* E-mobility is changing the user´s habits in different ways, such as electric energy instead of gasoline or diesel is needed to drive a car, refueling and charging respectively at home or at work and not at gas stations is possible, the need of charging and refueling respectively more often because of a lower range. These are example for the changing habits of the customers.

These characteristics demonstrate that e-mobility can be defined as system innovation.

As described in the theoretical chapter there are two main groups involved. These are the enablers and the users.[158] In e-mobility the users are the customers, who will buy electric vehicles. Basically, all vehicle users can buy electric vehicles, but there will be some groups of customers who will

[158] Cf. Grün, Hauschildt, Jonasch (2008), pp.178

invest in e-mobility first. These will consist of commuters, company car fleets, public fleets and model regions.[159]

Enablers are groups who initiate, develop and perform e-mobility. These are, among others, original equipment manufacturers, retailing, energy providers, mobility service providers, installation providers and automotive suppliers. This group is supposed to be smaller compared to the users of e-mobility in the long run.

4.1.4 Innovation at Porsche Austria

There exists an innovation system at Porsche Austria. In innovation the elements of a system are primarily persons, and secondarily materials and machines.[160] At Porsche Austria the focus is on persons and not on materials and machines, because it is a wholesaling company. E-mobility is an innovation for Porsche Austria; therefore a new department was founded to handle e-mobility.

Volkswagen in Germany is usually working with a modified Stage Gate process of Cooper. At Volkswagen the main focus lies on the product, in this case the electric vehicle. Therefore it is product innovation for Volkswagen. Porsche Austria is responsible for the last stages of the process. These are the steps of testing and validation and the market launch in Austria.

4.1.5 Resistance against E-Mobility

Innovation is often perceived as a nuisance, a radical change or a senseless turbulence. Therefore, innovation has to consider resistance.[161]

Also in the field of e-mobility there is resistance against it. Internal and external persons do not believe in e-mobility for different reasons. E-mobility is not already developed to the same extend as conventional cars; therefore it will take some more time to fulfill the requirements of all customers. It will be crucial for Porsche Austria to gain the acceptance of internal employees

[159] Cf. Federal Ministry for Transport, Innovation and Technology (2010), p.11

[160] Cf. Hausschild (2011), p.57

[161] Cf. Hausschild (2011), p.99

and then to communicate the strategy of Volkswagen in e-mobility to their customers.

4.2 Project Definition

This chapter is important to get a first impression of the project organized by Porsche Austria. It starts with an initial overview on the project and is followed by defining the project's objectives. Then, the project organization and the project budgeting are described.

4.2.1 Initial Situation in the Project

Volkswagen wanted, as first brand of the Volkswagen Group, to launch battery electric vehicles on the market. So, they decided to deploy a test fleet of electric vehicles in Germany as well as internationally. Important was to test quality and comfort of the electric vehicles, before giving it to real customers. In order to achieve this goal they decided to build a prototype battery electric Golf VI.

For the project in Austria a prototype was already developed. The next step was testing and validation of the product. This should finally and completely confirm the project of electric vehicles at Volkswagen. A typical activity in this phase is the product testing with customers as described in chapter 2.4.3. The product should not be tested in the development department only; it should also be tested how customers are using it and the customer also has to accept the product.[162]

In literature a test fleet would be described as extended field tests which enable the customer to test the product for a longer time period. The reaction and the buying intention are based on much more detailed and better information after the testing fleet.[163] E-mobility is a complex product and consists not of an electric vehicle alone, but also includes charging infrastructure, mobile online services, and renewable energy.

[162] Cf. Cooper (2010), pp.306

[163] Cf. Cooper (2010), pp.305

For the implementation of a consumer test a sample of potential customer had to be defined and qualified, this was done in the pilot project in Austria.[164] The next step was to handover the product to the customer, this was done in an official hand over event which included a press conference. The customer was subsequently using the product at home, work or anywhere else. In the test fleet the customers received the Golf Blue-e-Motion for a period of nine months. A well-structured market research campaign and well-organized support structure was important for the consumer tests. Both points have been covered during the test fleet.

Volkswagen first deployed the test fleet in Germany with 80 vehicles in three major cities. Wolfsburg, Berlin and Hannover were chosen because of their short distance to the Volkswagen main location in Wolfsburg.

There are two main reasons why they also deployed a test fleet in markets outside of Germany. On the one hand it was a positive publicity measure for Volkswagen to show the world that they are investing in electric vehicles. On the other hand they wanted to verify the performance of battery electric vehicle in countries with other weather conditions and different topographical features.

Volkswagen decided to start an international test fleets in Austria, Belgium, France and the United States of America. Austria was chosen for their cold temperatures in winter and their special topographical features, such as the Alps. In the end it was turned out that the language barrier was also easier to handle in Austria. Austria was a perfect starting market for the international test fleet because of this.

In Austria there have been 15 Golf Blue-e-Motion. In Belgium there have been ten Golf Blue-e-Motion, in France fifteen vehicles and in the United States of America the test fleet consisted of twenty Golf Blue-e-Motion.

In Germany it was a mix of private customer, key accounts, and customers from the public sector. On the international markets, it was a mix of key accounts and customers from the public sector.

Porsche Austria was chosen to organize this test fleet of fifteen Golf Blue-e-Motion vehicles in Austria. The challenge for Porsche Austria was to choose

[164] Cf. Cooper (2010), pp.307

fifteen users, qualify them and give them one of the electric vehicles for a time period of nine months.

4.2.2 Objectives of the Test Fleet

In general, it is important to prepare two crucial points for a market launch of a product. Firstly, a market overview of the different segments and the competition and secondly the buying behavior of the customers.[165] Both points are the basis for a market launch and have to be considered for the project.

The detailed objectives of the test fleet in Austria were elaborated in cooperation between Volkswagen and Porsche Austria. The objectives are listed below:

- First objective was to see the reaction of electric vehicles driving under extreme conditions concerning weather and temperature. It was especially important to observe how the range of electric vehicles would behave during a cold winter in Austria.
- Secondly, the reaction of the battery regarding the topography and the cold temperatures had to be observed. Which rate of recuperation is possible? What is the average range in a hilly landscape?
- Thirdly, it was important to understand the needs and requirements of the customers. How do they use an electric vehicle? What are the customer requirements concerning the charging of the vehicle?
- Fourthly, to gather experience in the interaction of electric vehicle, charging infrastructure and mobile online services.
- Fifthly, to recognize the critical fields of activity in e-mobility at an early stage.
- Sixthly, the preparation and qualification of the service organizations for e-mobility in the future.
- Seventh and the most important issue, to prepare the top customer satisfaction and the market leadership in e-mobility for Volkswagen in Austria.

[165] Cf. Wöhe/Döring (2008), pp.385

4.2.3 Project Organization

Porsche Austria decided to work with a matrix based organization on the project for the test fleet.[166] It was decided to have one project coordinator who was only responsible for the test fleet and a project team, which was working separately, but not independently of the functional structure. The project coordinator had to confirm his decisions with the top management of Porsche Austria.

The team consisted of the following project members:

- From the top management Mr. Wilfried Weitgasser was involved in the topic. He was chief executing officer of Porsche Austria responsible for sales and marketing. The important decisions had to be decided by him.
- Mr. Gerhard Welsch was head of the department for Service and Technology for key accounts. His responsibilities were customer contact and the service hotline.
- Mr. Eric Buchleitner was the head of the Product Support department. He was responsible for all issues concerning after sales and technologies.
- Mr. Josef Frauscher was head of the department for environment and homologation. He was responsible for many different tasks, such as costs, contracts and e-mobility at Porsche Austria in general.
- Mr. Alexander Pointner was the project coordinator. It was his task to coordinate the test fleet, to prepare decisions for the top management and to work with the project team.

There was also a project team with a project manager located in Wolfsburg, Germany. They were responsible for the test fleet in Germany and the coordination of the four international markets from the OEM side. Representatives of all involved departments were in the project team. This included departments such as sales, research and development, customer service, quality assurance, Volkswagen academy, law and rights and financial services. All information between Porsche Austria in Salzburg and

[166] Cf. Hauschildt (2011), pp.72

Volkswagen in Wolfsburg had to pass through Alexander Pointner. It was necessary to bundle all information in order to avoid double work.

4.2.4 Project Budget

Because the initial idea of the test fleet came from Volkswagen in Wolfsburg, they also offered to take over the costs. So Volkswagen took over the costs for the electric vehicles, the prototype itself but also for the registration tax and the insurance tax; for the iPhones and the mobile phone contracts, for the driver´s qualification event and the handover event as well as for the personal resources which were needed at Porsche Austria.

4.3 Project Planning

The innovation process by Thom consists of three phases; the idea generation, the idea acceptance and the idea realization.[167] For the test fleet the idea had already been defined, i.e. to organize a test fleet in Austria, but for the operating part new ideas had to be found. The project was separated into 50 fields, and then ideas for each field were generated. In the next phase the ideas for each field were confirmed for its feasibility and the decisions had to be approved by the top management. The last phase was the realization of the ideas as part of the test fleet. The different fields had different time schedules. The most important fields are described in the chapter that covers the fields of activities of the test fleet.

To get an overview of the project a chronological description of the different project phases are described in this chapter. It starts with the preparation phase in which the three phases of the innovation process were implemented, followed by the official start of the test fleet at the handover event of the Golf Blue-e-Motion and followed by the driver´s qualification event. Finally the fleet activities and the project closure are described.

[167] Cf. Thom (1980), p.53

Preparation Phase

The preparation phase lasted from the kick-off meeting in August until the official handover event of the electric vehicles to the customers in January 2012. A press conference was also part of the event. The different fields of activities for this phase are defined and described in the next subchapter. A project plan was designed, responsibilities were defined and a time schedule had been worked out.

Handover of the Vehicles

One important milestone of the project was the official handover of the vehicles to the customers. Additionally, a press conference for journalists was organized. These two events occurred as part of the Vienna Autoshow 2012. The fifteen prototypes were shown to the public for the first time.

The official handover event was organized for representatives of the chosen companies and for journalists. The physical handover of the cars to the drivers of the fleet took place later at the drivers´ qualification event in Teesdorf, Austria.

Drivers Qualification Event

The project's second important milestone was the drivers' qualification event. It took place in Teesdorf, near Vienna, in January 2012. The main issues were the high voltage sensitization, the introduction to the electric vehicle and the driver safety training. Each driver had to participate in order to be allowed to drive the electric prototype. After the event the customers were able to drive back home with their new battery electric Golfs.

Fleet Activity

The test fleet started directly after the drivers' qualification event in January 2012 and ended in October 2012. So the drivers were able to drive the electric Golf for more than nine months. There were two bases for the test fleet. The first was in Vienna and the second in Salzburg. The first contact point for the customer was a newly installed service hotline. In this phase project monitoring was necessary.

Project Closure

In the final phase the drivers had to give back the electric vehicles at the end of October 2012. The next step was the transport the vehicles back to Wolfsburg, Germany. A review had to be done and in December 2012 the project was officially completed. The performance in the project was accepted by the top management and the project was officially closed.

4.4 Fields of Activity

In this chapter the different fields of activity are discussed in detail. These fields are mainly related to the preparation phase. The handover and the drivers' qualification event were the highlights that followed the preparation phase. The different fields of the project are separated in seven parts, the fleet users, the fleet activities, the data collection, the qualifications, the electric vehicle, the charging infrastructure and the mobile online service.

4.4.1 Fleet Users

This chapter illustrates the selection of the customer for the test fleet, the customer approach, how customers were won for the project, the explanation of the official handover and the drivers´ qualification event and finally the communication strategy during the project.

Selection of Customers

The selection of the customers was a crucial and protracted phase of the project. Porsche Austria had to choose fifteen companies which participated in the test fleet project. These companies were allowed to propose two to three drivers for the Golf Blue-e-Motion vehicles. These drivers had to participate in the drivers´ qualification event in order to be allowed to drive the electric vehicles. The decisive factors for the choice of companies were:

- The sales of Volkswagen Golf vehicles to this company in the last years
- Percentage of vehicles by the Volkswagen Group in the car pool
- Sales potential for electric vehicles in the next years
- Location of company headquarters

The following table is a summary of the customer who participated at the test fleet:

Logo	Company	Field of activity	Location
PORSCHE AUSTRIA GMBH & CO OG	Porsche Austria	Importer	Vienna
PORSCHE AUSTRIA GMBH & CO OG	Porsche Austria	Importer	Salzburg
A1	A1 Telekom Austria AG	Telecom-munication	Vienna
Coca-Cola	Coca Cola	Beverage Industry	Vienna
kapsch >>>	Kapsch	Telecom-munication	Vienna
lebensministerium.at	Ministry of Agriculture, Forestry, Environment and Water Management	Federal Ministry	Vienna
ÖAMTC	ÖAMTC	Driver´s Association	Vienna
ÖBB	ÖBB	Passenger and Freight Services Industry	Vienna
PORR	Porr AG	Construction Enterprise	Vienna

Post	Post AG	Letter and Parcel Delivery	Vienna
Raiffeisen Meine Bank	Raiffeisen	Bank Sector	Vienna
Red Bull	Red Bull GmbH	Beverage Industry	Salzburg
REWE GROUP	REWE International AG	Retail Food Industry	Vienna
SPAR	Spar AG	Retail Food Industry	Salzburg
Verbund	Verbund AG	Energy Provider	Vienna

Table 2: Test Fleet Customers in Austria[168]

Customer Approach

The customer approach was an important step in the project. Porsche Austria decided which companies should participate in the project, but the companies still had to decide if they wanted to participate.

If the company was interested in participating, a personal presentation of the project took place at the companies´ sites. The presentation contained the most important information about the test fleet.

For most companies the important factors were the costs. Porsche Austria decided to hand over the Golf Blue-Motion to the companies for free:

- Free hand over of the electric vehicle for the duration of the test fleet
- The companies did not have to pay for registration or insurance of the vehicle
- Free repair of the vehicles, but with an fee of 290 Euros for self-inflicted damage

[168] Internal Information of Porsche Austria based on Expert Interviews

- Free wallbox for home charging with free installation and removal
- Free use of the iPhone including phone services , text messages and data download
- Energy consumption had to be paid by the companies itself

Compliance

Naturally, compliance was a topic during the project presentation because Porsche Austria handed the Golf Blue-e-Motion vehicles over for free. However it has to be considered that the customers also had to fulfill requirements for the test fleet. They had to join a market research program. They had to bring the Golf Blue-e-Motion to the service partner for a monthly check-up. Plus, they were collecting technical data about driving an electric car and Volkswagen is now making use of this data. And last but not least, the Golf Blue-e-Motion is a prototype and Porsche Austria could not promise that there would not be any technical problems during driving.

Co-Branding

All fifteen Gold Blue-e-Motion are colored in white with a branding on them: “blue-e-motion - The Electric Volkswagen” A picture of one of the cars is shown below:

Figure 12: Branding of the Golf Blue-e-Motion[169]

[169] Referring to Internal Information of the Volkswagen Group

The customers were allowed to have a co-branding with the logo of their company on the Golf Blue-e-Motion. It was a logo on the C-pillar of the car and on the rear window. The co-branding is shown in figure 18.

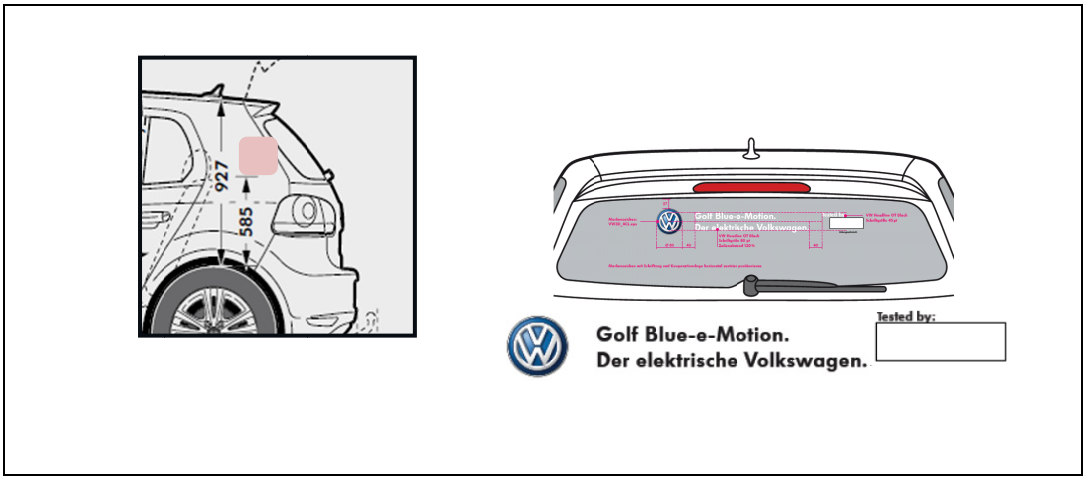

Figure 13: Co-Branding of the Golf Blue-e-Motion[170]

Contracts with the Customers

For the test fleet it was very important to have a temporary and not voidable contract between Porsche Austria and customer. The contract had one main part, the license agreement, and additionally six annexes.

The main part had to be signed between Porsche Austria and the participating company, also called the fleet partner. This part of the contract contained the following points:

- *Duration of the test fleet:* The test fleet started with the handover of the cars at the drivers´ qualification event in the middle of January 2012 and ended in October 2012.
- *Costs of the test fleet for the company and the driver:* As already described, there are no costs for companies and drivers, except for consumed energy.
- *Restrictions of using the Golf Blue-e-Motion:* This part is described later on.

[170] Referring to Internal Information of the Volkswagen Group

- *Violation of traffic regulations:* Of course drivers had to pay traffic tickets themselves.

The annexes have been a report of delivery for the handover of the vehicle to the driver, a contract for the installation of the Volkswagen charging box, a list of the technical data which were collected, the market research activities, and finally an after sales plan.

The Restriction of using the Golf Blue-e-Motion

There were restrictions for the use of the Golf Blue-e-Motion. These restrictions were necessary because the Golf Blue-e-Motion was a prototype. The prototypes had a high monetary value, and Volkswagen did not want to risk problems with it.

These restrictions were:

- Temperature range of -10°C to +40°C
- No underbody wash and no engine wash
- No driving with a trailer and no towing of other vehicles
- No usage in rough terrains and no motorsports events
- No driving in other countries besides Austria and Germany
- No disassembly of the vehicle
- No sale or rent of the vehicle
- No transport of dangerous substances
- When leaving the vehicle, the vehicle must be locked
- No usage of snow chains

Some of these restrictions seem rather obvious, but it was necessary to inform the customers about this restriction in order to be legally on the safe side.

Official Handover

Porsche Austria wanted to thank its customers for the participation and wanted to convince them that this was really an once-in-a-lifetime chance to participate in a test fleet with these Golf Blue-e-Motion vehicles.

Porsche Austria invited the drivers of the test fleet, the fleet managers, and the top management of the participating companies. The official handover took place as part of the Vienna Autoshow 2012.

After the welcoming words the representative of Volkswagen, responsible for E-Mobility, presented Volkswagen's strategy for the future of electric vehicles. The next presenter was the CEO of Porsche Austria, who talked about the test fleet in Austria while also referring about other activities of Volkswagen. These activities included the development of efficient powertrains and vehicles powered by compressed natural gas (CNG). At the end of the presentation a symbolic handover to all participating companies were arranged.

Together with the official handover also a press conference for journalists took place as part of the Vienna Autoshow 2012. About fifty journalists from different branches were invited. The press conference included also a presentation of the chief representative of Volkswagen responsible for E-Mobility about Volkswagen and their strategy and a presentation of the chief executing officer of Porsche Austria about the test fleet in Austria itself.

Drivers´ Qualification Event

The drivers´ qualification event was the project's highlight and took place just after the official handover of the vehicles. The official handover was a symbolic event for the top management of the participating companies. The handover of the Golf Blue-e-Motion to the drivers took place at the drivers´ qualification event.

For the event Porsche Austria booked the driving safety center in Teesdorf, Austria, for two days. This center is operated by the ÖAMTC, which is the Austrian drivers association.

Porsche Austria qualified two or three drivers for one Golf Blue-e-Motion. Each driver had to participate for one event day in order to be officially allowed to drive the vehicle. This was a restriction imposed by Volkswagen and Porsche Austria had to organize and check it.

The event was separated in three parts, the high voltage sensitization, the introduction to the electric vehicle and the driver safety training. After the official drivers´ qualification the Golf Blue-e-Motion vehicles were handed

over to the customers and they were allowed to drive back home. The three parts are explained here more in detail.

Introduction to the Electric Vehicle

The introduction to the electric vehicle contained the vehicle body information and also the internal differences to a conventional vehicle. For example, the display behind the driving wheel is also different. Additional to the actual speed it shows the remaining range, the remaining battery capacity and the current power, which is flowing to the electric motor.

High Voltage Sensitization

High voltage means, especially for hybrid and battery electric vehicles, a voltage above 25 Volt for alternating current (AC) or above 60 Volt for direct current (DC).[171]

The important message to the customer was that working on the Golf Blue-e-Motion was only allowed to qualified specialist workshops. These were the service partners in Salzburg and Vienna. But in order to reassure the customers it was also important to tell them that the high voltage system in the Golf Blue-e-Motion is safer than all household sockets.

Of course it was important to tell the customers to avoid touching high voltage components, since there is the chance of electrification. In case of doubt one should not touch anything at all. The only way to be certain are a visual inspection or to contact the service partners.

All high voltage components are indicated with one of the following signs:

[171] Referring to Internal Information of the Volkswagen Group

Figure 14: High Voltage Signs for High Voltage Components[172]

Driver Safety Training

For the drivers´ qualification event of the test fleet a standard training certification by the ÖAMTC was sufficient. It included three parts, the kick plate, the emergency braking mechanism and the turning corners on wet ground. The drivers had to successfully complete the training.

Communication

This chapter contains the commercial printing of the test fleet for the customers, the PR communication and the customer relationship activities.

Commercial Printing

This was an important point for the drivers´ qualification event. Porsche Austria wanted to hand an information box with sheets containing all important facts of the presentations to the customers. The box included sheets about the vehicle body, the charging process at home with the wallbox and in public, about the insurance of the car, the operating instruction for the iPhone and the app on the iPhone, about the service and maintaining and last but not least the restrictions on using a Golf Blue-e-Motion.

[172] Internal Picture of Volkswagen Group

PR Communication

The PR Communication started in November 2011 with a press release of Volkswagen in Germany. They were writing about the test fleet in Germany and they already mentioned the international test fleets in Austria, Belgium, France and the United States of America. This was the first time that the test fleet was mentioned in the media.

The next step for informing the media about the test fleet was the official press conference as part of the Vienna Autoshow. After the press conference, the official handover of the fifteen Golf Blue-e-Motions took place.

Another chance to present the Golf Blue-e-Motion was the Vienna Autoshow itself. The biggest motor show in Austria took place in January 2012.

To gain more media interest, a photo shooting of the Golf Blue-e-Motion took place at the Vienna Autoshow. It featured federal minister Nikolaus Berlakovich, who is responsible for Agriculture, Forestry, Environment and Water Management. Again some journalists participated in this event.

Customer Relationship Management

The test fleet was a big project for Porsche Austria, so it was important to involve the most important customers of Porsche Austria. This means the whole project was a kind of the customer relationship management (CRM).

At the end of the project a bigger event for the participating customers of the test fleet occurred. This was important in order to say "thank you" to the participating customers. But of course it was also important for the relationship between Porsche Austria and the key accounts.

Conclusion

The selection of the fleet user was important, because Porsche Austria already wanted to test the Golf Blue-e-Motion with target customer groups in e-mobility. Therefore, mainly key accounts of Porsche Austria with company car pools were chosen. The assumption was that fleet customers will be an important customer group for the next years in e-mobility. The test fleet confirmed this assumption, fleet user have a significant interest in buying electric vehicles for their company car pool in the next years.

To ensure the participation of these customer groups and to make sure that fleet users are using the electric car as much as possible, the Golf Blue-e-Motion was handed over for free to the participating companies. Furthermore, Porsche Austria wanted the fleet users to participate at the market research activities and also to bring the electric Golf to the service partner for a monthly check-up. These issues were important for Porsche Austria and to ensure this support of the fleet users the vehicle was handed over for free.

One the one hand, the test fleet was also used to convince the participating companies to buy electric vehicles in future, but on the other hand the test fleet was also used to present the electric vehicle of Volkswagen in public. The Golf Blue-e-Motion was branded to be present in public and to show that Volkswagen is also investing in e-mobility. Furthermore with the official handover event and the press conference the strategy of Volkswagen concerning e-mobility were presented to the public and to the test users. The test fleet confirmed that it is important for OEMs to be active in the field of e-mobility. The strategy has to be transported and the electric vehicles have to be present on the roads.

The driver´s qualification event was crucial to still the fleet users fear to drive an electric vehicle. The event showed that the first test drive with an electric vehicle can change customers' opinions. Customers really like to drive the Golf Blue-e-Motion, especially the comfort the driving enjoyment were mentioned often.[173] Therefore, it is necessary to organize as much as possible test drive opportunities for potential customers for the market launch.

At the event also a high voltage sensitization and an introduction to the electric vehicle took place. This was necessary because customers did not see an electric vehicle before and also did not know how to handle the Golf Blue-e-Motion. For the market launch it will be important how the electric vehicle will be introduced to the potential customer.

[173] Result of Market Research during the Project

4.4.2 Fleet Activities

This chapter treats the different support levels for the electric Golf during the project, the chosen service partners for the test fleet, the reparation processes, the market research during the test fleet, and finally the data logger.

Supporting

For the test fleet it was important to build up a support structure. For the customers the first contact was the service hotline. This number was helping the customer with all problems. They were answering questions about the test fleet in general but also about technical specifications, and they have been open for customer feedback.

The service hotline was not the only contact opportunity for the customers. The others were the towing services and the service partners. In case of emergency and beyond the times of the service hotline the customers were able to call the towing service to pick up the Golf Blue-e-Motion and get a courtesy car. This was important for the customer to have 24 hours support.

The service hotline, the service partner and the towing service have been the first contact level for the customers. For technical issues the service partner contacted the product support department of the Porsche Austria.

The third support level was Volkswagen in Wolfsburg, Germany. They had a technical support team and they had a so called ask team. The ask team was coordinating non-technical issues to the right department at Volkswagen in Germany.

The fourth level was the different departments of Volkswagen in Germany. They were the real experts for issues with the test fleet. The support structure is illustrated in the following figure.

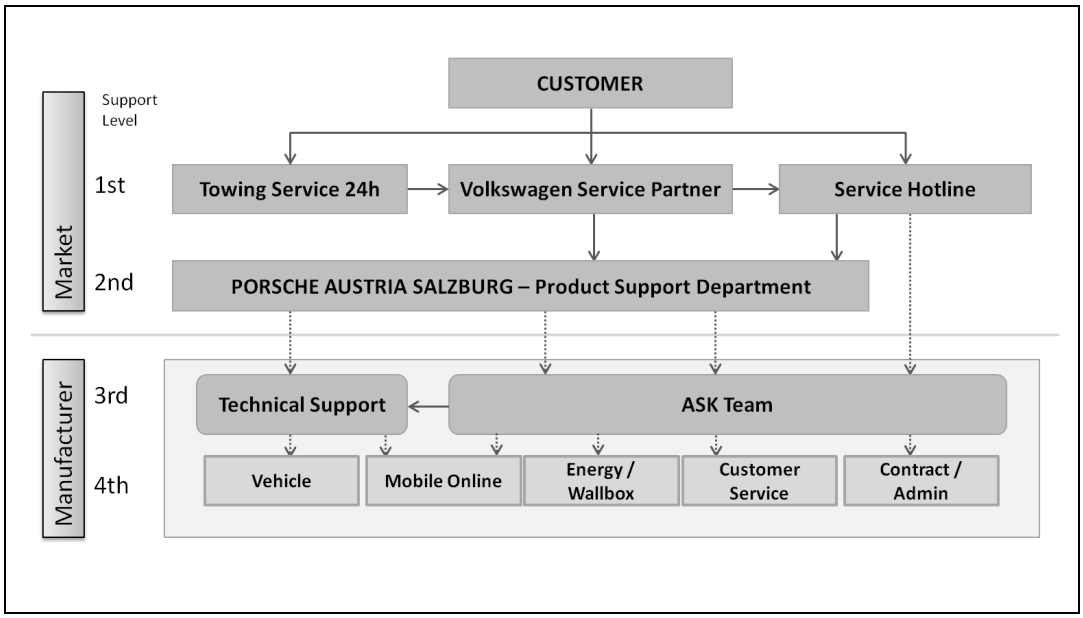

Figure 15: Support Structure of the Test Fleet[174]

Service Partners

There were service partners which were chosen to participate in the test fleet. Most of the customers lived in Vienna or Salzburg, so Porsche Austria decided to choose service partners in these cities. In Vienna the dealer Porsche Inter-Auto Vienna-Leasing is the biggest dealer in the area. In Salzburg the dealer Porsche Inter-Auto Salzburg was chosen. The locations of the two service partners are shown in the following figure.

[174] Own Illustration based on Expert Interviews

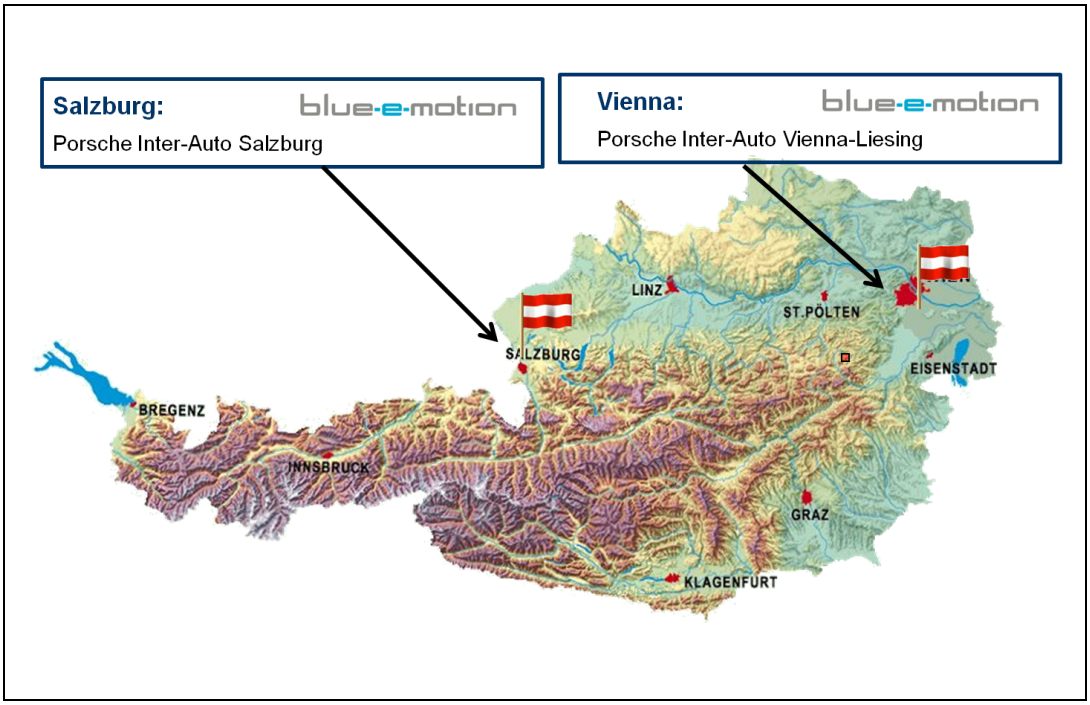

Figure 16: Service Partner for the Test Fleet in Austria[175]

Repairs

This chapter deals with the repair manuals, the repair process, the organized replacement mobility and the handling of the spare parts.

Repair Manual

The mechanics in Vienna and Salzburg got a 5-day training for working on the Golf Blue-e-Motion. In addition they got repair manuals which were downloadable to the mechanics computers. They were developed by the experts in Wolfsburg, Germany. These manuals were important for the test fleet, but also for the serial production of electric vehicles, because they mechanics had to know how to handle an electric vehicle.

Repair Process

As already described in the support structure, the mechanics always had to contact the product support team at Porsche Austria. This team was then contacting the technical support team in Germany. This intermediate stage was necessary to coordinate the different requests in Austria. If there was

[175] Referring to Internal Information of the Volkswagen Group

already a similar request, the product support team was able to give the right information directly to the service partner without contacting the technical support team in Germany.

Replacement Mobility

The customers of the test fleet were very important key accounts. Because of this reason a courtesy car was always available, if the customer had any problems with the Golf Blue-e-Motion. Also if the towing service picked up the Golf Blue-e-Motion, a courtesy car was always available for the customers.

Spare Parts

There were three issues concerning spare parts for the Golf Blue-e-Motion. The availability of the spare parts, the storage of spare parts and the logistics of the spare parts. After long discussion Porsche Austria decided to store the parts in Germany and send them to Austria in case of need per express service. The storage issue also solved the availability issue, because in Germany all the parts were on stock, always available.

Conclusion

The support structure of the test fleet consists of the service hotline, the towing service and also the service partners. For the market launch in e-mobility the call center of Volkswagen has to be prepared for electric vehicles. Another solution would be a separated call center number for e-mobility customers.

The towing services in whole Austria have to know the specifications of electric vehicles, to avoid damage at the cars and to guarantee a safe working environment.

A crucial issue for the market launch in e-mobility is the preparation of the after sales organizations. To sell electric vehicle without an appropriate after sales network would be unacceptable for the claims of Volkswagen. Besides an appropriate network, the organizations have to qualify mechanics and to buy proper tools.

4.4.3 Data Collection

This chapter explains the market research activities and the UMTS data logger system during the test fleet. In the end, a conclusion summarizes the chapter and describes issues for the market launch in e-mobility.

Market Research Activities

Market research was accomplished by an external institute. This institute got the customer data with names and contact information. The market research contained four online interviews, one personal interview in the middle of the test fleet and an interview as the customers returned the cars at the end of October.

For the online interviews, the institute got in contact with the customer per mail and requested to fill in an online questionnaire. The first occurred before the handover, to gain the customers' current knowledge about electric vehicles and their expectations. The other interviews occurred during the test fleet

For the personal interview the institute contacted the customers to determine a date for the interview. In a personal interview it is easier to get more information and impressions from the customers. The interview after the customers returned the cars was important to gather the overall impressions.

Results of the Market Research

The following figure shows an overview of which features of the electric vehicles is seen positive and which are seen negative. The result refers to the evaluation of the market research during the test fleet.

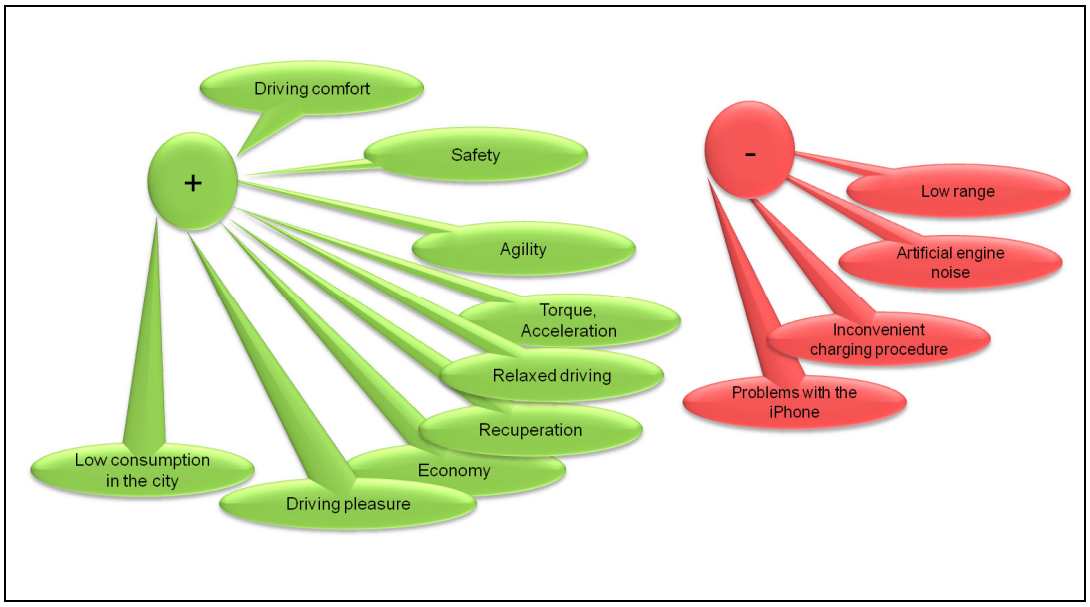

Figure 17: Results of the Market Research[176]

Figure 18 shows that driving comfort, safety, agility, torque and acceleration, relaxed driving, recuperation, economy, driving pleasure and the low consumption in the city are seen as very positive features.

Negative features have been the low range, the artificial noise, the inconvenient charging procedure and problem with the iPhone. It has to be notes that the charging procedure problems were solve during the project through different software updates at the charging box and at the electric vehicle. Also the problems with the iPhone were solved after the first weeks of the project.

UMTS Data Logger

Each Golf Blue-e-Motion has an integrated UMTS data logger. UMTS means Universal Mobile Telecommunication System. The vehicle is connected through a satellite to a server in Wolfsburg.

The data logger is collecting data about the driving profile of the customers, about the charging behavior and technical data from the vehicle. These information are sent to the server in Wolfsburg, where the data is evaluated. The collected data is listed in the following table:

[176] Referring to Results of the Market Research Activities during the Test Fleet

Driving Profile		
Usage of driving modes	Average speed	Torque
Number of revolutions	Driving time	Driving track
Speed	Recuperation modes	Standing time
Driven kilometers	Usage of comfort consumers	Temperature
Consumption	Heating	Air conditioning
GPS data		
Charging Behavior		
Battery condition	Charging duration	Number of charging
Charging place	Charging voltage	Charging power
Charging time	Battery temperature	
Technical Data		
ASR	Braking system	Recuperation power
ABS	Airbag	ESP
Electronics conditions		

Table 3: Data Collection of the UMTS Data Logger[177]

The most important data are the vehicle performance with respect to the topography and the route profile, for example, the highway, country road or city.

Every time customer data is collected data protection and data security has to be ensured. The data is used in anonymized form for the purposes of the company.

[177] Referring to Internal Information of the Volkswagen Group

Conclusion

The market research showed that e-mobility is generally a positive topic. Some problems at the beginning were solved during the project. The range was an often mentioned negative issue. It doesn't matter if the given 150 kilometers were sufficient or not, customers were used to have higher ranges and were therefore not satisfied with the range of the Golf Blue-e-Motion.

The UMTS data collection was helping to understand how an electric vehicle can be used and also how was used by different customers. The results also have to be considered for the market launch.

4.4.4 Qualification

This part is about the qualifications of the service hotline, the instructions of the rescue forces, the after sales qualifications and the internal qualifications.

Hotline

For support of the test fleet users Porsche Austria installed a new service hotline for the drivers. This service hotline had a new, special telephone number and was only given to test fleet users.

The service hotline consisted of a team of three people. Gerhard Welsch, who was responsible for customer contact, was the team leader.

In order to be able to give appropriate support these three colleagues went five days to Wolfsburg, Germany, to learn everything about the test fleet, the vehicle and organizational aspects. They were the first contact for customers and they knew where to get the right information.

Instruction of the Rescue Forces

Electric vehicles have high voltages components which are reacting differently during an accident or during a fire. Because of this reason it was important for Porsche Austria to inform the police, the fire fighters and the ambulance about the test fleet.

Porsche Austria sent technical information about the Golf Blue-e-Motion, a rescue guideline and a contact number to the highest institutions of police,

fire fighters and ambulance in Austria. But Porsche Austria also contacted the local rescue forces in Salzburg and Vienna.

After Sales Qualification

As already mentioned, there were two bases for the test fleet. The first was in Salzburg and the second in Vienna. For the after sales service of the test fleet it was necessary to have at least two qualified mechanics for repairs, maintenance and service of the fifteen Golf Blue-e-Motion for each service partner.

Internal Qualification

In addition to the service hotline and the after sales service, the project team also needed to join a qualification. The project team got the same information as the service hotline, the most important information from the after sales service qualification team and additional information about the organizational staff of the project.

It was also important for the internal employees to join a driver qualification session. The Golf Blue-e-Motion was the prototype of an electric vehicle, so it was also necessary for them to get a high voltage sensitization, information about the Golf Blue-e-Motion and to host a driver safety training. Only if the employees and the customers passed this training they were allowed to drive the Golf Blue-e-Motion. So all the mechanics, the service hotline team and the project team joined a driver safety training in Wolfsburg, Germany. For the Austrian customers an extra training in Teesdorf, Austria was organized, like already mentioned.

Conclusion

For the market launch of e-mobility different groups had to be qualified. The call center was already mentioned above. The rescue forces in Austria have to be informed to guarantee a safe rescue of persons involved in accidents. This topic has not only considered by Volkswagen, but also by other OEMs which have electric vehicle on the market.

In the after sales organizations there are three different qualification levels. These levels have to be considered in the network planning because e-mobility dealers need to qualify their mechanics. The number of qualified mechanics has to be defined and is depending on the vehicle volumes.

4.4.5 Electric Vehicle

In this chapter the vehicle body of the Golf Blue-e-Motion is described from the technical side. The fifteen electric Golfs were manufactured in Wolfsburg, Germany, in the plant of Volkswagen. The outside of the electric vehicle is just like any conventional Golf VI but the inner body is very different. Here the most important parts and features of the Golf Blue-e-Motion are explained:

Power Socket

Where normally the tank opening is placed the Golf Blue-e-Motion has a safety socket in order to be refueled with energy. Additionally, there is a second socket just below the Volkswagen emblem on the car front.

Battery Pack

The Lithium-Ion battery is below the trunk, below the rear bench seats and in the center tunnel of the vehicle. For the thermal management a separate cooling is installed. With a capacity of 26.5 Kilowatt hours (kWh) the battery offers a range of 150 kilometers (km). The big battery packs do not restrict the space in the car.

High Voltage Lines

From the power socket a high voltage line leads to the battery pack. This battery pack provides 324 Volt for high voltage components like the electric motor.

Battery Management System

Through this control unit information about the vehicle and the battery can be obtained from afar. For example with the application for the iPhone, this is described later on.

Solar Panel Roof

The solar panel roof is permanently feeding energy into the on-board power supply. When standing the solar panel roof provides energy for the ventilation system of the car.

Vehicle Control

In terms of acceleration the Golf Blue-e-Motion is like any other car. There is the acceleration pedal and the brake pedal. There is no clutch pedal, because it is possible to drive the car like an automatic gearbox vehicle. The difference is that the Golf Blue-e-Motion has just a one-shift gearbox. With more pressure on the acceleration pedal the energy supply to the electric motor is raised and the car is accelerates. The gearshift is only used to choose between parking, backwards, neutral or forward.

Vehicle Heating

The Golf Blue-e-Motion includes a heat able windscreen and heated seats. These are necessary to use the heat efficiently and demand power from the vehicle.

Power Electronics

The power electronics is crucial for the performance of the electric motor. It coordinates the interaction of the electric motor and the battery.

Electric Motor

The electric motor and the battery constitute the heart of the Golf Blue-e-Motion. With its 115 horse power (hp) a velocity of 135 kilometer per hour (km/h) is possible. It needs 11,8 seconds to accelerate from zero to 100 km/h. In contrast to a conventional motor, the electric motor provides a full torque from the beginning. This raises driving enjoyment immensely.

Engine Compartment

All important parts of the engine drive are in the engine compartment. The electric motor together with the permanently connected one-shift gearbox, the differential and the power electronics are the core components.

Recuperation

While braking, the Golf Blue-e-Motion is converting kinetic energy into electric energy and is using it to charge the battery. There are three different recuperation modes which convert a different load of energy.

The different components of the Golf Blue-e-Motion are shown in figure 12.

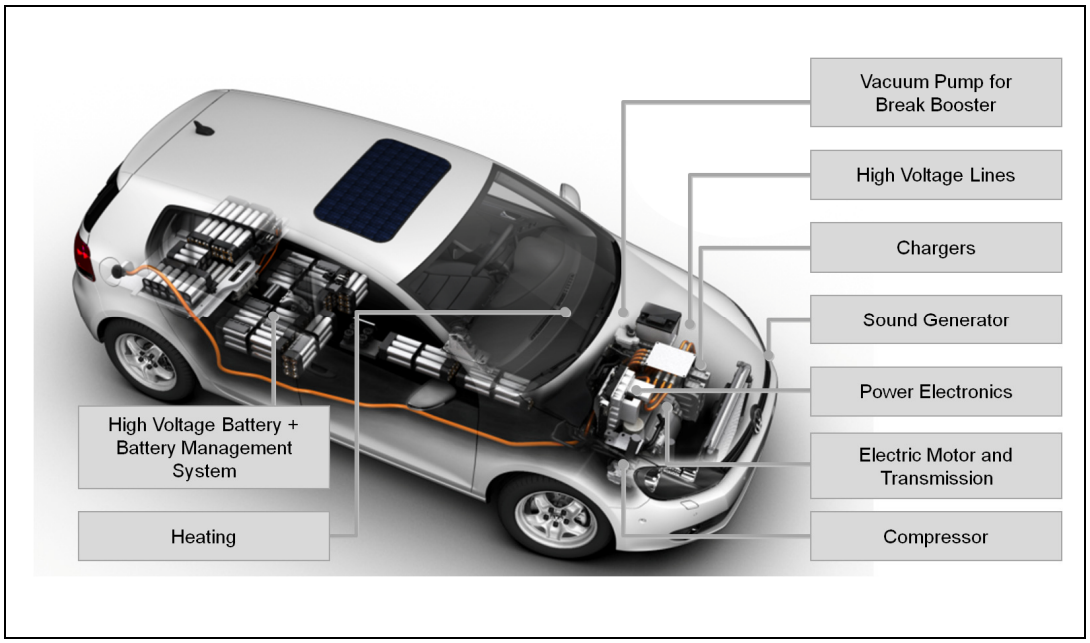

Figure 18: Golf Blue-e-Motion[178]

Vehicle Registration and Insurance

It was necessary to check if there are any legal requirements to drive with battery electric vehicles in Austria. This was done in cooperation with an insurance company.

As already described in chapter 3.2, the electric vehicles do not have to pay the registration tax and no annual tax in Austria.

Conclusion

In this chapter the different specific parts of the Golf Blue-e-Motion are described. The inner body of an electric vehicle differs strongly from a conventional vehicle. On the one hand, it is important to inform the customers about the different high voltage components in an electric vehicle, but on the other hand it is also important to consider new service and maintenance guidelines, because of new components.

It is a benefit that electric vehicle don´t have to pay insurance and annual tax in Austria, this information has to be communicated to the customers.

[178] Referring to Internal Information of the Volkswagen Group

This would be another positive argument for the customer to buy an electric vehicle.

4.4.6 Charging Infrastructure

This chapter covers the different charging possibilities which were available during the duration of the test fleet. These include private and the public charging as well as energy supply, an important topic in e-mobility.

Private Charging

For private charging, two issues had to be considered, i.e. the wallbox hardware for charging at home and its' installation process.

Wallbox Hardware

The wallbox is a charging box for the home garage. Like the Golf Blue-e-Motion, the wallboxes also were prototypes which were manufactured by a supplier of Volkswagen. The following figure shows a picture of the Volkswagen wallbox.

Figure 19: Volkswagen Wallbox for Charging at Home[179]

[179] Referring to Internal Information of the Volkswagen Group

With the Golf Blue-e-Motion there are different charging options. As already mentioned before, one charging plug is below the Volkswagen emblem on the car front and one at a well-known place at the tank opening. The options are illustrated in figure 15.

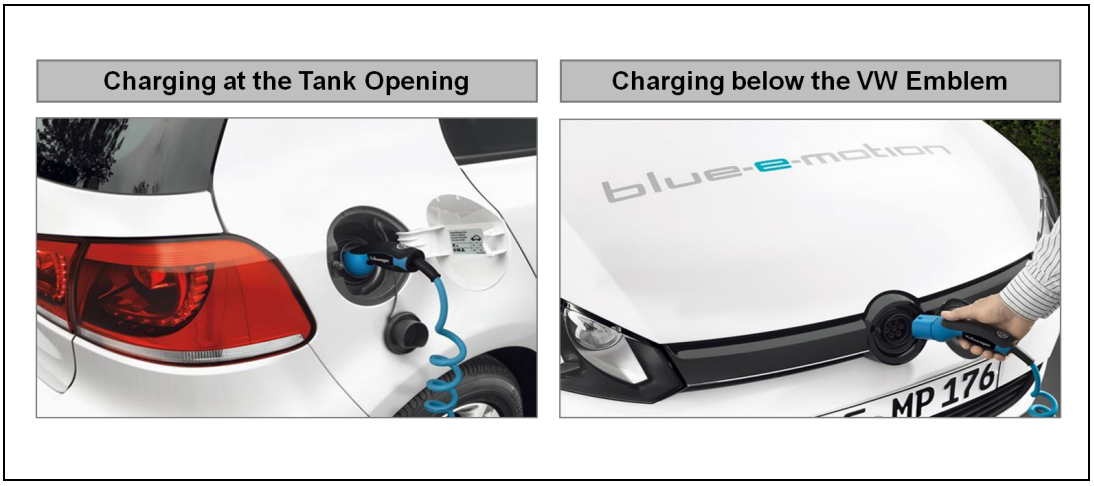

Figure 20: Charging at the Tank Opening and Charging below the VW Emblem[180]

With the wallbox the customers are able to charge the Golf Blue-e-Motion with about 11 Kilowatt (kW). With a battery capacity of 26,5 kWh it takes about two and a half hours to charge the vehicle from zero to one hundred percent energy. It is not possible to specify the exact charging time, because there are different charging losses, depending on the battery performance, the charging cable, the charging station and the energy grid.

Using the wallbox for charging is one of three possibilities to charge the vehicle. The second possibility is to charge the vehicle at a standard 230 Volt electrical connections, suitable for all household sockets. With this cable the customer is able to charge with 16 Ampere. This leads to a power of about 3,7 kW. When charging the complete battery it lasts for about seven to eight hours, again depending on charging losses.

The third possibility is to use the public charging infrastructure. Here it is possible to use the standard 230 Volt electrical connections or to use the additional Type 2 plug cable. This cable is able to charge with 400 Volt and 32 Ampere, which leads to a maximum power of about 22 kW. The different charging possibilities are shown in figure 16.

[180] Referring to Internal Information of the Volkswagen Group

There are advantages and disadvantages for fast charging. Fast charging means a power of 22 kW for AC charging or more than 40 kW for DC charging.[181] Advantage is a short charging time, which is important especially for public charging and leads to possible higher ranges. A disadvantage is the shortened lifetime of the battery, due to repeated fast charging. Therefore battery technology has to be developed to charging without lowering the lifetime of a battery.

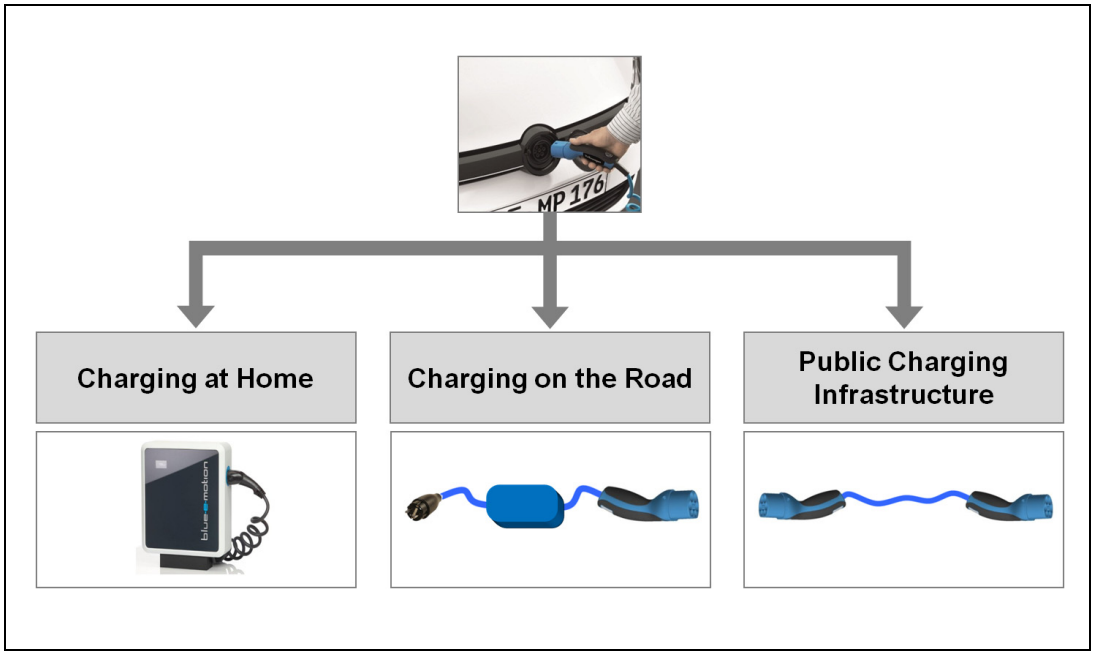

Figure 21: Charging at Home, Charging on the Road and Using the Public Charging Infrastructure[182]

Installation Process of the Wallbox

For the installation process of the wallboxes an electricity or installation provider was necessary. Porsche Austria's job was to prepare the tender documents in order to find an appropriate provider. The provider had to propose an offer which included the following points:

- *Inspection of the household electrical system:* The first step was to fix an appointment with the customers. The next step was the inspection

[181] Internal Information of Porsche Austria based on Expert Interviews

[182] Referring to Internal Information of the Volkswagen Group

of the electrical installations at the planned location of the wallboxes. Afterwards, they had to determine the time and effort for the assembly and last but not least they had to create a report including all important information about the customers´ electrical installations.

- *Installation of the wallboxes:* The first step was to arrange an appointment with the customer. Followed by delivery, set up and installation of the wallbox. The next step was to check the functionality of the wallbox. Finally a report had to be created, this time as a photo protocol.
- *Service and maintenance:* If customers encountered problems, the provider had to react to it by the next working day. Service and maintenance were always done in cooperation with the project's service hotline.
- *Disassembly of the wallboxes:* After the test fleet was disbanded the wallboxes had to be disassembled from the customers' places. This was necessary, because the wallboxes had only been prototypes. Again a photo protocol was created and the wallboxes were brought back to Porsche Austria.

Porsche Austria chose one appropriate offer and started to organize the installations. The chosen installation provider was Alpine Energie, which had already experience in installing of charging boxes at private places. The customers could choose if they wanted to have the wallbox at their home or at their working place. Three wallboxes were installed at the private homes of drivers. Twelve were installed at working places of customers and two were installed at Volkswagen service partners.

Public Charging

The public charging infrastructure in Austria is not really well developed. Part of the project was to check the public charging infrastructure and pass the information on to the drivers.

Porsche Austria was analyzing the 230 Volt electric connections, the Type 2 connection and also other stations with direct current (DC):

Name	Brands e.g.	AC / DC	Max. Volt	Max. Ampere	Number of Stations in Austria
CHAdeMO	Mitsubishi, Citroen, Peugeot	DC	600	83	**2**
Type 2	Volkswagen, BMW, Mercedes	AC	400	32	**47**
230 V electric connection	All brands	AC	230	16	**766**

Table 4: Public Charging Infrastructure[183]

Like shown in table 4, there are 47 public charging stations for the Type 2 plug, but the problem is that there are just five of them in Salzburg and just one in Vienna. While most of these charging stations are in Carinthia.

766 charging stations for the 230 Volt electrical connection seems like a lot, but the problem in this case is that charging via this connection can take more than eight hours. This is not a convenient option to charge the vehicle in the public.

The CHAdeMO plug was recently analyzed in order to obtain an overview about DC charging stations in public. This was not relevant for the prototype project, but it will be important for serial production. This information is also vital for the implications for Porsche Austria in the next chapter.

Energy Supply

One important factor why electric mobility is useful is that electric vehicles have less CO_2 emissions than conventional vehicles. For electric vehicles electric energy is needed. So it is important to have as few CO_2 emissions as possible in the generation of electricity.

As described in chapter 3.2, the level of CO_2 emissions really depends on the generation of electricity. In Austria, there is already a good mix of energy in the energy grid.

[183] www.e-tankstellenfinder.at [1.5.2012]

For the project it was often an issue whether or not Porsche Austria should provide renewable energy at the point of sale for its customers. The problem was that most of the customers wanted to have their wallbox installed at the work place. If they wanted to have renewable energy, they had to change their contracts with their energy providers. But bigger companies, like Porsche Austria's customers, have high energy consumptions and would have to pay a higher sum of money for renewable energy.

The final decision was that Porsche Austria should not force its customers to switch to renewable energy for the test fleet, as it would have involved high costs and high effort. However, Porsche Austria addressed this important topic to its customers and left the decision with them.

Conclusion

This chapter shows the different aspects of the charging infrastructure and the importance of renewable energy for e-mobility. For the charging at home an appropriate wallbox is necessary for the market launch. The charging box should ensure a comfortable and safe charging at home for the customers. Connected to the wallbox hardware an installation process for the charging box has to be defined. Therefore, a cooperation partner is necessary, because dealers are not able to do it by their own.

For the market launch it is important to observe the public charging infrastructure. Dealers have to know how many public charging possibilities are available in Austria to give this information to their customers. To get access to this public charging infrastructure cooperation with providers are necessary.

Like already mentioned, renewable energy is important for e-mobility to guarantee low CO_2 emissions of electric vehicles. For the market launch an appropriate offer of renewable energy to the customers has to be found.

4.4.7 Mobile Online Services

In addition to the Golf Blue-e-Motion the drivers received an iPhone for the duration of the test fleet. One iPhone for each car was distributed. On the iPhone an application was installed. This application fulfilled two functions. First, to get information about the car, like actual temperature, kilometers

driven, average speed, charging level of the battery and the actual position of the vehicle. The second function let the user actually control the Golf Blue-e-Motion. Users could start or stop the charging process, start the air conditioning and set the temperature in the car for an estimated time of departure.

There was also a vehicle control website. On this website the users were able to perform the same functions as with the iPhone application.

The application had already been programmed in Germany. For Austria, Porsche Austria had to think about a special feature for this application. The website also needed an adequate address. After checking available website addresses, Porsche Austria decided to use the following address for the vehicle control website: http://www.blue-e-motion.at.

The iPhone hardware was also of importance. After checking different offers of mobile phone providers Porsche Austria decided to buy the iPhones in Germany.

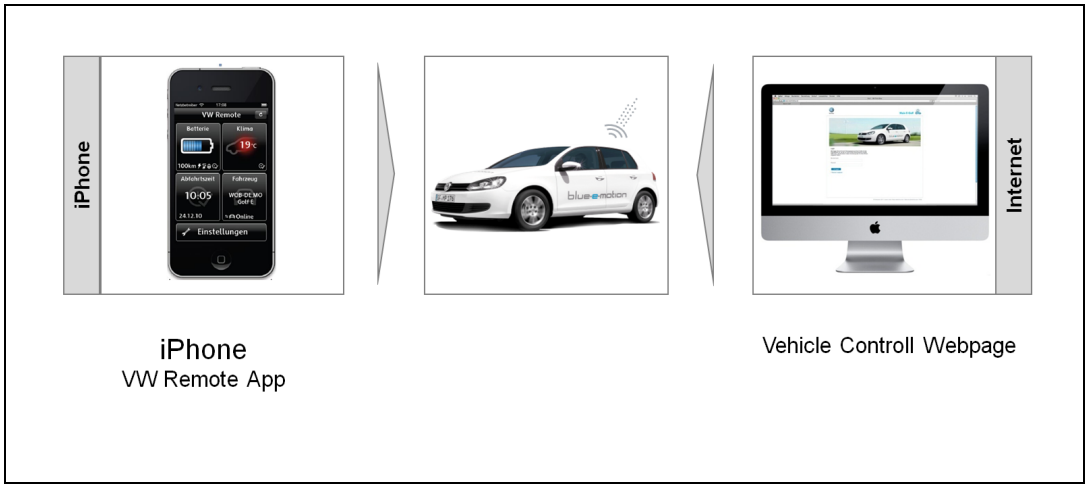

Figure 22: Mobile Online Services of the Test Fleet[184]

The electric vehicle, the iPhone application and the vehicle control website were connected to a server in Germany. This server controlled vehicle information and vehicle control functions. Therefore, the next step was to choose a telephone contract for the iPhones, because they had to keep contact to the server through the UMTS network.

[184] Referring to Internal Information of the Volkswagen Group

To offer the customers a helpful additional cell phone, the contracts included free telephone services; free text messages and a data download volume of five gigabyte. An overview of the mobile online services is given in figure 13.

Conclusion

The mobile online services were an attractive aspect for the customers of the test fleet, because of two special features.[185] Firstly, to know at any time the current range and secondly, to set the temperature in the car for an estimated time of departure during the electric vehicle is still charging with the wallbox. Therefore, the mobile online service should be seen as important aspect of e-mobility and has to be considered for the market launch.

[185] Based on Market Research Activities and Personal Interviews with Test Fleet Users

5 Implications for Porsche Austria

This chapter deals with important issues in e-mobility for customers and with the total system of e-mobility, which involves all aspects additional to the electric vehicle. Then, the relevant stakeholders for Porsche Austria in e-mobility are described and finally, a comparison of the market launch at Porsche Austria between conventional vehicles and electric vehicles is made.

5.1 Important Issues in E-Mobility

There are main issues for customer when talking about e-mobility, some of them are positive and some negative ones. They are described in the following paragraphs. Starting with the positive issues:[186]

- *Driving enjoyment:* The torque of an electric vehicle is higher than that of some other conventional vehicles. Therefore, the pleasure of driving is high. This is an important factor for customers.
- *Ecological responsibility:* For a lot of customer it is important to reduce the CO_2 emissions of their vehicles. Therefore, electric cars are fulfilling these requirements. Naturally, the source of the energy has to be considered.
- *Rising gasoline and diesel prices:* The prices for gasoline and diesel are rising in the long-term and often have strong short term fluctuations. Another problem is the peak-oil which in many studies is expected for 2050. This would be the start of highly increasing prices. Higher gasoline and diesel prices are making e-mobility more attractive.
- *Tax advantages:* There are tax advantages for users of electric vehicles. They do not have to pay the registration tax in Austria and they do not have to pay the annual tax every year. There is also an incentive for fleet customer for buying an electric vehicle. If the fleet customer uses renewable energy the incentives amount is 5.000

[186] Based on Market Research Activities and Personal Interviews with Test Fleet Users

Euros, without renewable energy it amounts to 2.500 Euros. A fourth advantage is the fact that electric vehicles are allowed to ignore the CO_2 emission-related speed limits in proximity to cities. However it has to be considered that national politics are able to change tax advantages and incentives in one or the other direction.

- *Vehicle ban in cities:* On the one hand, electric vehicles are more efficient in terms of energy consumption in cities. On the other hand, there is the possibility that politics start to ban conventional cars or cars with high CO_2 emissions in cities, the electric vehicles would become more attractive. This is another topic strongly influenced by national politics.
- *Electric vehicles are trendy:* This is a subjective opinion but it is supported by some studies as well. It is trendy to drive an electric vehicle and to care about the environment. E-mobility is also a topic often covered in the media. There was hype about e-mobility, which has already died down again, but it is still interesting for customers to distinguish themselves from others and to drive electric vehicles.

But there are of course negative issues for the customers concerning e-mobility as well. They are described here: [187]

- *Range:* The anxiety of too little range with electric vehicles is still important for many customers. The BEVs are mainly covering traffic in urban areas; therefore no higher ranges are needed. For longer distances the PHEVs fulfill all the requirements.
- *Purchase costs:* The purchase costs are currently much higher for electric vehicle than for comparable conventional cars.[188] The reason is that electric vehicles are new technology into which automotive companies started to invest only some years ago. The main cost driver is the battery package, but there will be new battery technologies. The Austrian government supports the purchase costs of fleet customers with incentives, but they do not support private customers. Incentives for private costumer would support e-mobility

[187] Based on Market Research Activities and Personal Interviews with Test Fleet Users

[188] Internal Information of Porsche Austria based on Expert Interviews

as well. For Porsche Austria there is the possibility to do lobbying for private incentives.

- *Battery technology:* The battery is the most cost-intensive part of the electric vehicle.[189] To reduce the costs a lot of research and development for new battery technologies conducted and there will be new technologies in the next years. The battery also influences the range of the electric vehicles.
- *Loss of value:* There is a high technological uncertainty for customers, because a lot of research and development is done on electric vehicles and for batteries technological leaps are announced.[190] There is also a problem for the residual value of the electric vehicles. In summary, smart financing concepts have to be developed to handle this problem.
- *Rising energy prices:* Currently, the energy costs for electric vehicles are lower than for conventional cars, but there is the possibility that energy prices are going to rise as well. The need for electric energy would not rise that much for electric vehicles, but the government will need other options to replace, for example, the mineral oil tax.

5.2 E-Mobility as Total System

As already described before, e-mobility can be defined as system innovation. The reasons are that e-mobility has innovation-specific partial activities, innovators are legally and economically independent, but they have inter-organizational arrangements, it brings up innovative combination of purpose and means, and it leads to a sustainable change in behavior.[191] This is important for Porsche Austria to understand in which new context e-mobility has to be seen. There has to be collaboration with other companies in order to realize e-mobility.

In the beginning of the project it was mentioned that e-mobility is not referring to the electric vehicle with the battery only, it is also about charging

[189] Internal Information of Volkswagen based on Expert Interviews

[190] ibidem

[191] Cf. Grün, Hauschildt, Jonasch (2008), p.178

infrastructure, renewable energy and mobile online services. The test fleet confirmed that e-mobility has to be seen as total system. But besides the already mentioned aspects, there have been three more new aspects, extended mobility, financing concepts and vehicle-to-grid. Furthermore, it was shown that charging infrastructure contains three parts, the charging hardware, the installation process and the public charging infrastructure. The following figure shows an overview of the different aspects of e-mobility. The findings of the project for each aspect added with the implications for Porsche Austria due to the findings are described in the next subchapters.

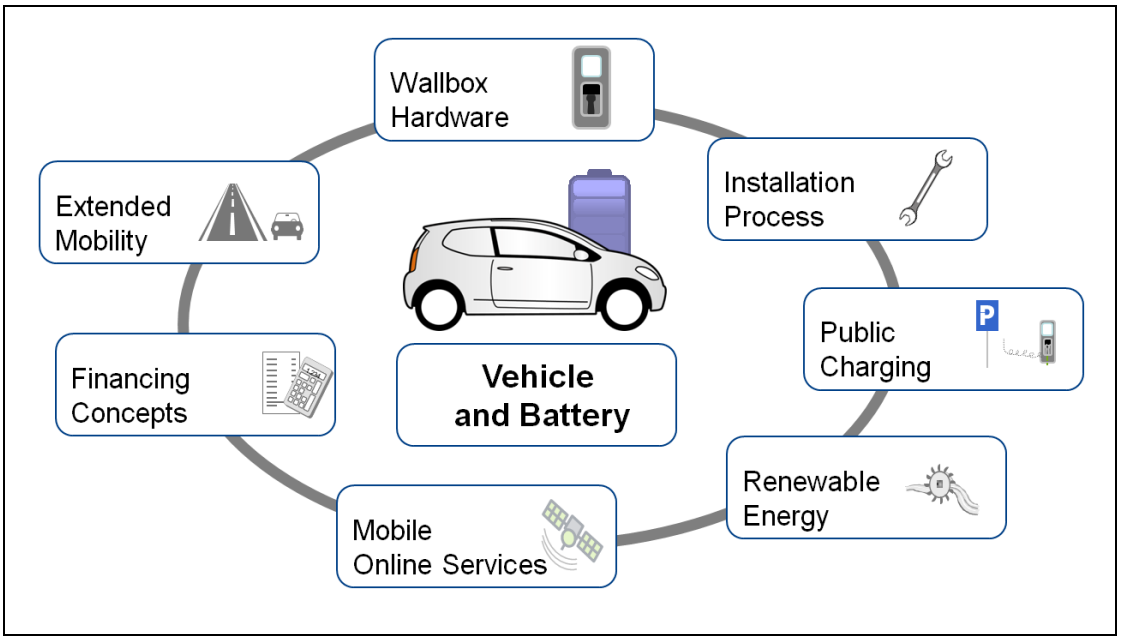

Figure 23: Different Aspects of E-Mobility[192]

5.2.1 Electric Vehicle and Battery

The electric vehicle was the main part of the test fleet. For Porsche Austria it is no problem to sell a vehicle, but for the market launch in e-mobility some issues have to be considered. The findings of the project regarding the electric vehicle and the battery are listed here:

[192] Own Illustration based on Expert Interviews

- *Lower temperatures lead to lower ranges:* Reasons for the lower range are the use of heating system and heating of the battery. In January and February the average range was between 110 to 120 kilometers.[193]
- *The sound generator is important for slow driving:* The main reason for a sound generator is the safety of other road users. Especially pedestrians and cyclist are in jeopardy. The sound perception is a subjective view.
- *The energy consumption depends strongly on the drivers´ behavior:* The driver is able to influence the range and the consumption through the use of recuperation for the energy recovery and through anticipatory driving.
- *The tire wear is not higher than for conventional cars:* This was an important question before the start of the test fleet, if there are significant differences in the tire wear. The test fleet showed that there are no differences for electric vehicles.
- *The Lithium-Ion batteries in electric vehicles are defined as class 9 in the dangerous goods classification:* This leads to special transportation and storage regulations.
- *The battery needs to be transported as a dangerous good:* The battery as part of the vehicle can be transported without restrictions. But if the battery is removed from the vehicle is has to be transported as a dangerous good. A damaged battery even has to be transported with an exceptional permission.
- *A long warranty for the battery is needed:* A crucial topic regarding the battery is the warranty on the battery. A longer warranty is especially important because of psychological issues. For the customer it is important to avoid technical uncertainty, therefore a longer warranty should be preferred. Warranty means in the case of vehicle batteries a remaining power of the battery of at least 80 percent.
- *There are four parts in the lifecycle of a battery:* After usage in new vehicles, ending with the loss of the warranty, usage in used vehicles

[193] Internal Information of Volkswagen based on UMTS Data Logger

is possible. The third part would be a high voltage battery as decentralized stationary energy storage. The last part is the recycling and reuse of the battery. There is just one recycling company in Europe for batteries of electric vehicles with headquarters in Belgium. Recycling would cost five Euros per kilogram of an used battery.

The findings were collected in expert meetings to find issues for the market launch of e-mobility at Porsche Austria. The implications for Porsche Austria due to the findings are listed below:

- The findings are important facts for sales processes and marketing at Porsche Austria but also for Volkswagen, the manufacturer of the electric vehicles.
- The customers should be offered a training to drive in an efficient way. Training can influence the range enormously and should be an option for the market launch.
- A defined logistics system with dealers and the parts distribution center for batteries is needed. This should be developed to ensure a safe and organized transport of high voltage batteries.
- A strategy for recycling or reuse of the battery has to be defined. Partners are needed and have to be found. Recycling and reuse would offer the opportunity for a new business model.
- A possibility for a certification of used batteries has to be found, because customers want to know the condition of used batteries. This would also be a new business model for after sales.
- Porsche Austria has to ensure a battery warranty of at least 5 years, because of a similar offer of the competition. A way to calculate the residual value of the battery is also necessary.

5.2.2 Charging Infrastructure

The charging infrastructure has to be split in two parts. There is the public charging infrastructure for electric vehicles and the private charging infrastructure. For the private charging infrastructure the wallbox hardware and the wallbox installation process are important.

The findings concerning the private and public charging infrastructure are listed below:

- *90 % of the users are charging at home or at work:* This is of course dependent on a developed or not developed public charging infrastructure. However, customer's opinions and a survey for the charging places showed a main usage of charging at home or at work. This was confirmed during the test fleet.
- *An inspection of the household electrical system has to be done:* Before installing a charging box the electrical system at the customer´s home has to be inspected. The reason is the strong difference in the electrical systems of the customers. An inspection would offer the opportunity to inform the customer about the costs before installing the charging box.
- *Costs for the installation of the wallbox can vary greatly:* This was a crucial output of the installation processes during the project. The costs are between 400 Euros to 4.000 Euro. But due to safety reasons a professional installation is necessary.
- *Currently, the public charging infrastructure is not well developed in Austria:* There are no DC charging stations in Austria with a Combo 2 plug-in. Public charging infrastructure is important due to psychological reasons. The customers know that they have the possibility to charge their vehicle on the way.

Charging is a crucial topic in e-mobility. It strongly differs from refueling a conventional car. The implications for Porsche Austria due to the findings concerning charging infrastructure are shown here:

- It is important to sell a wallbox in addition to the car due to comfort and safety reason. This charging box should be able to charge AC

with a minimum of 3,3 kW. Faster charging lowers the battery lifetime. Overnight a charging time of eight hours is sufficient for most of the customers.[194]

- An inspection of the electrical system and a certified installation are necessary. Therefore a business partner for the installation has to be found. In Austria there is one big player. Alpine Energie is also installing charging boxes for other OEMs and has the most experiences in this field in Austria. Other players are the energy providers, which have the constraint of working mainly just locally in one region of Austria.
- There should be no fixed blanket price for the installation, due to strong variation of the costs. Porsche Austria should offer a standard installation with a fixed price, but with the opportunity to spend more money. It should be also communicated in the right way to the customers to avoid misunderstanding and dissatisfaction.
- A public charging infrastructure is needed especially for psychological reasons. The range of electric vehicles is still a problem for a lot of customers and a public charging infrastructure would reassure customers. For Porsche Austria a partner for the public charging infrastructure has to be found. Players in this field are the local energy provider, but also national ones like the so called E-Mobility Provider, which is a joint venture of Verbund and Siemens.

5.2.3 Renewable Energy

As described in the theoretical chapters, for e-mobility it is also important to consider the energy sources used. As part of the one-stop offer it is important to consider this topic. The findings for renewable energy during the test fleet are described here:

[194] Internal Information of Volkswagen based on Market Research Activities

- *The combination of e-mobility and renewable energy is important:* It is important to see a well-to-wheel CO_2 emission value and not a plug-to-wheel one. Renewable energy is crucial for zero CO_2 emissions in an electric vehicle.
- *There are incentives of 5.000 Euro for fleet customers with renewable energy:* Fleet customers have to proof the use of renewable energy for their electric vehicles in order to receive an incentive of the government.

Renewable energy is a crucial aspect in e-mobility and will play a major role for the market launch. The implications for Porsche Austria due to findings concerning renewable energy are shown here:

- Renewable energy for customers should be offered at the point of sale. Therefore an energy sale or an intermediation is necessary. For energy sale it would be necessary to operate own power plants or to enter a joint venture. An intermediation would need an energy provider operating in all of Austria or a couple of cooperation with the local energy providers.
- Porsche Austria has to proof all incentives for electric vehicles in order to inform the customers at the point of sales about them. Currently, there is an incentive for fleet customer in the amount of 5.000 Euros. Different regions in Austria support e-mobility with local incentives.

5.2.4 Mobile Online Services

The findings for mobile online services are explained here:

- *It was often used by the customers and has potential for the future:* The customer used it as new feature and appreciated the connection of electric vehicle and smart phone. This service has the potential to extend and to offer new features.

The implications for Porsche Austria due to the findings concerning mobile online services are shown here:

- Mobile Online Services should be used as one aspect of e-mobility, due to different options which are useful for customers. Especially the current charging level, which also shows the remaining range, and the control of the air conditioning are reasonable. This would also be an advantage for the sales procedure.
- Through the high potential for the future, Porsche Austria should actively develop new feature for the mobile online services. This would be an opportunity to gain a new business model, because the involvement of applications for smart phones is very trendy. A suggestion would be to offer the possibility of searching, booking and paying of public charging infrastructure or to use a GPS tracking in case of theft.
- The mobile online service should be offered for free in the first year. In this way customers get used to have mobile online service and will then prolong the contracts.

5.2.5 Financing Concepts

Financing concepts are a new aspect of e-mobility. It is mainly concerned with the financing of the electric vehicle and the battery, but other aspects of e-mobility have to be considered as well. The findings regarding financing concepts are listed here:

- *There are three financing concepts for electric vehicles and batteries:* The first financing concept is the buy/buy option, which means the customer is able to buy the electric vehicle and to buy the battery. The second option would be a lease/lease, which means a leasing for both parts. A really new concept in the automotive industry is a buy/x concept. The x stands for financing, leasing or renting the battery.

The implications for Porsche Austria due to the findings concerning financing concepts are listed here:

- The financing concepts have to be checked if they are sustainable in legal terms, especially the buy/x concept. The focus should be on keeping the battery in the hand of the importer; therefore the buy/finance is no option any more. The rent of the battery would lead

to higher claims for the customers against Porsche Austria. For the buy/x concept the only solution would be the buy/lease one.

- A strategy for reselling of electric vehicles with a battery is necessary, again especially for the buy/lease concept. It is difficult to predict the residual value for electric vehicles; therefore a supported and stabilized value has to be ensured in cooperation of the OEM, the importer and the Porsche Bank. The warranty time and development of the used car market for electric vehicles are important points for the residual value.

5.2.6 Extended Mobility

Extended mobility isn´t a major aspect in e-mobility, rather it has to be seen as part of the one-stop offer for the customer. The findings regarding extended mobility are listed here:

- E-mobility customers prefer to have the opportunity to use a conventional car once a year.[195]

Due to this finding implications for Porsche Austria are:

- Cooperation with Europcar to offer a conventional car to customers is necessary. Europcar is a 100 percent subsidiary of the Porsche Bank and is therefore an appropriate partner. It should be one option as one aspect of the e-mobility offer to the customer. An example would be the possibility to use a conventional car for two weeks on holidays abroad.
- Car-Sharing in Austria should be considered. There are two opportunities, on the one hand to offer a public car-sharing project with electric vehicles in different cities and on the other hand a car-sharing project for fleet customers for their car pool.

[195] Internal Information of Volkswagen based on Market Research Activities

5.2.7 Vehicle-to-Grid

In the context of vehicle-to-grid also the term smart home is important. Smart home means the networking of the housing technologies, like smart meters, electric household appliances and internet. Vehicle-to-grid means to feed the electric household system with the energy of the vehicle batteries. The batteries are used as decentralized stationary electric storages. Currently, the disadvantage would be that high number of charging cycles is lowering the life span of batteries. [196]

The smart home approach is not directly an issue for Porsche Austria, but in combination with the vehicle-to-grid could it be an issue for the future. Here is important to observe the market developments and maybe to use the opportunity for new business models in future.

5.3 Relevant Stakeholders for Porsche Austria

Here in this chapter the stakeholders in e-mobility are defined and the implications for Porsche Austria are added. In the end a summary of the relevant stakeholders for Porsche Austria are illustrated. A stakeholder in an organization is, by definition, any group or individual who can affect or is affected by the achievements of the organization´s achievements.[197] To survive successfully on the market, it is necessary to define the relevant stakeholders and to involve them in the processes.[198] In the stakeholder analyses are three steps, the rational level, who are the stakeholders, the process level, how is the relationship to the implicit or explicit stakeholders and the transaction level, how is the transaction to these customers.[199] This chapter focuses on the first two levels of the stakeholder analyses, who are the relevant stakeholder and how is the relationship. But on the second level there is just a focus on the explicit stakeholder. To sum up, the external

[196] Cf. Nationale Plattform Elektromobilität (2012), p.24

[197] Freemann (1984), pp.46

[198] Cf. Goodijk (2003), p.150

[199] Elias/Cavana/Jackson (2002), p.305

stakeholders in e-mobility in the view of Porsche Austria are illustrated in this chapter: [200]

- *Original equipment manufacturer:* The OEMs are manufacturing the electric vehicles and they also invest a lot of money in e-mobility. They are working in close connection with the automotive suppliers and also with the battery industry to develop new batteries for electric vehicles. Volkswagen, as OEM, is also developing wallbox hardware together with the wallbox manufacturers, which will be then given to the importers. Porsche Austria is dependent on Volkswagen in Germany; therefore, a strong cooperation is necessary. On the one hand it is important to get all important information and on the other hand it is important to give a market-related feedback to them that they can understand the market.
- *Automotive supplier:* Automotive suppliers are part of the automotive industry as well. If OEMs are investing in e-mobility, it is a great opportunity for the automotive suppliers to find new business models with new products. Porsche Austria has not directly contact with the automotive suppliers.
- *Retailing:* The retailing sector is important for the direct contact to customers. The sales men have to be motivated to sell e-mobility. Retailing spots of the Volkswagen Group brands are mainly also subsidiaries of the Porsche Holding. For Porsche Austria it is crucial to inform the retailing sector, to prepare the sales process, to prepare a product offer and to define financing concepts.
- *Financing institutes:* E-mobility is demanding new financing concepts; therefore a financing institute has to be found. For Porsche Austria it is easy to find a partner, because the Porsche Bank is also a 100 percent subsidiary of the Porsche Holding and is specialist on financing concepts for vehicles. Together with the Porsche Bank it is important to find appropriate financing concepts and to solve the problems with the residual value and the technological leaps.

[200] Internal information of Porsche Austria based on Expert Interviews

- *Battery industry:* On the one hand the battery industry is important for the development of electric vehicles. Currently, the Lithium-Ion batteries are the most promising technology. On the other hand, it is important to know what to do with the batteries after they are depleted. The batteries have four life cycles. The first one is in new cars until they lose their warranty, the second is the used car market with the integrated used batteries, the third cycle would be a stationary use of the batteries for power storage, and the last cycle would be a recycling of the battery to build new ones. For Porsche Austria it is important to prepare for the different battery life cycles, because in Austria it is a law to take back the batteries if you sell them.
- *Wallbox provider*: Each electric vehicle, regardless if it is a BEV, PHEV or REX, has to have a charging station for home use. The reasons are safe and convenient charging at home and a maximum utilization of given household charging capabilities. Volkswagen will sell an electric vehicle with a wallbox, therefore the wallbox provider are not directly relevant for Porsche Austria.
- *Installation provider:* The wallbox hardware is an issue for Volkswagen in Germany. Volkswagen will find a supplier and will distribute it with the electric vehicles to Porsche Austria. But the installation provider will still be relevant, as they will have to install the wallbox for customers at home or at work. The challenge is to find an appropriate installation provider for Austria. There should be one provider for whole Austria for all Volkswagen brands to use synergies. Porsche Austria has to set a strategy, how to handle the installation process for the wallboxes. In the end one cooperation partners has to be defined.
- *Public charging infrastructure provider:* For e-mobility is important to have a public charging infrastructure. Volkswagen and Porsche Austria do not want to invest in a public infrastructure; therefore it has to be aimed at a partnership with a provider. There are some players in Austria, which will coordinate the charging infrastructure in Austria. Examples are “The Mobility House” and the “E-Mobility Provider”. For Porsche Austria it is important to be able to provide a cheap offer to

their customers. Therefore a cooperation with these providers is necessary.

- *Area provider:* Area providers can play a major role for the expansion of the public charging infrastructure. Examples are shopping centers or restaurants. For them it would be a possibility to attract customers to their businesses. For Porsche Austria it is important to observe the expansion of the public charging infrastructure in order to be able to have an appropriate charging offer for their customers.
- *Energy provider*: To be able to provide renewable energy for the customers of Porsche Austria, cooperation or an intermediation with an energy provider is necessary. It is important to find a provider with 100 percent renewable energy usage who is able to supply in whole Austria.
- *Customers:* Customers are the most important stakeholder in e-mobility. They decide about the growth of e-mobility in the next years, because customer acceptance is important. For Porsche Austria this leads to an appropriate communication strategy. The customers have to be informed about e-mobility to understand the problems and to see that e-mobility is able to fulfill requirements. For Porsche Austria it is also important to communicate their strategy and to explain why the Volkswagen group is waiting with the market launch of e-mobility.
- *Mobility service provider:* There are companies which try to offer different parts of e-mobility together as an add-on product to the electric vehicle. There is for example “The Mobility House” which is working worldwide and is offering the wallbox, the wallbox installation, renewable energy and access to a public charging system. For Porsche it is important to observe what these mobility service providers are doing. There is the possibility for cooperation, but also for a competition.
- *Mobile operators:* The mobile online services are not only developed for electric vehicles, but they will be the first ones with this feature. For this service a SIM card for the vehicle is necessary, therefore Porsche Austria has to find a mobile operator to conclude a contract. The mobile operators play no major role for Porsche Austria because the competition in Austria on the mobile phone market is high.

- *Used car market:* The used car market has to be observed and also stimulated, but it is difficult to control it because of many possible influence factors, like the residual value and the unknown supply and demand of electric vehicles in future.
- *Austrian politics:* The Austrian politics are able to push e-mobility in Austria and as well as to block e-mobility in Austria. Politics are able to influence all stakeholders in e-mobility and therefore have to be seen on a higher level. Currently, there are tax advantages and also incentives for fleet customers, but the government can stop them very quickly. Naturally, it would be also possible to raise incentives and also to offer them to private customers. There are elections on the national level every five years, which can result in big changes for e-mobility. Therefore, lobbying would be a possibility for Porsche Austria.

An overview of the stakeholder for the system of e-mobility and with a definition of the relevant stakeholders for Porsche Austria is shown in figure 26.

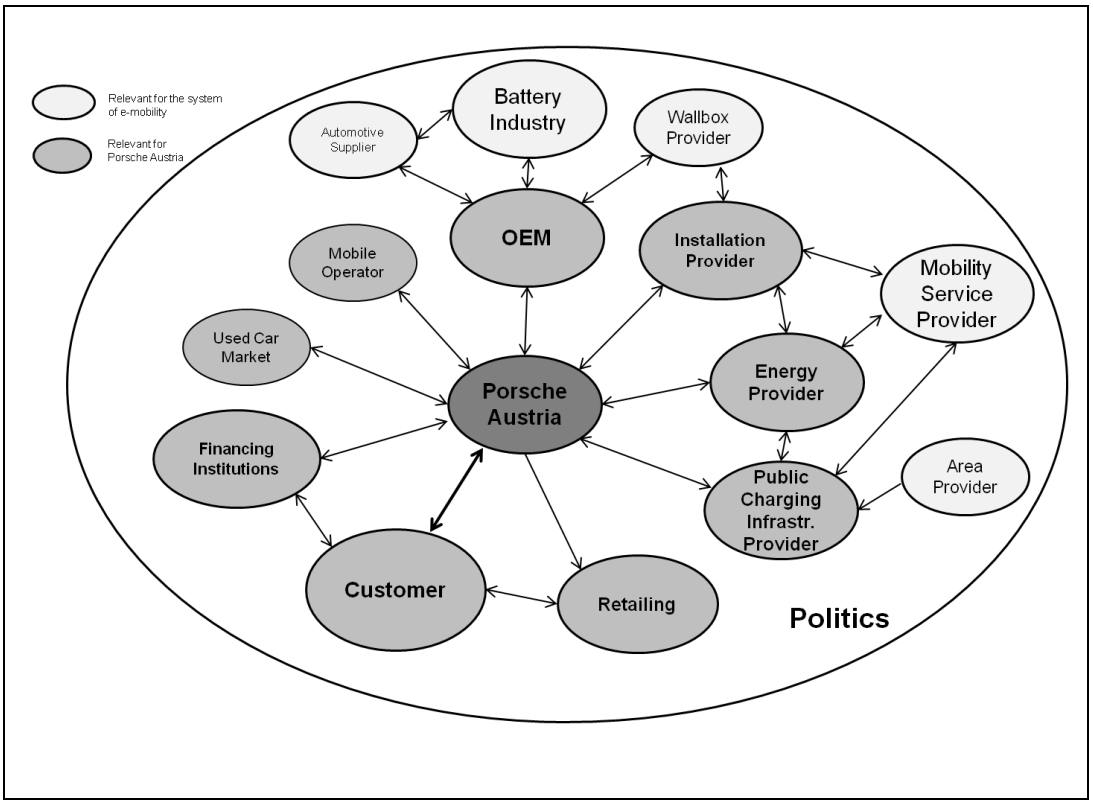

Figure 24: Relevant Stakeholder in E-Mobility and for Porsche Austria.[201]

To sum it up, there are three relevant internal stakeholders for Porsche Austria. These are the OEM, the retailing sector and the financing institutes, which is in this case the Porsche Bank. The relevant external stakeholders are the installation providers for the wallbox at home, the providers of public charging infrastructures and the energy providers. Minor roles are played by the used car market and the mobile operators. The customer is the big player. Customer-orientation in the beginning is really crucial in e-mobility for Porsche Austria. Finally, there is the politics which influence nearly all stakeholders in e-mobility.

[201] Own Illustration based on Expert Interviews

5.4 Comparison to Standard Market Launch

Usually, the marketing mix with product policy, price policy, promotion policy and the place policy is important for a market launch at Porsche Austria. In e-mobility the standard market launch with the marketing mix has to be done, but additionally, as already mentioned, the other aspects of e-mobility have to be considered. The four parts of the marketing mix are listed and the differences in e-mobility compared to conventional cars are described:

- *Product Policy:* Instead of having one model of a vehicle with different equipment, beside the electric vehicle with the battery there is a wallbox for home charging, the installation of the wallbox, a possibility to use the public charging infrastructure, an offer for renewable energy, mobile online services and an offer for extended mobility.
- *Price policy:* It is necessary to find optimized market prices for all aspects of e-mobility which are listed in the last point about the product. Additionally there are new financing concepts especially for the electric vehicle and the battery.
- *Promotion policy:* Besides the marketing and the public relations communication for the electric vehicles, a concept for the communication of e-mobility strategy of Volkswagen has to be defined. E-Mobility is an important issue for the brand image of an OEM.
- *Place policy:* In this field the customer groups have to be defined and an appropriate distribution way has to be found. The topic of an appropriate network planning is new, because market launches of conventional vehicle were able to use the existing one. In e-mobility it is important to define the number of dealership, depending on the volumes, the after sales qualification and the costs for standards.

5.4.1 Network Planning

In the beginning there will be just a small numbers of electric vehicles of Volkswagen in Austria. In 2013, the first BEVs will be on the market and in 2014 the first PHEVs. Because of that not all dealership will be able to sell electric vehicles. The most important aspects which have to be considered in the network planning for e-mobility are listed in this chapter:

- *Direct access to the customers:* There have to be dealerships with electric vehicles to keep the contact to the private customers. For the fleet customers direct selling through Porsche Austria is possible.
- *Infrastructure standards:* There are standards which have to be fulfilled in order to sell e-mobility. In the beginning there have to be charging stations in the showrooms, at the parking areas and in the after sales areas. It has to be considered that in future with faster charging infrastructure the electric supply cables have to be renewed to enable fast DC charging, which is related with high costs.
- *Training standards:* On the sales and the after sales level it is important to have well trained staff for e-mobility. The sales staff has to be able to sell e-mobility with all their different aspects. Therefore an appropriate training should take place, but a service hotline as second level support should be implemented as well. In the after sales it is important to have trained staff considering the technical issue of e-mobility. They have to be able to repair an electric vehicle. In conclusion, it would be important that the whole dealership is informed about e-mobility.
- *Profitability:* The standards for training and infrastructure are expensive, especially the electric supply cables. But there will also be costs for marketing, a demonstration car and tools for e-mobility. The target should be to reach the break even as fast as possible. This point has to be considered to avoid high costs for dealers.
- *Emotionality:* This issue will be relevant during the selection of the dealership for e-mobility. On the one hand, there will be dealerships which do not want to be e-mobility base dealers and there will be dealerships which want to be to present their innovative image. Therefore this issue has to be considered in the planning of the network for e-mobility.

The network planning in e-mobility for the market launch includes a lot of crucial issues. In conclusion the implications for Porsche Austria are listed below:

- It should be an open network to treat all dealers in the same way. This has emotional issues, as well as legal issues, because of existing contracts between importer and dealers.
- A certain number of dealers is necessary and the break even should be reached. On the one hand, there is a minimum number of dealers, because it should be customer-oriented, which means a customer should reach a dealer within forty kilometers. On the other hand, there is a maximum number of dealers, because the business with e-mobility should be a profitable one for each dealer. At Porsche Austria this means to force the dealers in the nine state capitals in Austria to become an e-dealer. These should be force but a higher number should not be pushed.
- The usage of synergies within the brands of the Volkswagen group is important. Especially for charging infrastructure standards, which are connected to high investments, should be shared within the different brands of the Volkswagen Group.

5.4.2 After Sales

The after sales sector also has a major role in e-mobility because contact to the customers does not end after selling the electric vehicle. Findings of the project concerning after sales are listed here:

- *There are less movable parts in an electric vehicle:* This leads to fewer turnovers in the after sales sector, but e-mobility is also opportunity to gain new business fields in the after sales sector. [202]
- *A well trained and informed after sales staff is important:* The after sales staff has to know about future trends. Therefore the whole after sales organizations has to be informed and also trained for e-mobility. There are three levels of qualifications in e-mobility for the after sales sector.
- *Higher power lines would be necessary for additional charging with higher power in future:* New power lines lead to high investments for the dealerships. It is important to consider the charging technology of

[202] Internal Information of Porsche Austria based on Expert Interviews

the future for the planning of the power lines. For a long-term planning will it be necessary to invest.

- *Investments in tools for e-mobility are necessary:* There are special tools for electric vehicles for the after sales sector. They are necessary to react fast on problems with the electric vehicle. Some tools are already stored at the dealerships because of the first hybrids of Volkswagen.

The findings lead to the following implications for Porsche Austria:

- The electric power lines have to be checked and renewed to be prepared for fast charging infrastructure in future. At the beginning for the chosen dealers with electric vehicles. Consideration of future charging technology is necessary.
- The after sales staff has to be trained for e-mobility. A strategy for different levels of qualification has to be defined. There should be at least two high voltage technicians at each dealer participating in e-mobility. Furthermore, at least one high voltage expert should be placed at the importer to guarantee fast reparation for the customers.
- Investments in tools are necessary to be able to react fast on customer problems. The costs for tools are about 6.500 Euros for each dealer.
- For damaged batteries a box, outside of the plant has to be installed. A working battery can be stored inside, but also with some restrictions.
- Possibility for new business fields should be checked. There will be less work, than for conventional cars, but e-mobility offers the opportunity for new business models.

6 Conclusion and Outlook

In summary, this master thesis shows that e-mobility is a huge and complex topic and a well prepared market launch is vital. For this reason, Porsche Austria in cooperation with Volkswagen organized the test fleet with fifteen battery electric vehicles in Austria. It was essential to understand what fields of activity and which stakeholders are important before launching the first electric vehicles in Austria.

The first important outcome was the confirmation that e-mobility has to be seen as a total system. E-mobility is comprised of the electric vehicle and battery, the charging hardware, the customer´s own charging hardware installation, public charging infrastructure, mobile online services, renewable energy, financing concepts and extended mobility.

Another outcome was the definition of the most important stakeholders for Porsche Austria in e-mobility. The relevant internal stakeholders are the original equipment manufacturers, which is the Volkswagen group in the case of Porsche Austria, the dealerships in Austria, which are strongly connected to Porsche Austria and last but not least the Porsche Bank, which is relevant because of the new financing concepts in e-mobility. The supplier industry, the battery industry and the charging hardware providers are connected to the Volkswagen group and are not directly relevant for Porsche Austria. The relevant external stakeholders for Porsche Austria are the charging hardware installation providers, the energy providers and the providers of the public charging infrastructure. Furthermore, politics plays a major role and is able to considerably influence e-mobility with only a few decisions. Last but not least, the customer, who is the most important stakeholder for Porsche Austria, has to be convinced of e-mobility. Customers may choose e-mobility as part of mobility in future; therefore Porsche Austria has to create the framework to persuade them.

If the process for the market launch of conventional vehicles and electric vehicles has to be compared, some additional issues, especially concerning the marketing mix, arise. The product is no longer simply the vehicle; it is the electric vehicle and battery, charging infrastructure, renewable energy, mobile online services and extended mobility, which are defined as product in the marketing mix and are followed by the price, the promotion and the

place. Regarding price, it is not enough to find the optimized price for vehicles anymore, it is also important to find the optimized price of all aspects of e-mobility and additionally there are new financing concepts for the vehicle and the battery. Concerning promotion it is important to get the e-mobility strategy of Volkswagen across to connect e-mobility and Volkswagen in the eyes of the customers. Last but not least the place, which means the distribution channel, here it is crucial to have a well prepared after sales organization and an appropriate e-mobility dealer network to reach all customers.

In conclusion, the output of the master thesis shows that e-mobility is important, as part of future business, for Porsche Austria. The next steps include more detailed planning on the different aspects of e-mobility and to get in contact with the relevant stakeholders. The network planning has to be finished in timely manner in order to begin the preparation of the after sales organizations. Finally the operative preparation of the market launch of the first electric vehicles of the Volkswagen group has to be done, before e-mobility can be part of future mobility.

List of References

ADCOCK, D.; HALBORG, A.; ROSS, C.: Marketing: Principles and Practice, 4.Version, Pearson Education Limited, 2001

ALBACH, H.: Culture and Technical Innovation – A Cross-Culture Analysis and Policy Recommendations, Berlin / New York, 1994

ARBEITSGRUPPE 2: Bedarfsgerechte Infrastruktur des Ladens Endbericht, Study, Vienna, 2011

BAKER, N. R.; SIEGMANN, J.; RUBENSTEIN, A. H.: The Effects of Perceived Needs and Means on the Generation of Ideas for Industrial Research and Development Projects, In: IEEE-Transactions on Engineering Management, Jg. EM-14, 1967

BAUMGARTNER, T.; SCHÖLLING, M.: Die Konditionsspreizung der Hersteller gegenüber dem Handel – gesehen als Principal-Agent-Problem, In: Der Markt 1/2000, 39.Jg., Nr. 152, 1993

BURGHARDT, M.: Einführung in Projektmanagement, 4. Version, Erlangen 2002

CE DELFT: Impact of Electric Vehicles, Delft, 2011

COOPER, R. G.; EDGETT, S. J.; KLEINSCHMIDT, E. J.: Optimizing the Stage-Gate Process: What Best-Practice Companies Do – II, In: Research Technology Management (Nov.-Dec.), 2002

DAHLIN, K. B.; BEHRENS, D. M.: When is an invention really radical? Defining and measuring technological radicalness, In: Research Policy, Jg. 34, 2005

E-CONNECTED: Abschlussbericht II, Vienna, 2010

ELIAS, A. A.; CAVANA, R. Y.; JACKSON, L. S.: Stakeholder analysis for R&D Project Management, In: R&D Management, 2. Version, 2002

EUROPEAN PARLIAMENT AND COUNCIL: Regulation (EG) Nr. 443/2009 of the European Parliament and Council, Brussels, 2009

FEDERAL MINISTRY FOR TRANSPORT, INNOVATION AND TECHNOLOGY: Pre-feasibility Studie zu „Markteinführung Elektromobilität in Österreich“, Vienna, 2009

FEDERAL MINISTRY FOR TRANSPORT, INNOVATION AND TECHNOLOGY: Strategie und Instrumente sowie prioritäre Anwender- und Einsatzbereiche für den nationalen Einführungsplan E-Mobilität, Vienna, 2010

FREEMANN, E. R.: Strategic Management: A Stakeholder Approach, Boston, 1984

GOODIJK, R.: Corporate Governance and Stakeholdermanagement: The ING-Case, In: Corporate Ownership & Control, 1.Version, 2003

FRAUNHOFER ISI: Roadmap zur Kundenakzeptanz, Berlin, 2012

GESCHKA, H.: Forschung und Entwicklung als Gegenstand betrieblicher Entscheidungen, Meisenheim a. G., 1970

GRÜN, O.; HAUSCHILDT, J.; JONASCH, M.: Systeminnovation als Multi-Organization Innovation (MOI), In: Zeitschrift Führung und Organisation, Band 77, Heft 3, 2008

KLEINKNECHT, A.; REIJNEN, J. O. N.; SMITS, W.: Collecting Literature-based Innovation Output Indicators. The Experience in the Netherland, In: Kleinknecht A., BAIN D. (Hrsg.): New Concepts in Innovation Output Measurement, Houndmills, 1993

KÖHLER, U.: Hybrid-, Batterie- und Brennstoffzellen-Elektrofahrzeuge - Technik, Strukturen und Entwicklungen, Expert-Verlag, Renningen, 2004

KOTLER, P.: Kotler on Marketing: How to create, win and dominate markets, The Free Press, 1999

LANCASTER, G.; MASSINGHAM, L.: Essential of Marketing Management, Routledge, 1. Version, 2011

LECHLER, T.: Erfolgsfaktoren des Projektmanagements, Frankfurt a. Main, 1997

LIMBERG, T.: Examining Innovation Management from a Fai Process Perspective, Wiesbaden, 2008

INTERNAL INFORMATION OF THE VOLKSWAGEN GROUP: E-Mobility at Volkswagen, Wolfsburg, 2012

INTERNAL INFORMATION OF PORSCHE AUSTRIA: Internal Presentation and Expert Meetings, Salzburg, 2012

INTERNAL INFORMATION: Market Research Department: Market Analysis, Porsche Austria, Salzburg, 2012

MAIDIQUE, M. A.: Entrepreneurs, Champions, and Technological Innovation; In: Sloan Management Review (2), Jg. 14, 1980

MIROW, M.: Innovation als strategische Chance., In: FRANKE N., BRAUN C.-F. v. (Hrsg.), Innovationsforschung und Technologiemanagement – Konzepte, Strategie, Fallbeispiele, Berlin et al., 1998

MÜLLER-HEGDORN, L. et al: Handelsmarketing, 2. Version, Verlag Kohlhammer, Stuttgart / Berlin / Köln, 1993

NATIONALE PLATTFORM ELEKTROMOBILITÄT: Die deutsche Normungsroadmap Elektromobilität, Version 2, Berlin, 2012

ÖSTERREICHISCHER VEREIN FÜR KRAFTFAHRZEUGTECHNIK: E-Mobilität ohne Verbrennungsmotor, Study, Vienna, 2012

PORSCHE MITARBEITER ABC: Hrsg. HR Departement Porsche Holding, 27. Version, 2011

POSCH, A.: Management von Innovationsprojekten, In: Strebel H. (Hrsg.): Innovations- und Technologiemanagement, Vienna, 2003

ROLAND BERGER STRATEGY CONSULTANTS: Powertrain 2020, China's ambition to become market leader in E-Vehicles, Study, Munich/Shanghai, 2009

SHENHAR, A. J.: From Theory to Practice: Toward a Typology of Project-Management Styles; In: IEEE – Transaction on Engineering Management, Jg. 45, 1998

SCHUMPETER, J. A.: The Theory of Economic Development: An inquiry into profit, capital, credit, interest and business cycle, Cambridge Mass: Harvard University Press, 1911

SCHUMPETER, J. A.: Business Cycle – A Theoretical, Historical, and Statistical Analysis of the Capitalist Process, 3. Version, New York / London; 1939

THOM, N.: Grundlagen des betrieblichen Innovationsmanagements, 2. Version, Hanstein 1980

TROTT, P.: Innovation Management and New Product Development, Third Edition, Prentice Hall, Pearson Eduction, 2005

UHLMANN, L.: Der Innovationsprozess in westeuropäischen Industrieländern, Berlin / München, 1978

WITTE, E.: Organisation für Innovationsentscheidungen, Göttingen, 1973

WÖHE, G.; DÖRING, U.: Einführung in die allgemeine Betriebswirtschaftslehre, Verlag Vahlen, 23. Version, Lüneburg, 2008

ZAHN, E.; Weidler, A.: Integriertes Innovationsmanagement, In: Zahn E. (Hrsg.), Handbuch Technologiemanagement, Stuttgart, 1995

Weblinks

Porsche Holding
http://www.porsche-holding.com/unternehmen/geschaeftsfelder
[30.07.2012]

Porsche Holding
http://www.porsche-holding.com/unternehmen/zahlen_fakten/2002_03_2010
[30.04.2012]

Porsche Holding
http://www.porsche-holding.com/de/unternehmen/standorte
[01.05.2012]

E-Tankstellenfinder
http://e-tankstellen-finder.com/at/de/catalog/index/at/0
[01-05-2012]

List of Figures

List of Tables

Abbreviations

BEV	Battery Electric Vehicle
EV	Electric Vehicle
HEV	Hybrid Electric Vehicle
HP	Horse Power
ICE	Internal Combustion Engine
KW	Kilowatt
KWH	Kilowatt-hour
OEM	Original Equipment Manufacturer
PHEV	Plug-In Hybrid Electric Vehicle
PR	Public Relation
REX	Range Extender Electric Vehicle
UMTS	Universal Mobile Telecommunication System