

# **Thema der Arbeit**

*Discussion of IT-infrastructure for electric mobility*

## **Bachelorarbeit**

zur Erlangung des akademischen Grades “Bachelor of Science (B.Sc.)” im  
Studiengang Wirtschaftswissenschaft der Wirtschaftswissenschaftlichen  
Fakultät der Leibniz Universität Hannover

vorgelegt von

Patrick-Oliver Groß



Prüfer: Prof. Dr. Michael H. Breitner

Hannover, den 09.08.2011

# Contents

<b>List of Figures</b>	<b>II</b>
<b>List of Abbreviations</b>	<b>III</b>
<b>1 Introduction</b>	<b>1</b>
<b>2 Definitions and Background</b>	<b>3</b>
2.1 Electric Mobility . . . . .	3
2.2 IT Infrastructure in the Context of Electric Mobility . . . . .	5
2.3 Smart Grid and Vehicle to Grid . . . . .	6
<b>3 The IT Infrastructure for Electric Mobility</b>	<b>10</b>
3.1 Status Quo, Projects and Goals . . . . .	10
3.2 Smart Charging - Charging Process, Information Management and Vehicle to Grid Integration . . . . .	12
3.3 E-Roaming as Billing Solution for Increased Charging Station Accessibility	16
3.4 IT Security and Privacy of Electric Vehicles and Smart Grids . . . . .	20
<b>4 Acceptance of Electric Mobility</b>	<b>24</b>
4.1 Private Users . . . . .	24
4.2 Commercial Users . . . . .	26
4.3 Relevance of IT Infrastructure for the Acceptance of Electric Mobility . .	28
<b>5 Conclusion</b>	<b>29</b>
<b>References</b>	<b>30</b>

# 1 Introduction

Mobility as a basic need of the modern society represents one of the main drivers for growth and progress. This need for mobility is constantly growing in the course of time due to various reasons (e.g. urbanization). Confronted with limited resources and environmental standards this circumstance demands new mobility concepts including new technologies and enhanced energy efficiency. On this occasion electric mobility plays a central role.<sup>1</sup>

Electric mobility has become a serious trend, daily presence in the media refers to significant general interest in this upcoming paradigm shift in automobile history. The term electric mobility encompasses a drive concept for vehicles which so far were driven by a conventional combustion engine and in the future shall be driven by an electrical engine. Main drivers for this development are climate change caused by the emission of greenhouse gases and the finiteness of crude oil. In the future electric vehicles are supposed to drive “green” powered by renewable energies.<sup>2</sup>

In 2009 the German government announced the “National Development Plan for Electric Mobility” and provided 500 million Euro of public funds for the development of electric mobility in Germany, targeting a total of one million electric vehicles to be driven in Germany by the year 2020.<sup>3</sup> Concerning this information technology plays a crucial role as electric vehicle, traffic-, power- and communications systems have to merge to a whole new system.<sup>4</sup> Adequate IT solutions are required to encourage the implementation of electric mobility support the availability of charging possibilities, enable identification and metering for billing purposes, allow the integration of renewable energies for charging as well as the integration of electric vehicles for grid management.<sup>5</sup>

In this paper the actual state of IT infrastructure for electric mobility will be considered as well as existing challenges and possible solutions. Hereby the main focus will lie on information and communication processes in charging and billing as well as security issues related to this topics. The first chapter will provide basic knowledge of the term

---

<sup>1</sup> cf. Wirtschaftsministerium Baden-Württemberg (2010), p. 10.

<sup>2</sup> cf. Yay (2010), p. 11.

<sup>3</sup> cf. Bundesministerium für Verkehr Bau und Stadtentwicklung (2009), p. 2 and 24.

<sup>4</sup> cf. VDE (2010), p. 13-14.

<sup>5</sup> cf. VDE (2010), p. 13-14.

electric mobility and its evolution, followed by a discussion of the term IT infrastructure in the context of electric mobility. The chapter will end on an overview of smart grids and their relevance to electric mobility. The second chapter will deal with actual status of IT infrastructure for electric mobility considering current projects and their goals followed by the investigation of the topics charging, E-roaming as a billing solution and security. Finally the third chapter considers acceptance of electric mobility and the influence of the underlying IT infrastructure to this acceptance.

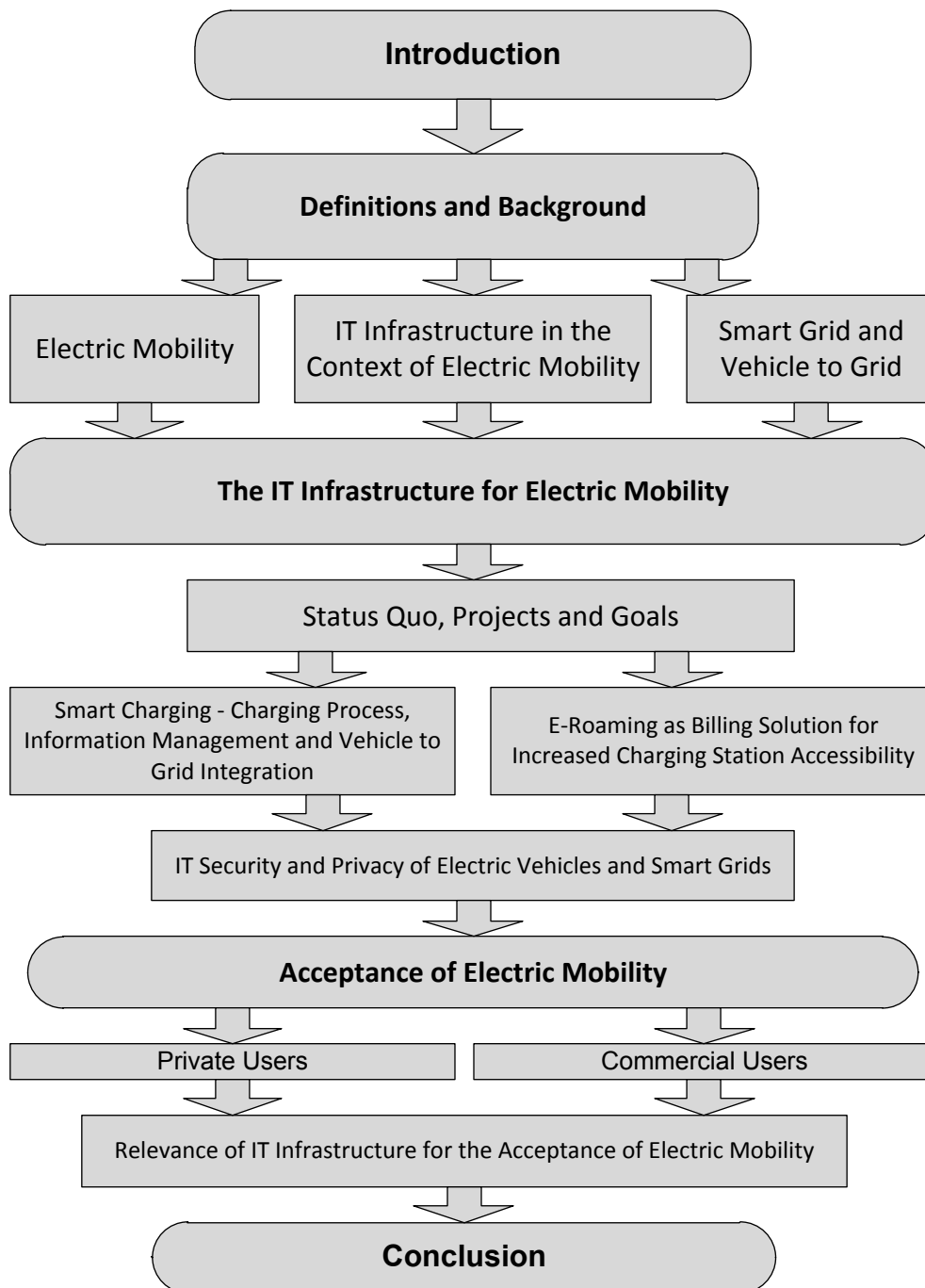


Figure 1: Structure of the Paper  
Source: own illustration

## 5 Conclusion

In this paper electric mobility and the underlying IT infrastructure were discussed. The relevance of IT infrastructure for the sustainable and large-scale introduction of electric mobility could be shown. The charging process needs to be “smart” which means it has to be automatized as well as to be connected to a reliable information system. Concepts like the Electric Vehicle Power Plant represent a possible solution to realize vehicle to grid services beneficial for both grid operators and end-users. To realize this, standardization plays a crucial role as it increases the interoperability between different systems. Another possibility to increase interoperability for charging purposes is E-Roaming. One of the the presented solutions to realize E-Roaming already considered the integration of electric vehicles into smart grids and thus into the Internet of Energy. Furthermore security threats arising from the introduction of electric mobility and smart grids were discussed and solutions to cope with them were presented. Finally user acceptance of electric mobility was considered based on a survey of the ‘Fraunhofer Institut für System und Innovationsforschung’ and the possible influence of the IT infrastructure to the acceptance of electric mobility was regarded.

Electric mobility and its IT infrastructure are still in an early stage but several solutions are already available. Some of these solutions were presented and discussed in the course of this paper but further research and development is required. Due to this support programs like “IKT für Elektromobilität” are an essential part to the establishment of electric mobility. In most of the current cases existing technologies are eligible to create adequate IT solutions. Nevertheless for a global interconnection of smart grids and electric vehicles, to realize vehicle to grid solutions which allow electric vehicle owners to trade and interact (Internet of Energy), new solutions and concepts are required. Additionally security represents an essential factor as with an interconnection of multiple complex systems (e.g. electric mobility systems and smart grids) malicious attacks got the potential to cause significant damage when not properly dealt with. Acceptance represents another factor which is required to the successful introduction of electric mobility. To determine in which specific way IT infrastructure influences this acceptance further research is required.