

Preface

The need to largely reduce the amount of Carbon Dioxide (CO₂) emissions in the coming years all over the world requires a large effort in decarbonising the economy. One of the sectors most in need of this effort is the transportation sector. In fact, only a large reduction of CO₂ emissions in this sector will allow coping effectively with this problem. There are two ways to perform it (1) by increasing the amount of biofuels to be used by Internal Combustion Motors or (2) by making a shift towards electromobility. However, this shift towards the electrification of the transportation sector can only be well succeeded if one increases simultaneously the proportion of non-CO₂-emitting power generation technologies, namely renewable based power sources. European Union (EU) is developing a large effort on these matters. In fact, the energy-related targets set by EU policy require careful examination of potential solutions for the integration of renewable energy sources to meet the electricity demand. On the other side, the expected growing energy demand resulting from the introduction of electric-powered cars needs the development of innovative concepts to exploit the variable power supply. The application of dynamic techniques for prediction of electricity supply and demand, including electricity prices in the market, is expected to support the optimisation of the grid balance. The European wind markets predict an installed capacity that would provide 14 % of the electricity consumption in 2020. Today in Denmark and Portugal, the wind power accounts for more than 20 % of the power production. However, the variable character of this renewable power supply imposes special requirements on the whole system, including the future adoption of active load management and storage. Several recent research projects and studies indicate that the battery capacity of electric cars could contribute to obtain an efficient way of dealing with the variable power supply from wind plants. Also the relative static grid system will have to become intelligent in order to deal with the future electricity supply and demand. Utilities will have to integrate large-scale renewable power technologies as core parts of their long-term generation strategies. In parallel electric cars may ease the integration of renewable energies in the electricity networks and markets since they are very flexible loads and will be therefore most suited to provide balancing services to the grids. This book aims at

establishing a state of the art and at identifying the needed solutions to support a massive integration of electricity consuming cars in our society. The book includes some material from the EU-funded project MERGE (Mobile Energy Resources in Grids of Electricity) and from the Danish EDISON project (Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks).

This book was inspired by the two courses held under the EES-UETP (Electric Energy Systems—University Enterprise Training Partnership) umbrella, in 2010 and 2011, in Denmark and Portugal, respectively.

This book encompasses nine chapters written by leading researchers and professionals from industry and academia who have a vast experience within this field.

Chapter 1 is the introductory part and gives an overview about the state of the art of this technology.

Chapter 2 describes the battery technology, including the modelling and performance of these devices for electric vehicle applications.

Chapter 3 demonstrates the influence of electric vehicle charging and its impact on the daily load consumption. The developed methodology may be used for new business models and management architectures for electric vehicle grid integration as further described in Chaps. 4 and 8, respectively.

Chapter 4 discusses different business models and control management architectures. The fuelling functions of an electric vehicle, how they influence the design of the electric vehicle and their grid connection infrastructure as enablers and limiters to the possible business models are mentioned. The comparison among three large electric vehicle integration projects is presented.

Chapter 5 shows up-to-date smart grid communication methods and related standardisation work for electric vehicle integration into modern power networks. A very extensive description of the information and communications technology solutions to incorporate electric vehicles is provided.

In Chaps. 6 and 7, steady state and dynamic behaviour advanced models, simulation tools and results for electric vehicle power system integration are presented. These chapters focus mainly on the development of different approaches and strategies to explain several important issues within this particular topic such as creation of load scenarios to evaluate electric vehicle grid impact, identification of charging management strategies for electric vehicle high controllability, identification of feasible electric vehicle penetration, feasibility of having electric vehicle participation in frequency control and electric vehicle contribution for the automatic generation control (AGC) to enable a higher renewable energy penetration into the electric system.

Chapter 8 gives a tutorial overview of the main regulatory issues of integrating electric vehicles into modern power networks, with more emphasis on the general role allocation and usual distribution of crucial functions. It describes and proposes a conceptual regulatory framework for various charging modes, such as home charging, public charging on streets and dedicated charging stations, giving justification for the development of two new entities as intermediary facilitators of the final service.

Chapter 9 illustrates the development of electric vehicle adoption from its very first steps to the numerous electric vehicle projects and activities around the world. The actual electric vehicle availability and the different electric vehicle manufactures are shown in this chapter with authentic photographs for the different electric vehicle technologies.

Electric Vehicle Integration into Modern Power
Networks

Garcia-Valle, R.; Peças Lopes, J.A. (Eds.)

2013, XI, 325 p. 202 illus., 134 illus. in color., Hardcover

ISBN: 978-1-4614-0133-9