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Book Review

Integration of Distributed Generation in the Power System, M. Bollen, F. Hassan. Wiley–IEEE Press, New Jersey (2011)

The increasing integration of new sources of energy like wind power [1], solar-power, small-scale generation, or combined heat and power in the power grid is something that impacts a lot of stakeholders: network companies (both distribution and transmission), the owners and operators of the distributed generation (DG) units, other end-users of the power grid, policy makers and regulators. A massive introduction of DG (including large-scale renewable energy sources) without any changes (investments) in the power system will result in unacceptable levels of quality and reliability. However, certain amounts of DG can be integrated in the existing system without any changes. Larger amounts can be integrated by making minor changes (i.e., small amounts of investment). For massive amounts, significant changes (investments) are needed. Small DG sources are connected to the low or medium voltage distribution system, where traditionally only consumption has been connected. The introduction of large amounts of them will require investments not only at the voltage level where the units are connected but also at higher voltage levels. The variation in production from renewable sources introduces new power quality phenomena, typically at lower voltage levels. Moreover, this variation as well as the difficulty in predicting renewable sources production impacts the design and operation of sub-transmission and transmission networks. These are the main reasons why the grid integration of DG is a very attractive research subject and it will continue being a subject of strong interest [1–29].

With this book Professor Bollen and Dr. Hassan contribute to the understanding of the impact of DG on the power system and to the presentation of methods for allowing more DG to be integrated into the power system. More specifically, *Integration of Distributed Generation in the Power System* offers a very comprehensive discussion of modern power system operation with DG by renewable energy sources. It discusses the possible impact on the power system of the shift from large conventional production units to small and/or renewable electricity production. The book discusses not only the problems but also the solutions. Understanding the problems is essential for being able to choose the right solution.

The book introduces the *hosting capacity* approach. The hosting capacity is the maximum amount of generation that can be integrated into the power system, while still maintaining its performance within acceptable limits. The book introduces systematic and transparent methods for quantifying the effect of DG on the power system, either at a specific grid location or in the grid as a whole. It shows how to calculate and increase the hosting capacity for different types of networks and various types of DG. It also goes into detail on both the shallow and deep impact of DG; it describes the impact of small generation on the distribution system and on the operation of the transmission system.

It is an advantage that the book includes simplified models of the power system and of the DG. In this way, the authors propagate the use of such simplified models as a tool to be used during initial discussions. Important conclusions can often be drawn from these simplified models. Moreover, the use of simplified models has a great educational value. The impact of different parameters is much better understood when simplified models rather than detailed simulations are used. Such detailed calculations are, however, needed in many cases before connecting DG to the power system. The structure of the power system is different across the world and the details are very much location dependent. The simplified models of the type presented in this book can be easily adapted to a local situation, whereas simulation studies have to be repeated for each location.

Another very interesting aspect of this book is that it gives alternative solutions to enable the increased penetration of DG in the power system. Among these alternatives, the most cost-effective one should be chosen.

This book presents practical and useful information about grid integration of DG. Professor Bollen and Dr. Hassan are authors of important articles in international refereed journals and conferences in the area of grid integration of DG. Their research experience ensures the theoretical and practical treatment given to their book.

The organization of the book is very good and the presentation with appropriate examples is very clear. The material of the book is organized in nine chapters. Chapter 1 is an introduction to the book scope and structure. Chapter 2 presents the different sources of energy behind new types of electricity production. The emphasis is on wind power and solar power, the renewable sources that get most attention these days. The different sources are discussed in terms of their variation in production capacity at different timescales, the size of individual units, and the flexibility in choosing locations. These are the properties that play an important role in their integration into the power system. Chapter 3 introduces the hosting capacity approach, which uses the existing power system as a starting point and considers the way in which DG changes the performance of the system when no additional measures are taken. Chapters 4–8 discuss in detail various aspects of the integration of DG: the increased risk of overload and increased losses (Chapter 4), increased risk of overvoltages (Chapter 5), increased levels of power quality disturbances (Chapter 6), incorrect operation of the protection (Chapter 7), and the impact on power system stability and operation (Chapter 8). Chapter 9 concludes the book.

It is an excellent reference book for undergraduate and postgraduate students, academic researchers, government regulators, and modern power and energy engineers working in the area of the integration/connection of distributed generation in the power system.

In conclusion, the implementation of the methodologies presented in this book could help removing some of the technical

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and non-technical barriers that the power system poses to a wider use of distributed energy resources.

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P.S. Georgilakis

School of Electrical and Computer Engineering, National Technical University of Athens (NTUA), Athens 15780, Greece

Tel.: +30 210 772 4378; fax: +30 210 772 3659.

E-mail address: pgeorg@power.ece.ntua.gr