

Preface

With the current trend of transforming a centralized power grid into a decentralized one for efficiency, reliability, and environmental reasons, distributed energy resources (DERs), such as rooftop solar panels, wind turbines, inverters, storage devices, electric vehicles, and smart appliances, are increasingly penetrating into the power distribution networks. These DERs are typically located at the customer side and operated for the purpose of supplying all or a portion of the customer's electric loads. They are also capable of injecting power into the transmission/distribution system, creating bidirectional power flows between the customer and the grid. The growth of DERs is driving the grid of the future and would bring tremendous benefits to our society if they can be effectively integrated. However, controlling large numbers of DERs presents a new challenge for operating the power network safely and efficiently. The adverse impacts on power quality of the network associated with high penetration of DERs, especially issues related to power fluctuations caused by intermittent renewable energy sources, have caused great concerns for the distribution network operators. Also, it becomes hard to instantaneously balance supply and demand for ensuring grid stability due to the distributed and uncertain nature of DERs. The goal of this book is to provide a hierarchical architecture for DER management and present stochastic optimization methods for resource management under the architecture. The targeted audiences are researchers interested in stochastic optimization for DER management, in particular graduate students. It is also our hope that this book can be useful as a quick reference to experts.

This book starts with an introduction on DERs and research challenges for managing DERs in smart grids. Then, a novel hierarchical architecture tailored for managing DERs in smart grids is introduced. Under this architecture, approaches are presented to manage DERs at different levels (i.e., home level, neighborhood level, network level) of this architecture. Different objectives and constraints are considered when formulating the problems at different levels. Stochastic optimization methods that are suitable for implementation at each level are described to solve the formulated problems.

Some of the calculations and proofs involved are mathematical and can be safely skipped in first reading. Nevertheless, we decided to include them because they either illustrate useful analytical skills or provide details that are missing in the original papers. Due to the limited time, space, and of course our knowledge and ability, the content of this book is far from extensive. It only includes closely related literature that we are mostly familiar with.

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