

PREFACE

This book is intended to bridge the gap between formal engineering texts and more popularly accessible descriptions of electric power technology. I discovered this gap as a graduate student struggling to understand power systems—especially transmission and distribution systems—which had always fascinated me but which now invited serious study in the context of research on implementing solar energy. Although I had studied physics as an undergraduate, I found the subject of power systems difficult and intimidating.

The available literature seemed to fall into two categories: easy-to-read, qualitative descriptions of the electric grid for the layperson, on the one hand, and highly technical books and papers, on the other hand, written for professionals and electrical engineering majors. The second category had the information I needed, but was guarded by a layer of impenetrable phasor diagrams and other symbolism that obviously required a special sort of initiation.

I was extremely fortunate to have access to some of the most highly respected scholars in the field at the University of California, Berkeley, who were also generous, patient, and gifted teachers. Thus I survived Leon Chua's formidable course on circuit analysis, followed by two semesters of power engineering with Felix Wu. This curriculum hardly made me an expert, but it did enable me to decipher the language of the academic and professional literature and identify the issues relevant to my work.

I enjoyed another marvelous learning opportunity through a research project beginning in 1989 at several large nuclear and fossil-fueled steam generation plants, where our team interviewed the staff as part of a study of "High-Reliability Organizations." My own subsequent research on power distribution took me into the field with five U.S. utilities and one in Germany. Aside from the many intriguing things we learned about the operating culture in these settings, I discovered how clearly the power plant staff could often explain technical concepts about their working systems. Their language was characteristically plain and direct, and was always guided by practical considerations, such as what this dial tells you, or what happens when you push that button.

In hindsight, the defining moment for inspiring this book occurred in the Pittsburg control room when I revealed my ignorance about reactive power (just after having boasted about my physics degree, to the operators' benign amusement). They generously supplied me with a copy of the plant operating manual, which turned out to contain the single most lucid and comprehensible explanation of electric generators,

including reactive power, I had seen. That manual proved to me that it is possible to write about electric power systems in a way that is accessible to audiences who have not undergone the initiation rites of electrical engineering, but who nevertheless want to get the real story. This experience suggested there might be other people much like myself—outside the power industry, but vitally concerned with it—who could benefit from such a practical approach.

After finishing my dissertation in 1995, I decided to give it a try: My goal was to write the book that I would have liked to read as a student six or seven years earlier. Considering that it has taken almost a decade to achieve, this turned out to be a much more ambitious undertaking than I imagined at the outset. A guiding principle throughout my writing process was to assume a minimum of prior knowledge on the part of the readers while trying to relate as much as possible to their direct experience, thus building a conceptual and intuitive understanding from the ground up. I hope the book will serve as a useful reference, and perhaps even as a source of further inspiration for others to study the rich and complex subject of electric power.

I envision two main audiences for this book. The first consists of students and researchers who are learning about electric circuits and power system engineering in an academic setting, and who feel that their understanding would be enhanced by a qualitative, conceptual emphasis to complement the quantitative methods stressed in technical courses. This audience might include students of diverse backgrounds or differing levels of preparation, perhaps transferring into an engineering program from other disciplines. Such students often need to solidify their understanding of basic information presumed to be second nature for advanced undergraduates in technical fields. As a supplement to standard engineering texts, this volume aims to provide a clear and accessible review of units, definitions, and fundamental physical principles; to explain in words some of the ideas conventionally shown by equations; to contextualize information, showing connections among different topics and pointing out their relevance; and to offer a glimpse into the practical world of the electric power industry.

The second major audience consists of professionals working in and around the power industry whose educational background may not be in electrical engineering, but who wish to become more familiar with the technical details and the theoretical underpinnings of the system they deal with. This group might include analysts and administrators and managers coming from the fields of business, economics, law, or public policy, as well as individuals with technical or multidisciplinary training in areas other than power engineering. In view of the scope and importance of contemporary policy decisions about electricity supply and delivery, both in the United States and abroad—from the siting of power generation and transmission facilities to market regulation and restructuring—a real need appears for a coherent, general education on the subject of power systems. My hope is that this volume can make a meaningful contribution.