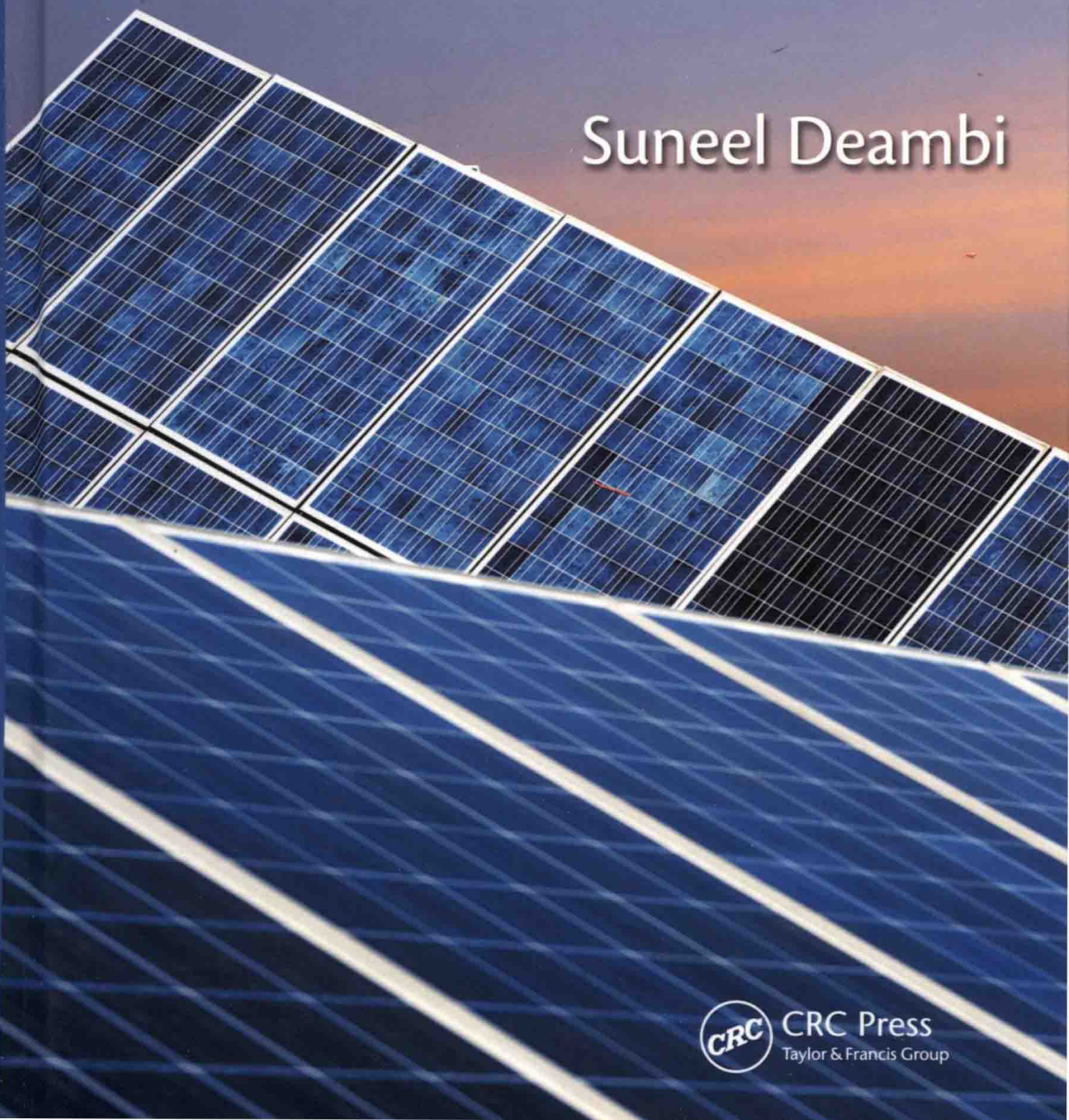
Photovoltaic System Design

Procedures, Tools and Applications



Suneel Deambi

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Preface

The world is currently assuming the form of a close-knit communication platform with or without access to electricity in several parts. Mobile telephony is fast spreading its wings far and wide, with those hooked on to it finding one channel or another to charge a mobile phone, for instance. Incidentally, there are several villages in India where electricity is unavailable, but happy phone users commute to adjacent areas to charge their phones. This raises the pertinent question of whether one can continue to live without electricity but not without a mobile phone. Of course, securing electricity access far outweighs other considerations, but it is simply unavoidable to align with modern-day transformations. This brings into focus the role of clean, safe and reliable green technologies such as solar photovoltaics (PV). Today, the role of PV technology is far more etched in several ways than ever before. Rooftops are fast becoming the agents of new change in terms of accommodating solar PV panels along with a mushrooming number of direct-to-home (DTH) dishes for viewing TV programmes. The list of end users taking an early recourse to PV system adoption grows by the day. Now, 'solar' is no longer an alien word, but the real issue hovers around its long-term reliable use.

It is worth mentioning here the repeatedly talked about number of ill-performing PV systems for various end-use applications, including lighting, water pumping, battery

charging (for multiple uses) and, most importantly, power generation. We should also keep in view the fact that non-solar appliances malfunction at times. So solar is no exception on this front. The fact is that PV systems have now become more reliable than ever before, even though it still makes sense to keep monitoring their performance under actual field operating conditions.

Proper selection of a solar-worthy site from all possible considerations is fast becoming a norm rather than a choosy affair. A majority of PV systems now rely on the use of simulation software, for example, to determine power generation. Site resource assessment is now an important activity preceding the actual system sizing procedure. Several PV simulation softwares are currently available in the marketplace with different degrees of actual utilization across the world. However, the underlying logic is to first gain familiarity of the key factors prior to undertaking a system simulation exercise. The moot question is whether manual system sizing procedures are better than simulated procedures any day. Well, the latter techniques offer a plethora of benefits due to the embedded nature of checks and balances within the software.

A larger issue is the capability to utilize the simulation software available in the market today. In a country like India, obtaining an individual licence to softwares is mostly out of the question due to their high costs. However, there are several softwares with identical purposes available for free download most of the time. This brings into the realm of immediate discussion the curiosity of getting the most accurate results while dealing with PV systems under actual field operating conditions. Several parametric considerations delve deeply into the relevant scheme of things so as to suggest that a system simulation activity is not a cakewalk. It needs to be performed with the best of system design and engineering capabilities so as to romp home with a good enough harvest of the expected energy generation. The real need is to devise a true synergy amongst all the factored-in values of actual

importance in the system size estimation and the accompanying values of the expected system performance. Capacity building, vis-à-vis these modern-day tools and procedures, is an important activity of the whole charter, failing which not much can be accomplished on this important front.

According to the market analysis made by GTM Research, global solar PV installations for 2015 touched a high of 59 GW. This marks an increase of around 34% over the total installed PV capacity achieved in 2014. Further, there is an expected cumulative realisation of worldwide PV capacity of about 321 GW by the end of 2016. Geographically, the largest markets, yet again, are China, Japan and the United States as per the available market estimates of a well-known PV market information company with diverse interest in several core areas including energy (i.e. IHS). Grid-connected PV energy storage installations grew in 2015, though not appreciably. Likewise, PV systems up to 100 kWp accounted for as much as 20–30% of global installations. Monocrystalline silicon cell technology is gradually inching forward to retrieve its lost ground to the currently-in-vogue polycrystalline technology. India has recently upscaled its PV installation target to around 1,00,000 MW by 2022, which seems to be a gigantic target by any means. The sunrise technology sector in India is set to gain expanded horizons of use across the diverse sectors of energy economy. This really signals a heightened impetus for spreading awareness about PV simulation tools and procedures in no uncertain terms.

This book lays down a preparatory framework on the diverse aspects of PV technology, applications and programmes from a variety of end-use considerations. It is expected to serve as a basis for realizing expected gains from PV systems while taking recourse to simulation activity. There are eight chapters in the book with clearly spelt-out objectives and expected outcomes. Chapter 1 touches upon the role of renewable energy technologies in a holistic energy scenario in terms of several projected demand and supply scenarios and underlying

solutions. Chapter 2 makes a clear categorization of off-grid and on-grid PV applications while drawing upon the relative advantages and limitations. Chapter 3 highlights the significant promise of solar radiation availability on Earth in terms of vital dependencies on several processes, phenomena and cyclic variations of several elemental considerations. Chapter 4 takes up the issues related to on-site-specific considerations. It is crucial to gain a clear understanding of the issues which may impact the operation and smooth running of PV facilities in one way or another. Chapter 5 involves a basic treatment of the system design considerations from a variety of parametric aspects and site-specific prevalence of the important issues. Chapter 6 introduces PV system sizing procedures via the modern use of simulation software. The specific objective is to draw out clear advantages of basing a system design on the resultant outcome of a simulation activity from a variety of end-use considerations. Each of these softwares holds out relative merits and demerits in terms of its applicability to a given field situation. Chapter 7 presents an analysis of actual PV power plant sites when designed via the use of simulation software. It goes on to determine the weak links in a PV system design-cum-engineering chain, for instance, in terms of the assessed number of failures as attributed to that from real-time monitoring of the systems. Finally, Chapter 8 brings out the clear importance of capacity-making initiatives vis-à-vis the available range of PV simulation software, tools and, most importantly, procedures at large. It takes up a few case-specific examples of education, training and awareness generation activities of a selective few organizations from a practical perspective.

Overall, this book attempts to familiarize interested readers with solar PV technology and its key attributes, end-use applications, system design requirements, influence on climatic and site-specific parameters, utilization of simulation procedures and expected performance levels in an easy-to-understand manner.

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Finally, I dedicate this book to the cherished memory of my late father, Sh. Brij Nath Deambi. My affectionate thanks also go to my wife, Neeru Bhat Deambi, and daughter, Tammana Deambi, for their patience and support throughout the stages of the book preparation.

About the Author

Suneel Deambi, PhD, is a solar energy specialist with practical experience of about 25 years in the renewable energy (RE) sector. His active areas of interest are RE policy, planning, technology, financing, programme implementation, performance evaluation and capacity building initiatives. He is a prolific writer on energy–environment issues with three books to his credit plus a large number of published articles/features/reviews etc. in the leading media of information dissemination.

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