Book Review

Energy Harvesting – A New Publication from DEStech Publication Inc. – A Review

Ravi Anant Kishore, Anthony Marin, Congcong Wu, Ashok Kumar and Shashank Priya: Energy Harvesting: Materials, Physics, and System Design with Practical Examples. DEStech Publications Inc., August 2018, 280 pages. Hard Cover $144.50, eBook $99.50.

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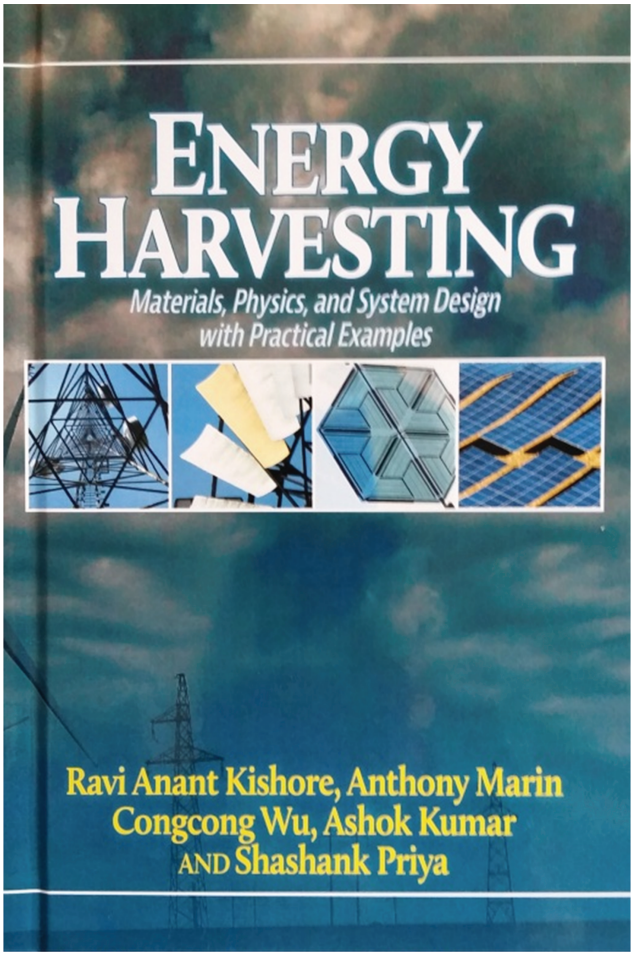

The world we live in rapidly transforms into a world of data. While we get used to documenting and broadcasting our social activities, personal opinions and customer interests on widely popular networks, the physical world around us prepares for a new revolution where things start to speak, start to share information, start to communicate data. At the brink to this evolution, the focus is set on small or miniaturized low-energy devices such as sensors, actuators, transducers, receivers, transmitters, power generators and so forth. Integrated into walls and attached to surfaces, these devices will be able to collect, process and transmit relevant data from buildings, transport systems, industrial machinery, household appliances or even the human body by linking themselves to any wireless network within reach. Thereby, maintenance routines, continuous monitoring, as well as automated decision making will become increasingly part of our industrial, our socioeconomic culture. A perfected integration into objects, however, limits accessibility: it will become increasingly impractical to power these devices with conventional short-lived batteries which require manual exchange or recharging. This is where *Energy Harvesting* comes into play. Provided that the devices can be empowered by energy, directly extracted from the environment, a nearly unlimited life-span makes this integration concept feasible. The relatively young research field of Energy Harvesting is a specialized subject on its own, and it is growing fast at the pace of increasing demands for smart sensors and monitoring devices in novel network-based manufacturing and maintenance concepts. The growing interest also necessitates that the currently available knowledge about this field is comprehensibly transferred from experts to a wider audience in order to foster education, research and exchange between scientific disciplines involved. An (incomplete) search in the literature for Energy Harvesting related publications results in some sixty findings published not earlier than within the last decade. Among them only a handful deals with the topic in a sufficiently surveying way while most choose to pick a special aspect only such as vibrational, thermal or photovoltaic energy harvesting and elaborate on this area to the detail.

With the new book *Energy Harvesting* by R. A. Kishore, A. M. C. Wu, A. Kumar, and S. Priya from DES*tech* Publications, the demand for an up-to-date edition, likewise suitable for the interested student, the active researcher and the university lecturer, is met in a very convincing way. What type of energy harvesting can be applied? What is the physics, what is the mathematics behind it? Which sort of materials can be used to convert energy from one form to another? How do basic device designs look like? All of these questions and much more are addressed in this book devised by some of the leading experts in this field and supported by a plenty of instructive graphics, schematics, and photos of actual prototypes. In the introductory part, *Overview of Energy Harvesting*, we are introduced to the various methods by which energy can be extracted from the environment: vibrational, thermoelectric, photovoltaic and wind energy harvesting. This chapter presents some basic mathematical treatment, quantitative assessment of the available energy and provides first examples of application. With a look on electric circuitry and energy storage elements the chapter completes and leads to the following paragraphs with in-depth descriptions. The reader is thereby comprehensively guided along the essential cornerstones of energy harvesting as outlined in the introduction. Owing to the importance of the conversion process of mechanical to electrical energy, this next section fills approximately hundred pages and elaborates on the principles of electromagnetic (inductive), piezoelectric and magnetostrictive techniques. Further energy harvesting concepts such as thermoelectric and photovoltaic energy harvesting are covered in the subsequent two chapters, and the authors succeed to impart sufficient knowledge on semiconductor physics to make the underlying physics comprehendible. Browsing through the following chapter on wind energy harvesting, the reader should not be fooled by thinking on high-rise megawatt systems decorating the horizon. In fact, small- and micro-scale wind turbines with rotor diameters down to 10 cm fit in well in the conceptual strategies of energy harvesting for low-energy devices. The background theory here is less demanding, and only geometrical and engineering considerations require the reader's attention. Finally, the authors provide a summary on less established techniques such as the shape memory alloy heat engine, thermomagnetic and electrostatic energy harvesting. Throughout the text, the relevant physics and mathematics, necessary for the understanding of the respective subject, is outlined and mostly does not require deeper knowledge than an undergraduate has already on hand after some semesters. At one point or the other, the curious reader may feel the need for further reference work to achieve deeper insight on how some mathematical formulas are derived, as e. g. in electromagnetics, or to understand the specifications of certain types of solar cells. In general, however, the included background theory is presented in a precise, clear and fully sufficient way to focus just on the essentials. Furthermore, for more complex problems the authors employed numerical simulations, using ANSYS, and provide some example coding in the appendix. Here, future editions of the book might consider a brief introduction into the matter. Numerical simulations are quintessential to assess advanced prototype designs which rarely fit into the narrow framework of mathematical basics. Some words on this topic, the implementation of the problems in finite-element simulations, and a basic introduction into model development by this (or any other software) can have an important educational impact on students to prepare them for 'real-world' problems and their solutions. Beside this potential improvement, the authors generally have to be acknowledged for choosing an application-oriented approach throughout the chapters. They provide, wherever possible, prototype designs which illustrate important working examples. One final word on the excellent design of the chapters: the authors decided not only to retrospect on the history of the respective technologies for each individual topic but also to include commentary on the state-of-the-art and on envisaged future developments. This conceptual structure makes the book particularly worth reading and entertaining, and the less experienced reader will benefit from this holistic expert view. Congratulation for this excellent edition!

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