Chapter 10
Energy Harvesting Systems:
A Detailed Comparison of Existing Models

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ABSTRACT

For the past few decades, the scientific community has been paying attention to energy harvesters to reduce the use of batteries as the main power source for IoT devices and MEMS. Energy harvesters allow for the use of ambient energy, mostly a by-product of an application, to generate electricity while relying on batteries as a backup option to store the excess energy. This chapter includes a review of each energy harvester type, subtype, configuration, usage, and power output to understand the different kinds of energy harvesters and motivate a discussion between their advantages and limitations. The chapter also discusses the advantages and the limitations of current storage options for energy harvesting and how applications can benefit from future research in this area. The chapter concludes with a discussion of the challenges and future opportunities still open in the field of energy harvesters to obtain more reliable, cleaner, and cheaper energy sources.

INTRODUCTION TO ENERGY HARVESTING SYSTEMS

For the past few decades, the scientific community has been paying attention to energy harvesters to reduce the use of batteries as the main power source for IoT devices and MEMS. Energy harvesters use ambient energy, mostly a by-product of an application, to generate electricity while relying on batteries as a backup option to store the excess energy.

Low-power electronics in medical equipment, transportation, consumer devices, military, diagnostic systems, and industrial controls are the most suitable targets for energy harvesters. The goal is to reach self-sufficient, self-powered systems that rely on their surrounds as their source of energy (Ahmed,

DOI: 10.4018/978-1-6684-7684-0.ch010

2021; Foong et al., 2021; Nayak et al., 2021). The currently used harvesters reduce a device's battery dependence as the main power supply by using the kinetic energy of movement, thermal energy given by the gears' motion within a device, or other types of ambient energy. However, these devices still rely on a system battery as their main source of energy (Chetto & Queudet, 2016; Kim et al., 2009).

The most common source of ambient energy used in harvesters is vibration energy, as it is intrinsic to all materials as part of the natural vibration of atoms. Other types of harvesters include thermal, wind, radio frequency, solar, pyroelectric, geothermal, and a combination of all or some of these previously mentioned types (Safaei et al., 2019). Figure 1 shows the general classification of energy harvesters depending on the energy source.

This chapter provides an encompassing review of many energy harvester types, subtypes, configurations, usage, and power output to understand the different energy harvesters and motivate a discussion between their advantages and limitations. The chapter also discusses the advantages and the limitations of current storage options for energy harvesting and how applications can benefit from future research in this area. The chapter concludes with a discussion of the challenges and future opportunities still open in the field of energy harvesters to obtain more reliable, cleaner, and cheaper energy sources.

Figure 1. Classification of energy harvesters in relation to the energy source