

## Open Thesis / Project

# Profiling and Emulating Energy Harvesting Devices for a Battery-free IoT

### Thesis Type

Bachelor Thesis / Master Project / Master Thesis

### Motivation

The Internet of Things is growing rapidly and connects a huge number of constrained, wireless devices. Nowadays, these types of devices are typically battery-powered and thus their deployment is both costly in terms of maintenance (i.e., battery replacement) and environmental impact (i.e., battery disposal). To overcome these drawbacks, recent efforts have been made to develop *battery-free* devices powered by ambient energy (light, wind, vibrations, etc.). These systems consist of an energy harvester (e.g., solar panel) that extracts energy from the environment, a capacitor to buffer small amounts of energy, and a computing device. Compared to batteries, the energy provided by harvesters varies significantly and unpredictably over time. To cope with the limited and fluctuating energy availability, sophisticated hardware and software solutions are required. However, the development, debugging and, in particular, the evaluation of such systems is difficult, as the harvested energy highly depends on the environmental power sources and is thus hard to be reproduced in the lab. One option to deal with this problem is the use of *emulators*. Energy harvesting emulators can record harvesting conditions and replay the ‘harvested power’ accurately to a test device running in the lab. It is a valuable tool to explore and understand the potentials of different harvester devices and to allow proper application development, debugging and evaluation of battery-free systems.



### Goals and Tasks

Within this context, the student can explore several directions and perform different tasks:

- Rebuild an emulator for energy harvesting (e.g., Ekho), including both hardware and software support;
- Record and profile different off-the-shelf harvesting devices in diverse environments;
- Based on the found database of recordings, build an emulation system to allow fast and easy evaluation in the lab;
- Investigate the provided energy patterns of harvesting devices and set them into context to the power consumption of different sensor nodes and their applications.

### Target Group

- Students of Electrical Engineering (EE), Information and Computer Engineering (ICE), and Computer Science (CS).

### Required Prior Knowledge

- Excellent C programming skills;
- Experience with embedded platforms, circuit design, and DIY electronics is of advantage.

### Contact Person

- DI Hannah Brunner  
hannah.brunner@tugraz.at
- Assoc. Prof. Carlo Alberto Boano  
cboano@tugraz.at

