# GreenPeak about Energy Harvesting

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Energy Harvesting, Ambient Energy Sourcing, Energy Scavenging... different terms to mean very much the same thing: extract energy from the environment to drive electronics circuits independent from the mains power or from a battery.

The “raison d’être” of energy harvesting in wireless sensor applications is straightforward: ridding the data cable to read the sensor value solves only half of the problem: the installer still needs to run a power wire. And half a problem solved is as good as not solving it at all. Furthermore, replacing the mains power by a battery substitutes the wiring cost by a battery replacement problem, which is not an advance at all.

Energy from the environment is plentiful: solar light, vibration or motion are generally well understood. Example applications include soil acidity monitoring in precision farming using solar cells and motor monitoring in an industrial plant using vibration collectors. Vibration is already used widely in a well known consumer application: wrist-watches that do not need a battery nor rewinding.

But also less obvious sources can generate sufficient energy to power a wireless sensor system: the temperature difference between two touching surfaces - such as a pipe carrying warm liquids and the surrounding atmosphere - can be used to drive a pressure sensor and the wireless communication system. Furthermore, the temperature difference between the human body and its environment enables some very interesting applications in health monitoring: a temperature difference of 9 °F (5 °C) generates sufficient power for real-world applications. Another interesting finding is that indoor lighting can actually be used, for example, to power a wireless light switch.

Energy harvesting not only reduces the maintenance effort by ridding the batteries, it also provides an effective answer to an ever growing awareness for the need for *green* appliances: appliances that do not present a liability to the environment. At the next level, at GreenPeak we strongly believe in the additional *positive* effect of driving wireless sensor applications on energy harvested sources: they are increasingly deployed in more and more in applications as a *key enabler* to increase the level of environmental friendliness of the application, something that would not have been possible through a wired communication network. The example is leak

detection in far-out oil pipes: retrofitting a cable to wire together all sensors is not economically viable even in the light of the enormous burden to the environment that oil leaks cause. Conversely, a wireless network based on energy harvesting is fairly cheap and straightforward to install.

The challenge in energy harvesting lies not in identifying the energy source, but in (A) efficiently converting the energy source into electric energy and (B) carefully managing the health of the energy source and transforming the electric energy in a form appropriate for the electronic circuits, wireless as well as sensor related.

Startups and large technology companies alike have embraced challenge (A): the energy conversion stage. GreenPeak forms partnerships with the leading providers of these systems in order to support the widest range of energy sources to accommodate the needs of a broad span of wireless sensor applications.

Challenge (B), the energy source monitoring, management and energy transformation is an essential ingredient in the GreenPeak offering. Managing the energy source requires careful consideration of how the energy is “leaked” to the environment. An informative example is how a solar cell in the outdoors generates small bits of energy during the day and then usually shuts down completely during the night. The small energy bits need to be collected and transferred to a useful voltage and current level or the electronics. Moreover, the on-board energy management algorithms carefully measure the state of the energy source to distinguish between *healthy*, *intermediate* and *alarm* states. The state is an essential piece of information for the application to take appropriate action, such as setting itself in a fail-safe state.

A quite different example is a piezo-electric energy harvester. Such as device can be integrated in a light switch to convert the movement of a switch depression into electric energy. This energy is bursty in nature. It requires careful management of the total available energy, because the system has to perform the full communication task with this one-off spike of energy, because it has no ability to know when the next push of the switch or “energy reload” will take place.

The energy monitoring and management functionality is embedded in the GreenPeak products, effectively replacing a separate functional block in the system to take care of this task, typically including a microprocessor and analog components for monitoring the status of the energy source. And in cost sensitive applications - which most sensor applications are - a higher level of

system integration has a direct impact on cost. Conversely, by integrating these functionalities within the communication system, a lower system cost is achieved, enabling new applications, otherwise beyond the reach of wireless communication technology.