Energy Harvesting for Electronic Systems

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With the ever decreasing power consumption of low level electronics new ways of powering products are on the rise. It is now not only possible to power small electronic devices through batteries and cables but also through energy found in everyday environments.

There are products on the market today with such a low power requirement that they can be powered by their own environment. This technology is called energy harvesting. The devices powered by energy harvesting essentially works as tiny power plants meaning they provide a small relief to the power grid. This offers the possibility to avoid battery exchange and power cables. Avoiding this can be very beneficial in places hard to reach for maintenance or where mobility is of significance.

An example of low power products possible to power with energy harvesting are wireless sensor nodes. Wireless sensor nodes are self-powered sensors communicating with each other over a network. These can for example be combined with temperature, occupation or tracking sensors.

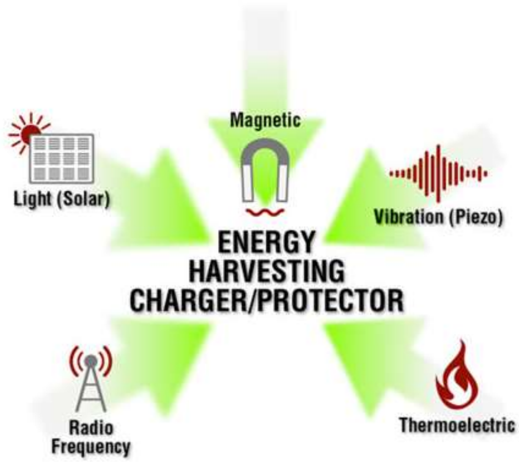

Figure 1. Energy harvesting technologies. Source: maxim integrated.

This thesis evaluates the most promising or popular energy harvesting technologies. The focus lies on the amount of energy that can be harvested and how limited the technology is to a specific environment. The technologies evaluated are photovoltaic, electromagnetic, piezoelectric, thermoelectric and radiofrequency generators.

Photovoltaic cells are relatively easy to use and it is not difficult to find an environment with a sufficient amount of energy for a practical purpose. However, there are different types of photovoltaic cells suitable for different environments. Amorphous cells are best suited for indoor lighting and monocrystalline cells are best in outdoor sunlight. One of the prototypes is based on amorphous cells and manages to harvest an average of 152 µW in indoor office lighting. This prototype proves that a sufficient amount of energy can be harvested in indoor office lighting for a practical purpose.

Electromagnetic harvesters utilizes electromagnetism to convert movement into electricity. The movement can be both vibrational and rotational. Vibration generators work best when something is vibrating at a certain frequency. It is difficult to make a small generator that works with vibrations found in everyday environments. Rotation generators can be made out of electromagnetic motors. In the thesis one of these are mounted on an office door. There is enough energy harvested to use it with, for example, an *Internet of Things* application.

Thermoelectric generators can be very useful where a continuous temperature difference can be found, for example in combustion engines in cars. This continuous temperature difference is not easy to find in many everyday environments. Piezoelectric harvesters are vibration dependent, making them difficult to use in many environments. The energy available for radiofrequency harvesters is too low for a useful energy harvesting application.

To conclude, photovoltaic cells and electromagnetic harvesters are the most promising harvesting techniques. The other methods were not found to be as useful as the photovoltaic cells or electromagnetic harvesters, since they require very specific environments to generate a usable amount of energy.