

# Energy harvesting

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## Concept of Energy harvesting

Energy harvesting is a technology that allows to capture otherwise unused ambient energy (such as vibration, strain, temperature gradients, energy of gas and liquid flows) and convert into usable electrical energy which is stored and used for performing sensing or actuation. Energy harvesting is a perfect match for wireless devices and wireless sensor networks that otherwise rely on battery power.

Benefits of Energy harvesting Energy harvesting provides numerous benefits to the end user. Energy harvesting solutions can:

- Reduce dependency on battery power. Harvested ambient energy may be sufficient to eliminate battery completely. The device can be powered only from by the harvester and rely on internal energy storage to smooth out variations in available ambient energy.
- Reduce installation costs. Self-powered wireless sensors do require wires, conduits and are very easy to install.
- Reduce maintenance costs. Energy harvesting allows for devices to function unattended and eliminates service visits to replace batteries.
- Provide sensing and actuation capabilities in hard-to-access in hazardous environments on a continuous basis.
- Provide long-term solutions. A reliable self-powered device will remain functional virtually as long as the ambient energy is available. Self-powered devices are perfectly suited for long-term applications looking at decades of monitoring.
- Reduce environmental impact. Energy harvesting can eliminate the need for millions on batteries and energy costs of battery replacements.

## Types of energy harvesting

The type of energy harvesting depends on the kind of energy that is tapped into for powering the device. Usually the following types of energy harvesting are distinguished:

Radiant energy harvesting. Harvesting solar energy is probably the oldest way for powering of electronic devices.

Mechanical energy harvesting. Mechanical energy of vibration or strain is converted into electrical through various techniques.

Thermal energy harvesting. Relies of thermoelectric effect to convert thermal gradients into useful energy.

## Electromagnetic energy harvesting

An electromagnetic harvester uses the principle of a spring-mass system to convert energy of vibration into electrical energy.

The same principle is used in our electromagnetic harvester for highway bridges .

In this specific example, vibration of a highway bridge or overpass is created by traffic passing over on top.

Mass and geometry of the structure dictated that the strongest vibration occurs at low frequencies that are on the order of few Hz.

Nevertheless, displacement of structural element is not that great and need to be amplified through the resonance.

The frequency of the harvester is finely matched to the vibration frequency of the bridge by adjusting the spring's parameters.

Mechanical motion of the mass is converted into electrical energy by electromagnetic coupling between the magnet(s) attached to the mass and stationary coil(s).

What can one do with harvested energy?

Levels of harvested energy may vary significantly from application to application. Large solar panels can produce enough energy to power a house. An energy harvester used with wireless sensors can produce from microwatts to milliwatts of power. Therefore spare usage of available energy is of utmost importance. Energy accumulated over a period of time can be used to perform a sensor measurement and a wireless transmission of data.

Here we list a few examples showing practical use of harvested energy:

- Highway bridge monitoring
- Energy harvesting in a passenger car

Links to energy harvesting resources

Wikipedia about energy harvesting