Energy Harvesting Circuits in one page

Two important Notions
Energy = V * I (voltage times current)
Voltage = potential energy per unit current, every “active” electronic component works on a specific voltage. More voltage = death. Less voltage = not functioning. One needs 2-3V for a LED or a microcontroller, wireless, BLE

Circuit=> Boost: (low voltage to a higher voltage), Buck (high to low voltage)

Induction principle: because of the building of the magnetic field a coil “resists” starting voltage ⇔ voltage “persist” if the magnetic field is in place, when switching off current, this means current and voltage when the circuit is already open. When current is still flowing to an open point, voltage is built up. This effect is used to “boost” a low voltage to a higher voltage.

Examples, with LED

1: Simple circuit with a coil and a switch. A Capacitor is added to store the energy. The switch can be closed and openend. The frequency of closing and opening determines the resulting voltage.

2: The manual switch can be replaced by a transistor. The base of the transistor is included in the coil, so the switching becomes “automatic”. This circuit is called a “Joule Thief” because it seems that the energy for an LED at 3V is “stolen” from a battery of 1.5V or even an “empty” battery. Of course no “free” energy” is used, but the low voltage of the empty battery is boosted to the 3V, if the battery is really exhausted, nothing can be done anymore.

3: Professional Joule Thiefs (Step Up converters, from AAA, AA to 3 – 5V)

Examples in summercamp: MCP1640, NCP1400

4: Energy harvesting chips. Needed is 3-5V. Meant for sending data once in a while. Many sources of energy having either very low voltage, or very high voltage – combined with very low current. Varying voltage – solar cells. Special chips are developed to make the process of collecting low energies very efficient. Other chips are developed who are able to cope with high voltage and make it lower (“buck circuits”). This in combination with smart storing of energy in supercaps.

Demo Examples in summercamp:

LTC3105 – Solar, “normal” low voltage, variable voltage and current

LTC3109 –peltier, low voltage, low current

LTC3588 – Piezo, high voltage, low current