

The Internet of Things Energy Considerations

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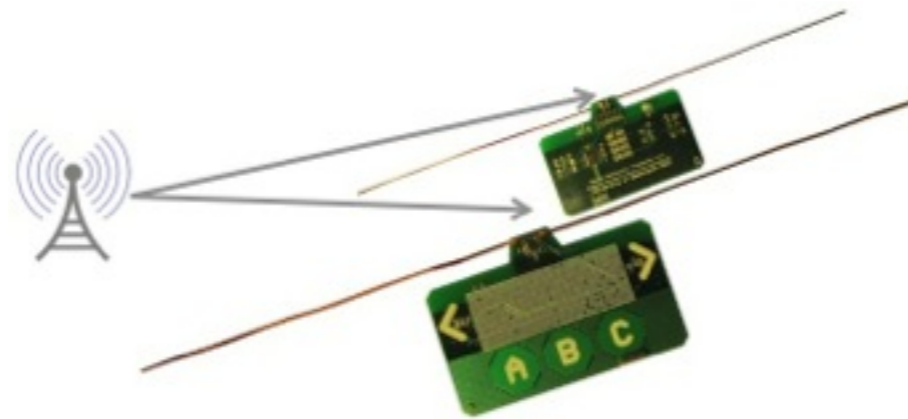


Energy System Considerations

- Amount of Power Required
- Stationary or Mobile Application
- Robustness
- Physical Size
- Level of Human Interaction Required
- Technological Maturity

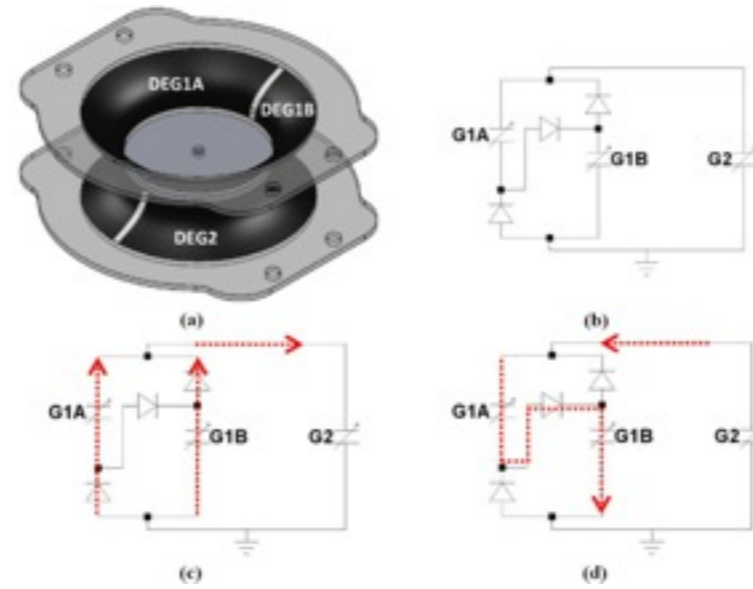
Power Generation

Ambient Backscatter



Ambient Backscatter transforms existing wireless signals into both a source of power and a communication medium. It enables two battery-free devices to communicate by backscattering existing wireless signals. Backscatter communication is orders of magnitude more power-efficient than traditional radio communication. Further, since it leverages the ambient RF signals that are already around us, it does not require a dedicated power infrastructure as in RFID.

Biomechanical



Biomechanical is an area that hasn't quite reached prime time. In recent years patents have been filed for materials like this one that you could stick in a pair of shoes to generate electricity just by walking.

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 UNIVERSITY OF OREGON

 NSRC
Nonlinear Systems Research Center

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Induction



Induction power is achieved by a device that produces voltage when exposed to a magnetic field. It's typically used in near-contact situations where having a cable would be inconvenient - like recharging a wireless toothbrush, and for near-field communications devices. My bus pass is an NFC device that has a microprocessor and runs javaOS. It can power on, boot up, conduct a transaction, and shut down all in 200ms.

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Electro-Magnetic



If you've ever seen a flashlight that you shake to use, or a radio that you turn a crank to power up, you've seen mechanical power. The device above is a GravityLight, an LED lamp that gets powered by a weight attached to a cord that turns its generator for about 30 minutes. Mechanical power is great if you've got a person around a place with no electricity - say a bus stop in a remote location.

Electro-Magnetic

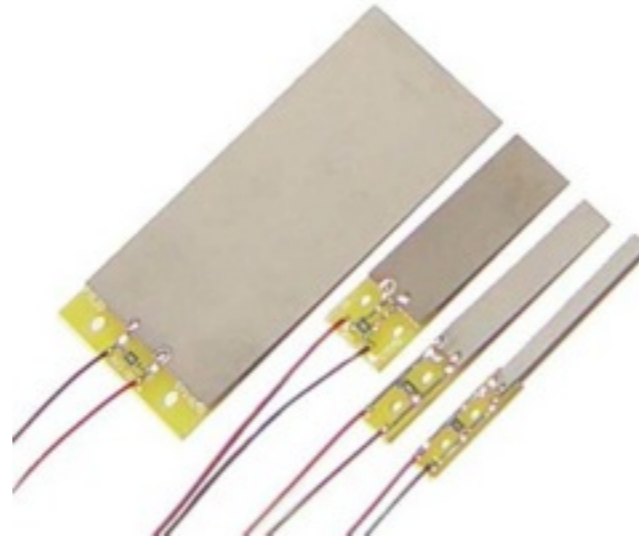


Micro-Hydro (Electro-Magnetic)



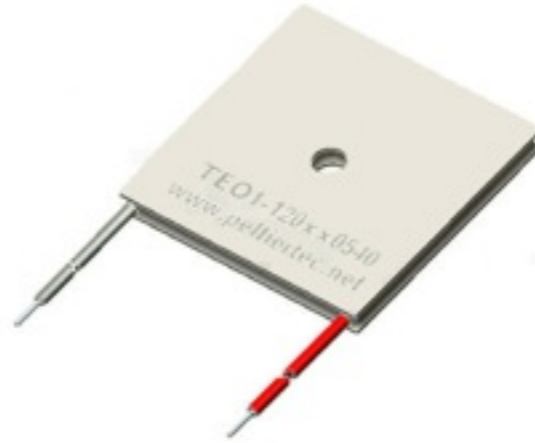
This particular micro-hydro generator is actually a complete power supply - it has a battery and charge controller embedded in it. Others just have a generator component. If you've got clean, filtered fresh water nearby, micro-hydro might be a good fit for your application.

Piezoelectric



Tiny amounts of electricity can be produced with piezoelectric elements - for example when you press a mechanical button to light a burner on a gas stove, the spark that lights your gas often comes from a piezoelectric element. These panels are meant to vibrate when you apply power to them, but the opposite will work too - vibrate them the right way and they will produce electricity. As with ambient backscatter and biomechanical methods, I haven't listed a price next to Piezoelectric power generation - for now it's the domain of experimenters and inventors.

Thermoelectric



Peltier devices like this one translate differences in heat into electricity. The bigger the difference between hot and cold, the better they work. Last year a company called Biolite released a couple of woodstoves with Peltier based thermoelectric devices embedded in them. Power from the peltier is used to drive a fan, causing the fire to burn hotter and cleaner, while extra power is sent to a USB port for charging phones or rechargeable lights.

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Solar



Finally we have solar. This two-watt panel is a bit bigger than my hand, and costs less than ten Euros. I understand Sebastian is going to talk about solar power later in the week, so I'll leave it to him.

Solar



Power Storage

Power Storage: Considerations

- One-Use or Renewable
- Capacity of Storage
- Lifetime / Charge Cycles
- Current Required
- Physical Size
- Environmental Impact

Alkaline Battery



Standard alkaline batteries have a long storage life and a relatively high capacity when used for low power applications. They're cheap, and the world treats them as disposable, consuming around 15 billion a year. Alkaline batteries made today are generally free of toxic heavy metals, but they're still a waste of resources.

Lead Acid Battery



Lead Acid batteries are the most common rechargeable batteries made, and are used in vehicles, alarm systems, solar installations, and most cellular and wireless base stations. They're not as energy-dense as Lithium-Ion batteries, but they're a lot cheaper. Depending on how they're made, they can last from a few years up to two decades, retaining a large amount of their charging capacity.

Lithium Battery



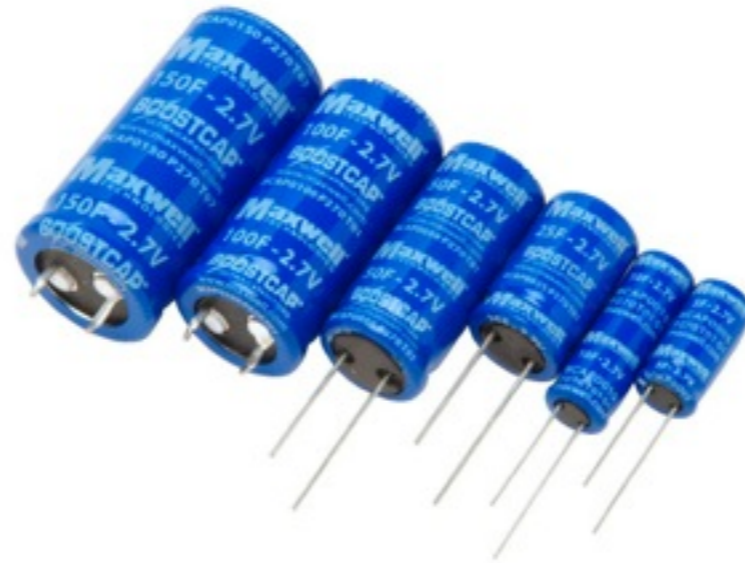
This Lithium battery is a one-use, non-rechargeable battery. It's got a lifespan of more than ten years, and if use carefully, will power a device with intermittent usage over all that time. Internet of Things company Taggle combines single-use lithium batteries with PICmicro processors and their own proprietary radios, and claim with a D-cell battery they can transmit data from a sensor to their network once an hour for ten years.

Lithium Ion Battery



Lithium ion and lithium polymer batteries are the most common batteries used in electronics today. They've largely replaced older technologies like Nickel metal hydride, and they're starting to replace lead acid for applications where size and weight matter. Lithium Ion batteries lose a bit of capacity with every charge, and rarely last more than 1000 charges. If you're charging via solar every day, don't expect your batteries to last more than three years.

Super/Ultra Capacitor



A capacitor can be an inexpensive way to collect and use power very quickly. Why use a supercap and not a battery? For their size, supercaps only hold 10% of the energy of a similar sized battery, but they can charge and discharge 10x as fast, and they can charge many, many more times than a rechargeable battery without wearing out.