

Energy Harvesting Brings Sustainability to the IoT

The Internet of Things is revolutionizing many industries and devices, but serious problems arise when it comes to its dependency on batteries. So, what's the answer to the ecological and economic side effects of the IoT revolution?

The Internet of Things (IoT) revolution has cut across myriad industries, clearing the way for innovation on multiple levels let alone significant economic growth. New IoT deployments are happening daily with sensors, beacons, and other connected devices in smart homes, smart cities, retail, and industrial settings.

However, these connected devices have created a serious problem with their dependency on batteries. Billions of batteries get disposed of each year, contaminating the world's landfills with dangerous toxins like lead and lithium. When you couple that with the maintenance costs incurred by consumers and businesses constantly replacing dead batteries, you start to understand the unintended ecological and economic problems created by the IoT revolution.

To help resolve this issue, the tech industry is now embracing energy harvesting, which can extend battery life or even eliminate batteries entirely. Energy harvesting captures energy from ambient sources such as RF waves, light, thermal gradients, or mechanical motion to power IoT devices.

The best energy-harvesting method for an application will vary depending on both the environment and the device's operational requirements. So, while a deployment in an office or retail environment might be able to rely on ambient light to power IoT devices, harvesting thermal energy or mechanical motion from operating machinery can make more sense in a factory.

Solving the Battery Dilemma

The most common approach to extending battery life is to use a low-power radio communications standard like Bluetooth Low Energy. BLE is optimized for the transmission of short bursts of data and has the flexibility to meet the connectivity requirements of most IoT applications.

Another feature that can reduce device power consumption is "on-demand wakeup." On-demand wakeup tech-

nology enables a device to seek a specific RF-transmission signature while maintaining a very-low-power state. This on-demand wakeup feature, which can be built into a system on chip (SoC), uses a separate very-low-power RF receive path that can be configured to pattern-match for one or multiple RF signatures. It will indicate, for instance, that the device should wake up for an incoming message or report out its status.

The use of multiple signatures allows for signaling to either a single device or a group of them as required. Once the RF signature is received, the rest of the SoC wakes up and performs any functions needed to complete the desired operation.

With this technique, the SoC's processor uses the primary connectivity radio (transmitter and receiver) only when required, further reducing a device's power consumption and extending battery life. When employed with a low-power radio design, this on-demand technique can reduce power consumption by up to 100X relative to other competitive low-power wireless solutions, depending on the specific application.

New Energy-Storage Models

By adding energy harvesting to the mix, new models of energy storage and usage can support extending the lifetime of batteries or even eliminate batteries entirely. The simplest implementations use energy harvesting to power the device when energy is available and revert back to a standard battery when any stored harvested energy is exhausted.

Depending on the application, its energy requirements, and the effectiveness of the harvesting method, when combined with a very-low-power wireless solution, a single battery may last the entire lifetime of the device. As an alternative, harvested energy can be used to trickle-charge a rechargeable battery to ensure operation during extended periods when harvested energy isn't available.

Battery-free operation is possible when the device is required to operate only when harvested energy is available or uses battery-free energy storage (like a supercapacitor) to extend operation. Devices in environments with a consistent source of harvested energy can operate completely maintenance-free in this configuration.

The combination of Bluetooth technology and the ultra-low-power technology helps keep overall device power consumption low enough for devices to use harvested RF, light, motion, or heat energy. And still it provides the range and coverage equivalent to many other standards-driven wireless devices.

Key Industries for Energy Harvesting

Energy-harvesting technology is a game-changer for countless industries. It provides an abundance of applications with enough power to render batteries unnecessary. Some examples include:

Retail

Programmable electronic shelf labels (ESLs) and other digital signage are quickly gaining popularity among retailers. ESL and digital signage allow managers to apply price changes and inventory adjustments quickly and automatically across product lines with just a few keystrokes.

With energy harvesting in place, retailers can deploy ESLs effortlessly without worrying about the maintenance time of replacing batteries as units deplete at similar rates. Retailers also can enjoy the cost savings that come from not constantly replacing the batteries typically found in these digital signs.

Smart Cities

As cities around the world continue to “go smart,” millions more connected devices are required to keep these cities running smoothly. Such solutions include sensors that can monitor temperature, humidity, air quality, the presence of gas, and more.

Smart cities use IoT devices to collect and analyze data that’s applied to improve infrastructure, public utilities, and services. By employing energy harvesting, cities can potentially save enormous costs in both batteries and labor—reducing the number of “truck rolls” that are particularly expensive. Those cost savings will allow cities to allocate funds to other projects, such as education, public land, and health-care.

Smart Buildings/Homes

From door locks to lights and beyond, there are a host of ways to turn any building into a smart building. While these smart devices and applications can help buildings operate more efficiently, many such devices still require costly batteries. In some cases, depleted batteries are only a minor inconvenience. Consider a smart thermostat: If a battery is exhausted, room temperature regulation is no longer possible.

However, an exhausted battery could be much more serious in other cases—for example, if a carbon-monoxide sensor stops working, it can’t alert people to rising emission levels. Energy-harvesting technology could help to significantly extend the battery life of connected devices, and even enable some to operate without any batteries at all, averting these unwanted scenarios.

Hospitality

Hotels are a major adopter of IoT solutions, and these solutions are often used across multiple properties. A common deployment for hospitality is door card readers, which tend to be battery-powered to ensure operation during a power outage. Energy-harvesting technology significantly reduces maintenance times and the total cost of ownership, in addition to furthering a hotel corporation’s green initiatives.

Industrial

Today’s factories use connected sensor technology to do some of the same environmental monitoring seen in smart cities, while adding the sensing and monitoring of equipment and production flows to increase efficiency and reduce machine downtime. These applications are well-established, but they may require the placement of devices in very hard-to-reach locations, making it more important to eliminate battery replacement.

Conclusion

Ultimately, the IoT can’t sustain its current trajectory in global battery usage. To combat the costs and environmental waste associated with batteries, connected devices with ultra-low power consumption and energy harvesting are a must.

By creating a new era of connected devices with batteries that never need replacing—or don’t require batteries at all—we can significantly reduce the costs of battery maintenance for the billions of connected devices around the world. In doing so, we also will reduce the environmental impact of the IoT, allowing for many more years of sustainable innovation.



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