Smart energy management without wires

Energy harvesting wireless offers an easy, inexpensive alternative for adding energy management features to older automation systems.

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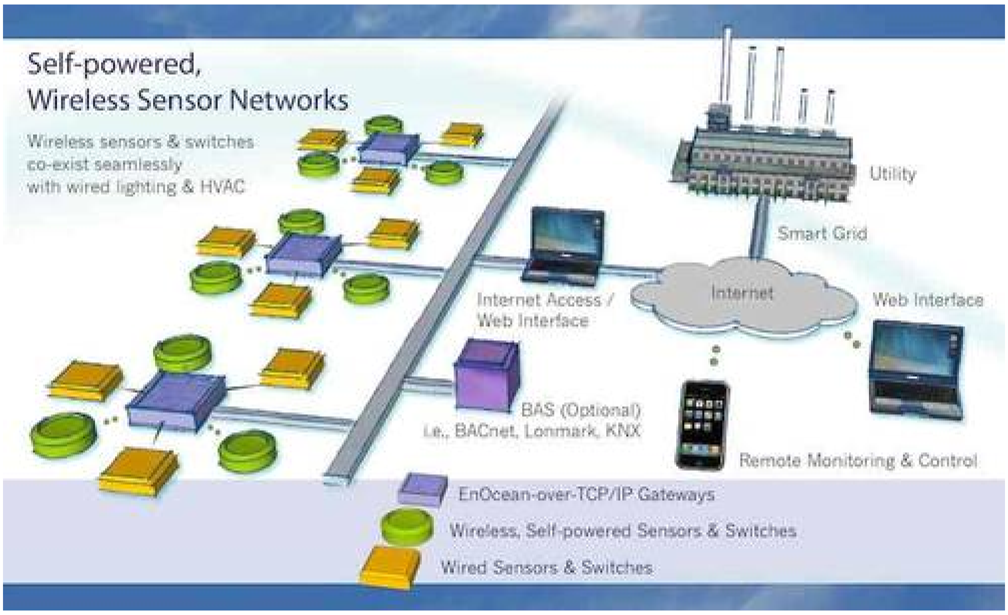


There is a fast-growing need for more efficient use of energy in industrial facilities. Newly constructed plants typically incorporate energy efficient buildings and equipment; however, existing facilities are often less efficient and face greater retrofit challenges.

These retrofit projects call for innovative, sustainable technologies that can be easily installed at relatively low cost. Energy harvesting wireless technology is proving to be just such a solution.

Automation systems monitor, control, and conserve energy, typically delivering savings between 20% and 40%.

A matter of power

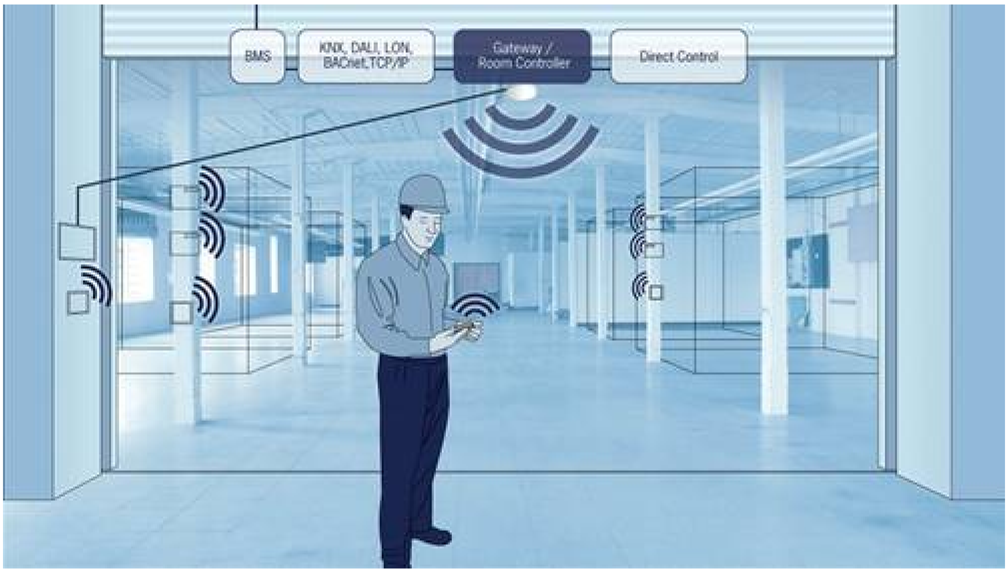
The intelligent control of energy requires sensors to collect the relevant data from several points of measurement and receivers to process the information. A larger system can be composed of hundreds to thousands of these sensory organs. All of these require power and communication capability.

There are established technologies already, primarily in the field of automation, which can be a driver for intelligent energy management. In a building automation system, for example, thousands of sensors measure data from many different points, recording data on temperature, CO2, light, or room occupancy to enable a central control system to manage all technical building areas in an optimized way, meeting individual requirements. It is not much of a stretch to go from building automation to an energy management system. Thus, the building automation principle can be the basis for industrial energy automation processes.

A major challenge is how to network an increasingly large number of individual wireless nodes or sensors that can communicate with long-range wireless networks. Different wireless standards can be used for this purpose, for example GSM, Bluetooth, or IP.

These standards support applications in which large volumes of data must be transmitted quickly, for example in smart metering systems. However, the high data rate comes at the price of high energy demand at the remote node, which requires a continuous supply of power either over cables or using high-power batteries with large capacity.

Hurdle of wires



For smaller devices, such as sensors for detecting data, these technologies are suitable to a limit. This is particularly true when measured data from many different points must be available to an intelligent controller. Here, power cables or batteries can prove to be a drawback in complex applications. Batteries last for only a limited time, depending upon the application, and must therefore be replaced regularly and disposed of properly. In such a highly connected system, which energy control in industrial plants requires, this can be costly and lead to downtimes. But downtimes are out of the question in the industrial field where essential factors for the success of a business include production uptime and process machinery efficiency.

Energy harvesting wireless technology can overcome these challenges, connecting a large number of batteryless and maintenance-free sensors into existing Wi-Fi or mobile networks that process data for intelligent energy control.

Energy out of air for sensors

Energy harvesting wireless technology stems from a simple observation: where sensor data resides, sufficient ambient energy exists to power sensors and radio communications.

Harvestable energy sources include motion, indoor light, and temperature differentials. These ever-present sources provide sufficient energy to transmit and receive radio signals between wireless switches, sensors, actuators, and controllers, sustaining vital communications within an energy management system. Instead of batteries, miniaturized energy converters generate power for the wirelessly communicating devices, keeping the maintenance effort to a minimum and enabling highly flexible installation.

For optimal indoor RF effectiveness, the radio protocol uses sub 1 GHz frequency bands. This provides a safeguard against other wireless transmitters, while offering fast system response and elimination of data collisions. In addition, sub-GHZ radio waves have twice the range of 2.4 GHz signals for the same energy budget, and better material penetration within buildings. As a reference point, duplicating the energy harvesting wireless system

at a 2.4 GHz system requires about four times more receiver nodes to cover the same area. This increases its cost compared to a sub-GHz solution, for example. RF reliability is assured because wireless signals are just 0.7 milliseconds in duration and are transmitted multiple times for redundancy. The range of energy harvesting wireless sensors is about 300 meters in an open field and up to 30 meters inside buildings.

Collaboration of devices

A major requirement of reliable and cost-efficient systems is interoperability between the products of different manufacturers—which is why smart energy control calls for standardized technologies. Interoperability of different end-products based on energy harvesting technology has been an important success factor for the technology's establishment on the market. For this reason, the EnOcean Alliance, a consortium of companies working to further develop and promote self-powered wireless monitoring and control systems for sustainable buildings, has formalized standardized application profiles (EnOcean Equipment Profiles, EEP 2.5) based on the international wireless standard ISO/IEC 14543-3-10, which is optimized for ultra-low power and energy harvesting applications. The profiles allow for products from different manufacturers to be able to communicate and work among themselves.

Deeply connected network

These wireless devices can be integrated with other communications protocols such as EtherNet/IP, KNX, BACnet, or LON via gateway controllers incorporating the standardized energy harvesting wireless technology into energy management programs. IPv6 network connectivity, for example, can easily be achieved by a number of gateway controllers and dedicated gateway products from members from members of the EnOcean Alliance with the option to secure network communication via industry-standard AES-128 encryption with rolling code.

This enables plant operators to plan a widely distributed automation system that combines the added value of easy installation, reliability, and lowest maintenance effort, providing better user acceptance of the needed energy control measures. Due to this integrated system approach, sensors measure energy consumption and automatically create a website visualizing status and trends.

The user instructs the system over a web portal, for instance, to adapt setpoint data to an optimal level. In addition, batteryless wireless sensors can measure data, which together with the current production volumes can be used by the automation system to calculate the required energy.

Energy management is not only about monitoring but also decision-making. The more input data via sensors is available, the better are the yields of an insight into the system status. Decisions on controlling machines for an optimized efficient use of energy can be made faster and closer in accordance with the actual production process. Unlike the standard approach of one or more sensors being connected to one central control unit, wireless networks allow diverse systems such as lighting, HVAC, and process controls to utilize the same information.

A cardboard factory sets standards

In Montreal, Canada, the Norampac 427,000-sq-ft cardboard factory has 25 gas-fired unit heaters originally controlled by mechanical thermostats. The challenge was to integrate the heaters within the existing BACnet IP system of the factory. Because installing miles of conduits and wires throughout would be costly and cause downtime, the wireless option was the only one offering a short payback period.

Using EnOcean-based relays, controlled wirelessly by CAN2GO wired and wireless controllers, themselves equipped with embedded BACnet IP gateways, the mandated contractor was able to install the link between the heaters and a BACnet management system without extensive wiring costs or significant downtime.

In the factory, 16 heaters are now controlled by energy harvesting wireless sensors communicating with CAN2GO controllers. One controller is connected to the LAN, sending the end-devices' data as BACnet objects to the third party BACnet IP system.

The contractor estimated spending 40% less time on the job than if it had been a completely wired retrofit. More than 4,000 feet of conduit and wires were saved. The total estimated savings, including labor and materials, exceeded $45,000—for a 25-controller project.

The energy savings are respectable as well. Due to the new intelligent system, integrating the two wireless industry standards, BACnet and EnOcean, the factory could save $37,000 in energy costs in the first year and $42,500 in the second year.

Flexible communication level

Wireless and batteryless technology facilitates energy monitoring and control with only little intervention into the existing systems. The wireless devices are highly flexible to install so that individual components can be easily networked to form a deeply connected system without complex cabling, especially in retrofit projects. Due to these characteristics, the standardized batteryless technology is ideally suited for the last communication level in energy management applications, providing the needed data from each measurement point for optimized control and a comfortable user experience.

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