Power Puck Replaces Batteries With Energy From Air

Pacific Northwest Natl Lab

The quest for renewable energy is not entirely fueled by recent political winds or green movements. Much of the momentum comes from earlier efforts to overcome the one obstacle that prevents nearly every technological achievement from reaching its zenith: cheap and continuous energy.

The Perpetua Power Puck, a source of energy for remote wireless sensors and radio frequency transmitters that lasts for decades, thus sprang from a recurring need for new energy sources but debuted in a most timely fashion. The device completely eradicates the need for batteries or an electrical supply by using ambient temperature differences.

Although in development for years, the technology appeared to burst onto the commercial scene, but not without its trials and not without the intricate work of several partners.

“Research and development work on this technology began over a decade ago,” explains Cheryl Cejka, technology commercialization director at Pacific Northwest National Laboratory (PNNL). The timing of its completion as a marketable technology, however, could not have been more perfect. “We were fortunate to have someone interested

in the very early stages of our marketing efforts," says Cejka.

"One of the founders of Perpetua Power Source Technologies Inc., Jon Hofmeister, did market research and came back and said he wanted to license it," she explains.

Thus the technology known as Thermoelectric Ambient Harvester (TEAH) became a near-overnight success and the basis for the product called Perpetua Power Puck.

"The deal still took about a year to put together," says Cejka. "Considering that over the course of the process, a company had to be established, investors had to be engaged and the terms of the license concluded, this deal went relatively quickly."

The discovery, however, always precedes the deal and is rarely achieved in a hurry.

The Path to Power

Back in the 1990s, John DeSteese, an engineer at PNNL in the Energy Technology Development Group, proposed and conducted a funded project to explore a large variety of energy conversion technologies that can produce electric power from all forms of environmental energy. Wind and solar power are common examples that are now in commercial use.

"My emphasis was on devices that operate indefinitely in remote areas without human attention," he says. "I recognized little work had been done to exploit the natural thermal energy in the environment, particularly in devices that produce less than a watt of electricity."

He continues, "I invented the conceptual energy-harvesting basis of the Power Puck when I discovered the limitations of the prior design of this kind of device."

TEAH, the technology in the Perpetua Power Puck, directly converts heat into electricity using the thermoelectric effect. In other words, it produces electrical power from the heat that is available in its surroundings.

"It's the way some digital thermometers work," explains DeSteese. "If I make two junctions of dissimilar metals, holding one junction at, say, the freezing point of water (32 F) and the other junction in air, the circuit of just these elements will produce a voltage proportional to the difference in temperature of the two junctions."

Using just the right combination of materials maximizes the effect, he says. "Optimizing the material properties enables the effect to significantly increase performance," he adds. "Now, multiply the number of junctions by a factor of thousands using semiconducting manufacturing processes, and we have a device like the Power Puck that produces renewable energy to run sensors and data communication equipment."

Cejka says the PNNL team and Perpetua have created "a remarkable amount of new materials and embodiment technology that culminates in Perpetua's current product."

> *Because it has no moving parts, the Power Puck is ideal for harsh climates and remote industrial, military, environmental and agricultural applications.*

The company recently won government contracts to develop wearable energy harvesters that convert body heat into energy for powering wireless sensors. Market applications include powering ultra-long-life location devices for military personnel and first responders. It is also ideal for some medical applications, such as those that help patients with diabetes, heart disease and sleep disorders.

The Power Puck can power virtually any wireless sensor, regardless of the sensor's purpose. Among the applications identified so far are sensors for law enforcement, border security, hospitals, automotive, consumer electronics and tracking devices for outdoor sportsmen, athletes or pets.

Green Aspect Adds Commercial Appeal

The green aspect of the Power Puck added additional commercial appeal as countries around the world seek new sources of renewable or alternative energies and a means to reduce landfill poisons.

"Energy harvesting can make a direct environmental impact by reducing the number of batteries disposed of in landfills every year, save businesses significant money by eliminating costly battery replacements and enabling valuable electronics to be deployed in areas otherwise not practical," explains Hofmeister, who serves as Perpetua's president.

Perpetua negotiated an exclusive license from Battelle, the entity that has operated PNNL for the U.S. Department of Energy since 1965, to develop and commercialize the technology in 2007. Perpetua then worked on ways to improve volume manufacturing of the thermoelectric material, which it branded Flexible Thermoelectric Film. The film is incorporated into marketable products and solutions such as the plug-and-play Perpetua Power Puck.

"We first heard about Pacific Northwest National Laboratory's work with flexible thin-film thermoelectics through relationships with the University of Oregon," says Hofmeister. "The southern Willamette Valley area here in Oregon, including the University of Oregon, Oregon State University, and Oregon Nanoscience and Microtechnologies Institute, is one of the top thermoelectric research areas in the world."

Perpetua began selling products in early 2009, and the Perpetua Power Puck is the flagship product using the Flexible Thermoelectric Film technology.

"They are designed to harvest waste heat from almost any warm surface for powering wireless sensors used in industrial applications such as condition-based monitoring of critical equipment," he says.

"We're teaming with wireless radio providers, energy storage companies, industrial equipment manufacturers and facility owners bringing our industrial solutions to market."

The Power of Partnerships

Hofmeister credits the PNNL team for being "extremely helpful in making sure that Perpetua succeeds in bringing thermoelectric energy harvesting to market."

Indeed, it takes a team effort to bring any new idea to market, but it isn't a true partnership unless the effort benefits all.

"Collaborating with commercial partners on efforts like this reduces research and development costs for companies and allows the development of new products," says Cejka. "And, each successful effort recognizes the work of our talented R&D teams and further fuels the desire to commercialize their innovations."

PNNL also has a rewards and recognition program that has recognized the team's efforts which DeSteese applauds.

"I can only speak for myself," says the primary inventor, DeSteese, "but being recognized as an inventive individual by peers and the scientific community is my biggest motivation."

Everyone involved likes to see the research out on the market helping people in all walks of life and in real scenarios.

“Because so many ideas, and even those that get as far as being reduced to practice in the laboratory, still fail to find commercial application, the special joy that comes from this invention and its subsequent development is knowing that it will actually enter the marketplace as a useful and hopefully socially beneficial product rather than remaining a soon-forgotten laboratory curiosity,” says DeSteese.

The Power Puck may power sensors for decades, but its success also helps power the next batch of discoveries at PNNL.

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