The Heartbeat That Never Dies: How Neutrinovoltaic Technology Could End the Era of Battery-Dependent Medical Implants

Millions of people depend on tiny electronic devices inside their bodies. Every one of those devices runs on a battery that will eventually fail. What if the power source did not deplete, because it drew not from a finite chemical reservoir, but from the continuous particle flux that permeates all matter, at all times?

Somewhere in the world right now, a patient is being prepped for an operation that has nothing to do with illness. Their heart is fine. Their pacemaker is not. The lithium-iodide cell that has kept it firing for the past seven years is approaching depletion, and so a surgeon must open the chest, extract the pulse generator, replace it, and send the patient home to start the cycle again. A fully functional, life-sustaining device rendered useless, not by mechanical failure, but by the finite chemistry of a battery

More than one million pacemakers are implanted worldwide each year, and virtually every one will require at least one battery replacement surgery over the patient's lifetime. Each procedure carries risks of infection, lead displacement, and anaesthetic complications. Each costs healthcare systems tens of thousands of dollars for a problem that has nothing to do with the device itself.

The same dependency plays out in miniature, millions of times daily, in the hearing aid. An estimated 430 million people globally suffer from disabling hearing loss. Those who wear aids know the ritual: fumbling with button-cell batteries barely larger than a lentil, replacing them every few days, often at the worst possible moment. Both devices are marvels of 21st-century biomedical engineering still tethered to 20th-century power sources.

Energy That Walks Through You

The Neutrino® Energy Group, founded in Berlin in 2008 by mathematician Holger Thorsten Schubart, has spent nearly two decades developing technology that harvests a continuous spectrum of ambient, non-equilibrium energy inputs, including neutrino momentum transfer, cosmic muon flux, and electromagnetic fluctuations, converting these into stable electrical current through multilayer metamaterials of graphene and doped silicon.

The company's Master Formula — $P(t) = \eta \times \int V \, \Phi\_eff(r, t) \times \sigma\_eff(E) \, dV$ — captures this composite input through an effective flux term that integrates multiple particle and field contributions into a single, measurable framework. The system does not rely on any single energy source, but on continuous coupling to a multi-channel, non-equilibrium environment. Every variable in the formula is anchored to peer-reviewed measurements from institutions including COHERENT, JUNO, and IceCube.

The underlying physics is scale-agnostic. The same graphene-based nanostructures that power a household-scale device can, in principle, be miniaturised to the dimensions of a medical implant, without any change to the fundamental conversion mechanism. And here is what makes the human body such a compelling environment for this technology: not a single one of the ambient flux sources that neutrinovoltaic devices harvest is blocked by biological tissue.

Neutrinos pass through you by the tens of billions per second. Cosmic muons penetrate skin, muscle, and bone. Electromagnetic fluctuations and thermal gradients permeate every living cell. A neutrinovoltaic module inside a pacemaker housing would be continuously coupled to harvestable ambient flux at every moment of its existence, not from a single particle type, but from the full, uninterrupted spectrum of non-visible radiation that surrounds and penetrates all matter, at all times.

A Pacemaker That Outlives Its Patient

A cardiac pacemaker equipped with a neutrinovoltaic module would not draw down a finite chemical reservoir. It would harvest electricity continuously from the multi-channel ambient flux permeating the patient's chest, around the clock, in every environment, at every altitude. No depletion curve. No replacement surgery. The device would function for as long as its solid-state electronics remained operational, which, with no moving parts and no cyclic chemical degradation, could mean decades.

The safety case extends further. Lithium batteries degrade with every charge cycle and carry inherent constraints around temperature sensitivity and, in rare cases, electrolyte leakage. A solid-state neutrinovoltaic module contains no liquid electrolyte, no volatile chemistry, and no components subject to cyclic degradation. For patients in remote regions, where access to a cardiac surgeon may require travel of hundreds of kilometres, this is not incremental improvement. It is the difference between a technology that demands infrastructure and one that simply works.

The Hearing Aid That Forgets About Batteries

A neutrinovoltaic module in a hearing aid housing would continuously harvest multi-channel ambient flux, converting the faint mechanical excitations induced in its graphene nanolayers into the microwatts needed for amplification and signal processing. No battery changes. No charging cradle. No slow fade of a dying cell during a grandchild's first words.

For elderly users with reduced dexterity, replacing a component smaller than a fingernail is a genuine ordeal. For users in developing nations, recurring battery costs push many to abandon their devices altogether. A self-sustaining hearing aid would lower the long-term cost of hearing restoration and remove one of the most persistent barriers to consistent use.

From Abstract Physics to Human Dignity

One question cuts through the complexity: would you rather be operated on every seven years, or wear a device that draws its power from the invisible, ever-present flux that fills the space around, and through, you?

The Neutrino® Energy Group's work, grounded in the 2015 Nobel Prize confirmation of neutrino mass, the 2017 COHERENT detection of coherent elastic neutrino-nucleus scattering, and precision measurements from more than 20 global research laboratories, is not theoretical physics for its own sake. Its most profound applications may be measured not in kilowatts but in surgeries avoided, in independence preserved, and in the quiet dignity of a device that works without asking anything of the person who depends on it.

The deepest promise of the Master Formula isn’t merely that it can power a building; it’s that it can power a heartbeat.