Recycling Energy and Reducing Solid Waste: A Novel Battery-Charging Device with Optical Concentrator Reflector Design that Optimizes Indoor Energy Harvesting

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Demand for portable power continues to grow along with its corresponding environmental impact as Americans throw away more than three billion batteries or roughly 180,000 tons of battery waste each year, 48% of which are single-use batteries. To support sustainability efforts, this research designed a device that energizes rechargeable batteries using a PV (photovoltaic) cell and compound parabolic concentrator reflector as a way of harvesting indoor LED light energy thereby recycling energy and reducing solid waste. Optical concentrators for outdoor solar PVs have been studied, but research is lacking regarding the effect of concentrator optics with indoor LED light sources to improve harvesting efficiency; in addition, current PV battery-charging devices only use outdoor solar energy. Battery-charging devices which recycle indoor LED light energy are not available. In this research, PV types were tested for effectiveness in LED energy harvesting. LED-reflective materials were tested and utilized in construction of three geometrically-designed optical concentrators, an inverted truncated rectangular pyramid, an inverted truncated elliptical cone, and a compound parabolic concentrator. Each were imaged with 3D-design engineering software, built, and tested for effectiveness in concentrating LED energy onto a PV. Experimental results supported the hypothesis that increased indoor light energy harvesting could be achieved with an optical concentrator design for LED light sources. Utilizing this PV-optical-reflector component along with coding a C++ program that estimated battery charging times, a novel battery-charging prototype was built and tested. The device was able to recharge a variety of battery sizes using recycled indoor LED light energy.

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