An assessment of wearable electric generators as a source of alternative energy

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Review

An assessment of wearable electric generators as a source of alternative energy

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Abstract: Averagely since about the age of two, human bodies continue to generate noteworthy amounts of energy that impart into the environment unharnessed. In this paper, an evaluation of the current progress in actually harvesting this dissipated energy and converting it into a usable form is done. In dissecting this progress, a group of different generators were researched, giving a diverse, suitable-for-various-environments-and-body-parts abundance of results. Some of the factors found to be considered during the designing process were the end-user's comfort, the power output, and the price of the unit. The most notable creations that managed, in part or completely, to combine those design choices were the piezoelectric generators, piezoelectric generators, and thermoelectric generators. The piezoelectric generator works on turning the constantly changing pressures at the different points of the human body into usable, storable electricity. The thermoelectric generator works on turning the difference in temperature of the human body relative to ambient temperature into a force that derives electrons around a circuit, essentially creating electricity. On the other hand, the triboelectric generator works on harnessing the static electricity present naturally on the human body. Authors were able to form those generators into different configurations, ranging from textiles (making wearable clothes-generators), to slaps present only at the joints (where most movement is found). Remarkably, they were able to create products that could produce power ranging from 5 μW to 10 W. The different achievements comprised different levels of usability and function, represented in devices that power wearable instruments such as watches and sensors, and in chargers that power batteries, capacitors, and even cellphones. However, the one thing they agreed on is that they all pointed to one dictum: wearable generators represent a credible solution to the problem of alternative energy.

Keywords: piezoelectric generators, Seebeck, triboelectric nanogenerators, wearable generators

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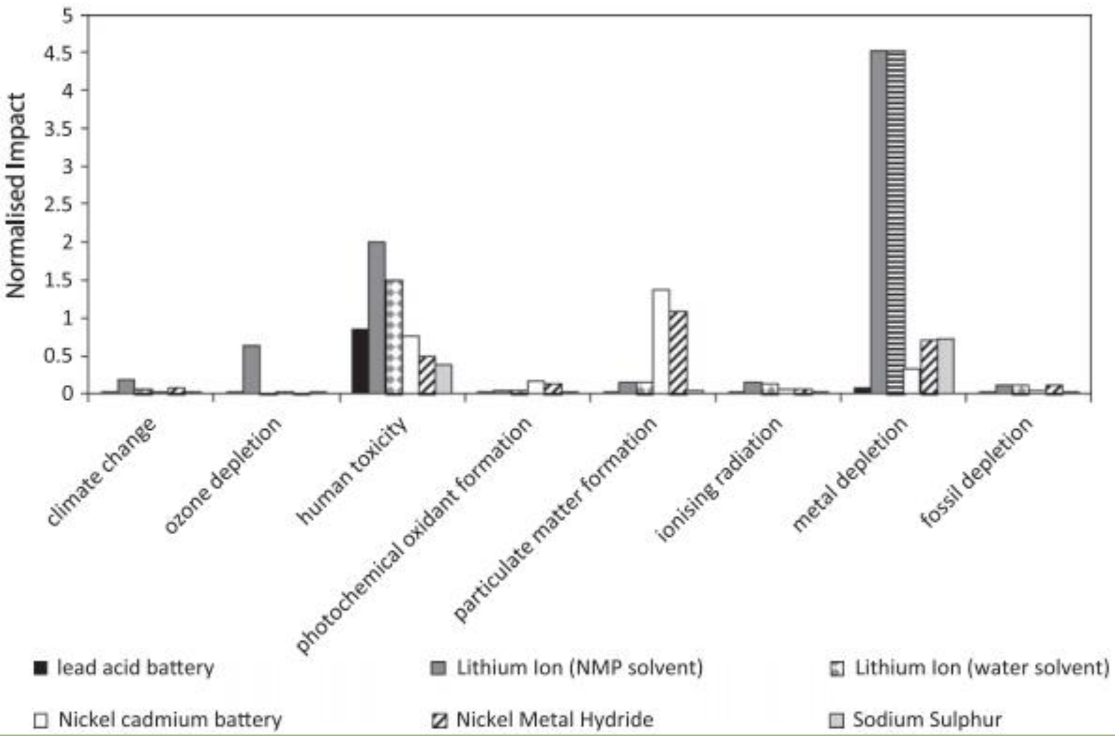
Introduction

The world needed to look further than solar energy, wind power, and hydropower from the environment if it hoped to better compete with the energy crisis threatening the sustainable development of modern society. However, world did not need to look past its own inhabitants' body to find a possible contender to solving such a crisis. Additional research in the field of flexible and wearable electronics prompted the scientific interest in finding body-attachable, foldable electric generators to power such devices. (Bae et al., 2011; T. W. Kim, Yang, Li, & Kwan, 2012; Li, Son, Cho, Kim, & Kim, 2009; Son et al., 2010; Stoppa & Chiolerio, 2014; Zeng et al., 2014; Zhong et al., 2014) In doing so, researchers paved the way to pivot from the excessive usage of batteries and their supplementary environmental effects, which are illustrated in Figure 1. (McManus, 2012) Especially when the electronic



devices to be powered are integrated into wearable items, the transportable, green supply of energy should play an important role with regard to global energy problems. With that in mind, research in the field of self-powered wearable electronics that harvest energy from the ambient environment should be crucial in order to solve the problems relating to energy conservation and pollution control. (S. J. Kim, We, & Cho, 2014) So, the question needed to be answered is as follows: can the human body achieve such feat—provide enough energy to power wearable electronics, and, in conglomerates where much movement is present such as factories, for national usage?

Of note are the two different forms of energy surrounding the human body: mechanical energy (in the form of vibrations and mechanical friction) and heat energy. All of these energy forms, in most cases, go to waste. Recently, however, with the advent of piezoelectric, thermoelectric, and triboelectric generators, there became a way to produce electricity by harvesting the body's energy. (Fan et al., 2012; Zhu, Lin, et al., 2013) Wu et al. created a piezoelectric material that is formed into fibers capable of harnessing the energy in the body's motion and turn in into electricity capable of powering small wearable.

(Wu et al., 2012) Wan et al. created a bendable thermoelectric foil capable of producing power of 32 μW/cm^2. (Wan et al., 2016) Lu et al., however, made a fiber thermoelectric foil, of power output reaching 15nW at temperature difference of 20 K. (Lu, Zhang, Mao, & Li, 2016) In the triboelectric realm, Choi et al. created a textile-based triboelectric generator to harness the electrostatic charge normally present on a human body. (Choi, Lee, Park, Kim, & Kim, 2017) Moreover, Zhu et al., using also triboelectricity, created a shoe insole that is capable of charging even a smartphone. (Zhu, Bai, Chen, & Lin Wang, 2013)

In the rest of the paper, a discussion about what each mechanism brings to the table is made, comparing two implementing the same category and clearing what each one does right and wrong.

Literature Review

Conclusion

Recommendation

Citation

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