Let's cool the world by illuminating it: A thermodynamical model for heat harversters

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Emissive energy harversters (EEHs) have been proposed in the last 3 years as a new form to produce clean electricity by converting the energy waste (heat) into electricity [1, 2, 3, 4, 5, 6, 7]. In the first works the researchers presented calculations of EHHs efficiencies obtained using the Detailed Balance Method (DBM) and the first principle of the thermodynamics. According to that calculations EEHs working at temperatures between 500 and 700 K are able to produce output powers of a few tenths of W/m^2 at efficiencies about between the 20 and 30%.

Very recently I have published a work [8] in which an endoreversible model of an EHH is developed. This new model combines the DBM and the endoreversible thermodynamics and allows to calculate EHH efficiencies taking into account the entropy losses happening in the interaction of the EHH and the hot/cold reservoirs assisting the conversion. In this poster I present the most important features of the model and discuss the impossibilities of optimizing the efficiency of EHHs with respect to any of the internal parameters defining its functioning.

[1] S. J. Byrnes, R. Blanchard, and F. Capasso, Harvesting renewable energy from Earth's mid-infrared emissions, Proc. Natl. Acad. Sci. U.S.A **111**, 3927-3932 (2014).

[2] R. Strandberg, Theoretical efficiency limits for thermoradiative conversion, J. Appl. Phys. **117**, 055105 (2015).

[3] R. Strandberg, Heat to electricity conversion by cold carrier emissive energy harversters, J. Appl. Phys. **118**, 215102 (2015).

[4] W.-C. Hsu, J. K. Tong, B. Liao, Y. Huang, S. V. Boriskina, and G. Chen, Entropic and near-field improvements of thermoradiative cells, Sci. Rep. **6**, 34837 (2016).

[5] S. V. Boriskina, J. K. Tong, W.-C. Hsu, B. Liao, Y. Huang, V. Chiloyan, and G. Chen, Heat meets light on the nanoscale, Nanophotonics **5**, 134-160, (2016).

[6] T. Liao, X. Zhang, X. Chen, B. Lin, and J. Chen, Negative illumination thermoradiative solar cell, Optics Lett. **42**, 3236 (2017).

[7] J. J. Fernández, Thermoradiative energy conversion with quasi-Fermi level variations, IEEE Trans. Electron Devices **64**, 250-255 (2017).

[8] J. J. Fernández, Endoreversible model of thermal to radiative energy converters, J. Appl. Phys. **123**, 164501 (2018).