The Summer Undergraduate Research Fellowship (SURF) Symposium
7 August 2014
Purdue University, West Lafayette, Indiana, USA

Solar-Combined Thermoelectric Power Generation Simulator

Hemanth Chenchu
School of Electrical and Computer Engineering, Purdue University
Je-Hyeong Bahk, and Kazuaki Yazawa
Birck Nanotechnology Center, Purdue University

ABSTRACT

Photovolatic (PV) devices are gaining popularity in harnessing solar energy as a form of sustainable renewable source to generate electricity. However, these devices are limited to utilizing only high energy photons (UV and visible) from the solar spectrum which curtails their efficiency restricting them from being employed in large-scale power generation. This study explores ways to tap into the wasted wavelengths of the spectrum by adding a thermoelectric (TE) module and a steam turbine cycle to the system in hopes of improving power output and thus overall efficiency. The TE device makes use of solar heat to develop a temperature gradient which through the Seebeck effect will later be used to produce electricity. A steam-driven Rankine cycle through a heat exchanger will connect to thermal storage as well as a mechanical engine. This storage will allow for dispatchability at a modest cost. The simulation tool built allows to compute expected power output and efficiency at each individual stage of the combined system. The user is at liberty to manipulate parameters such as concentration of the solar selective absorber and material properties of the TE and PV modules. Test runs indicate that the overall efficiency of power generation has increased by the combined system. This system can be used as a basis for future models in large-scale energy production.

KEYWORDS

Solar-Energy, Photovoltaic, Thermoelectric, Efficiency, Purdue University

REFERENCES

Bell, L. (2008, September 12). Cooling, heating, generating power, and recovering waste heat with thermoelectric systems. *Science*, 321, 1457-1461

Gray, J., & Wilcox, J. The design of multijunction photovoltaic systems for realistic operating conditions.

Yazawa, K., & Shakouri, A. (2011, July 27). Cost-efficiency trade-off and the design of thermoelectric power generators. *Environmental Science & Technology*, 45, 7548-7553.