$\dot{Q}_{abs} = (1-\eta_{PV})GA_p$

Modeling Integrated Thermoelectric Generator-Photovoltaic Thermal (TEG-PVT) System

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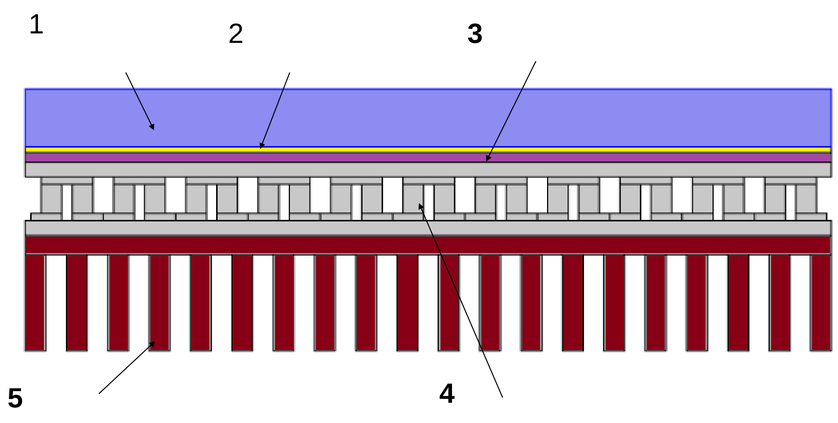
Introduction

Thermoelectric generation is a promising technology which cleanly converts waste heat into electricity. They have been applied in aerospace applications and waste heat recovery from cars and industries [1-3]. Photovoltaic (PV) based technology is also another clean source of energy which produces electricity from sunlight. The waste heat from the PV panels could be put into useful energy by using TEG.

A 2D steady state heat conduction-electric current model was created in COMSOL Multiphysics to study the performance of thermoelectric generator-photovoltaic-thermal (TEG-PVT) system. Four different cases were studied in the paper.

In case 1, PV cells without concentrator was simulated while in case 2, concentrator ratio range from 2 to 5 was utilized In case 3, the convection heat transfer coefficient was varied between 6.2 and 14.2 W/m2K. The value of thermal insulation between PV cells and TEG was decreased for case 4.

PVT-TEG system

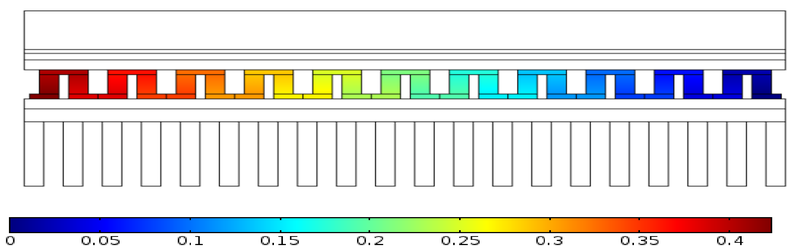


1	Glass Cover
2	PV cells
3	Insulator
4	TEG module
5	Finned heat sink

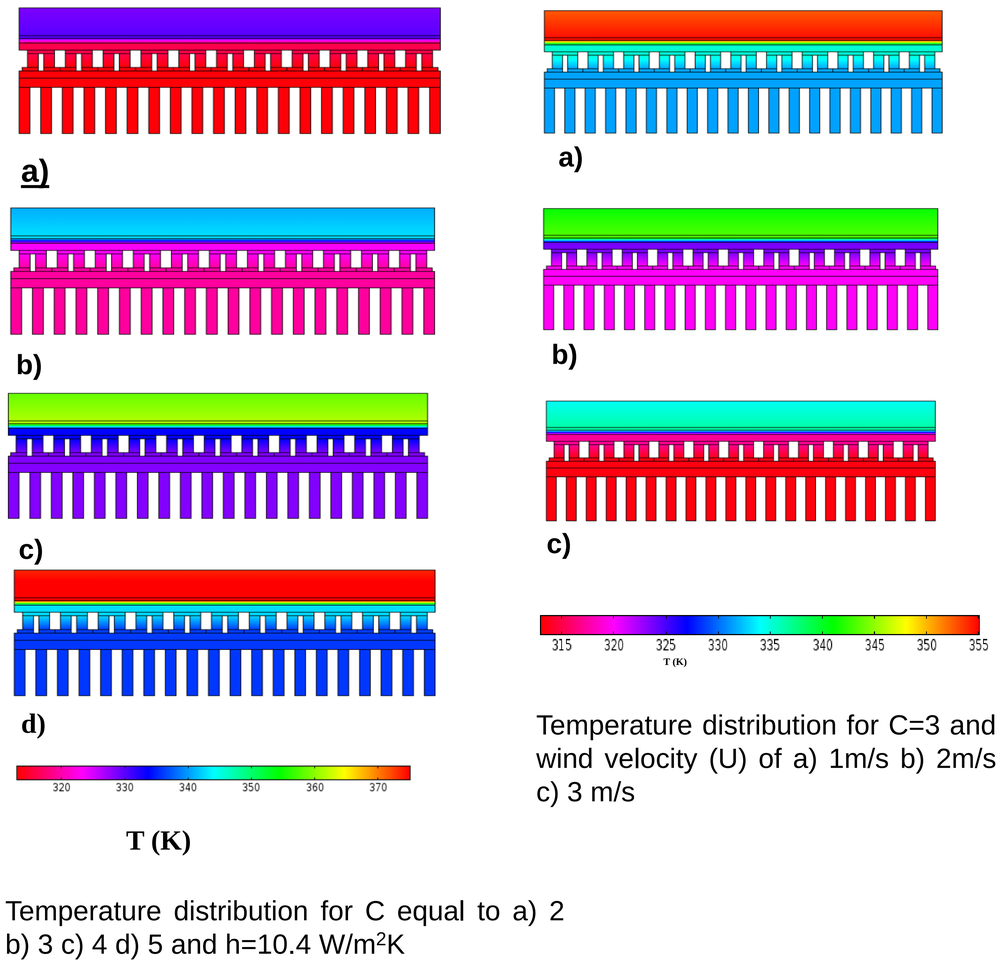
Schematic of PVT-TEG system

COMSOL Simulation Results

The power produced by TEG modules depends on the temperature difference between the hot side and cold side of the module (ΔT_{teg}). Thus, an increase in net het input in PV cells results in higher hot side temperature at the TEG module.



Electric potential for C=3 and U=3 m/s



Temperature distribution for C=3 and wind velocity (U) of a) 1m/s b) 2m/s c) 3 m/s

Temperature distribution for C equal to a) 2 b) 3 c) 4 d) 5 and h=10.4 W/m^{2}K

Conclusion

In this paper, the integrated design of thermoelectric generator and PVT cells is studied using COMSOL. Temperature and electric distribution in the integrated system and electric potential and current at TEG module has been simulated.

The results indicate that having a higher concentration ratio results in higher power production from TEG module due to increased absorbed heat flux. It is also observed that decreasing thermal resistance between the PV cells and TEG module also assists in keeping the PV cells temperature at optimum value. With an increased efficiency of TEG modules, the integrated system could produce useful power from the TEG module augmenting power production from PV cells.

References

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