



# CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

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<b>Project Title</b>  <b>Waste Heat Recovery Utilizing Bismuth-Telluride Thermoelectric Generators and Lauric Acid Phase Change Material</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives</b> The purpose is to measure the effects of a phase change material (PCM) unit on efficiency of a thermoelectric generator (TEG) waste heat recovery system and determine the appropriate applications of the unit.</p> <p><b>Methods</b> TEG tabs, heatsink with fan, and a thermal interface plate are used to simulate thermoelectric waste heat recovery system. The system is placed on electric stove and wattage measured by multimeters. System efficiency will be compared with and without lauric acid PCM unit. Constant and intermittent operation of stove used to determine appropriate applications of lauric acid unit. Intermittent will test at 2 intervals; 5 minute and 15 minute intervals. Cool-down time is additionally included.</p> <p><b>Results</b> Under constant heat, system with lauric acid unit produced average 227.8 milliwatts and a total of 273 joules as compared to system without lauric acid unit producing average 214 milliwatts and a total of 257 joules. Both were over 20 minutes. Under intermittent heat (5 minute intervals), system with lauric acid unit produced average 4 milliwatts over 140 minutes and total 34 joules as compared to system without lauric acid unit producing average 49 milliwatts over 49 minutes and total 145 joules (time variance due to accounting for cool-down). Under intermittent heat (15 minute intervals), system with lauric acid unit produced average 42 milliwatts over 170 minutes and total 428 joules as compared to system without lauric acid unit producing average 84 milliwatts over 78 minutes and total 393 joules. It was noted that the lauric acid took 8 minutes to melt, compared to the intermittent heat at 5 minute intervals.</p> <p><b>Conclusions</b> Analysis of why the PCM unit enhanced or reduced efficiency finds that the heat source being constant or intermittent is not the key factor that determines efficacy of the PCM unit. The key factor is if heat generated by the waste heat source is sufficient to melt and transfer through the PCM unit. If it is insufficient, PCM s should not be used; if it is, PCM s should be used. This study provides an alternative method of increasing efficiency of TEG s outside of the TEG s themselves, furthering knowledge on how efficiency of thermoelectrics may be improved in the future.</p>	
<b>Summary Statement</b>  I used thermoelectrics to recover waste heat, and determined appropriate applications of phase change material units to effectively enhance efficiency, which brings thermoelectrics closer to practical efficiency.	
<b>Help Received</b>  My science teacher assisted during preliminary tests and explained key properties of thermodynamics. During the construction of thermoelectric waste heat recovery system and the real tests, my mother supervised. I did my own research on thermoelectrics, phase change materials, and for construction.	