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## Impact of thermoelectric panels on energy harvesting and thermal management of a rechargeable battery pack

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With the exponential rise in the adoption of electric vehicles (EVs) globally imperative to extend the recharge intervals of the battery pack. Rechargeable lithiumion battery packs, commonly used in EVs, generate heat during operation. This heat can degrade performance and reduce lifespan of the battery unless properly managed. Novelty of this work is, that we aim to extend recharge intervals of the battery by trickle charging from thermoelectric (TE) panels attached to the battery pack using the waste heat. The TE panel employed in this study is TEC1-12706 module, composed of bismuth telluride (Bi2Ti3) based semiconductors. These panels are integrated into the battery surface using thermal paste, where they harness the thermal gradient between the battery and ambient environment. These panels will convert waste heat from the battery pack into electricity, providing an additional charge, extending the recharge intervals. It is also important to maintain the temperature of a battery pack below 45°C in order to maintain the health of the rechargeable battery cells. The primary objective of this research is to monitor and maintain the cooling efficiency of the battery pack, after attaching the TE panels. Heat dissipation rate for the battery pack and heat dissipation rate after attaching the TE panels were calculated after measuring necessary parameters experimentally. Algebraic expressions were derived to model the heat losses before and after the attachment of TE panels. The results indicate that integrating TE panels with the battery pack only slightly reduced the heat dissipation rate from 2.8 J s<sup>-1</sup> to 2.5 J s<sup>-1</sup>, still maintaining sufficient cooling. This suggests that the energy can be safely harvested from the battery pack using TE panels, while maintaining the battery pack within the safe temperature range.

**Keywords:** *electric vehicles, heat dissipation rate, rechargeable lithium-ion battery pack, thermoelectric panels, waste heat*