

Thermoelectric HPWH Priced for Mass Market Deployment with 30% Less CO₂

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Current Water Heater Market

A More Efficient, Yet Affordable, Solution

- Current water heater technology is either affordable (natural gas, electric resistance) or efficient (air-source heat pump), but *not both*
- A heat pump water heater (HPWH) with a small thermoelectric heat pump likely costs less than HPWH with a large vapor-compression heat pump
- Thermoelectric materials can provide a higher efficiency than that of natural gas and electric resistance technologies

Project Results

- Fabricated prototype thermoelectric heating unit
- Implemented controls for two heating stages



- Integrated thermoelectric heat pump with AO Smith electric resistive 40-gallon tank
- Reached first hour rating goal of >45 gal
- Achieved 13% higher efficiency over electric resistance under Uniform Energy Factor (UEF) draw profile
- Developed tank temperature stratification and thermoelectric module models

Impacts

- ORNL stratification model is computationally 2,000 times faster than and as accurate as the most recent publication (Cruz-Larado et al., 2023) on stratified tank modeling
- Full adoption of thermoelectric over electric

resistance could result in 146 TWh energy savings and reduction of 20.7 Mt/year CO₂ for water heaters with storage <30 gal

Future Research

- Nest the stratified tank model into the water heater system-level model
- Evaluate coupled system under standard conditions







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