

Laboratory Performance Evaluation of Residential Scale Gas Engine Driven Heat Pump

Ahmad Abu-Heiba

Isaac Mahderekal

Ayyoub Momen

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Outline



- Why GHPs?
- Project overview.
- Laboratory testing results.
- Technical and market barriers.
- Future plans.

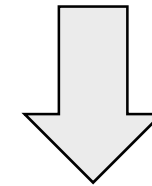
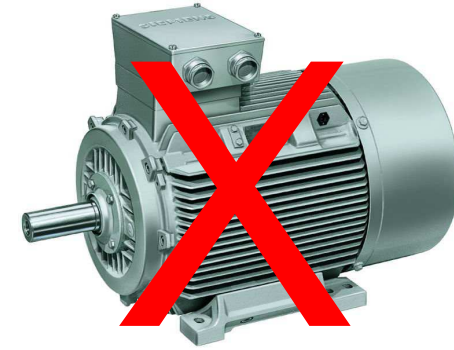


Benefits of GHP



- Electric demand reduction by 80%.
- Elimination of electricity transmission losses.
- Heat recovery from engine block.

BTO report in 2012 estimated energy saving potential of GHP technology in residential sector to be 44 Terawatt-hour (0.15 Quads) annually.





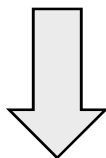
Project Overview



Southwest Gas

+

**Oak Ridge National
Laboratory**



CRADA





Project Overview



NextAire 11-ton Packaged Rooftop Heat Pump

- Demonstrated for 12 months at six DoD bases.
- Electric and Gas utility savings reported for all locations.
- Utility combined savings ranged from \$680 to \$2,134.





Project Overview



Main Specifications

- Single family residence.
- 4-ton cooling capacity at 105°F (40.5°C)
- Water heating capability.
- Condensing unit power consumption < 1 kW.
- Multi-stage operation.

Other design targets

- Noise requirements.
- Low vibration levels.
- Footprint.



Project Overview



CRADA Outcomes

- Final design built.
- Laboratory tested.
- ETL certified.

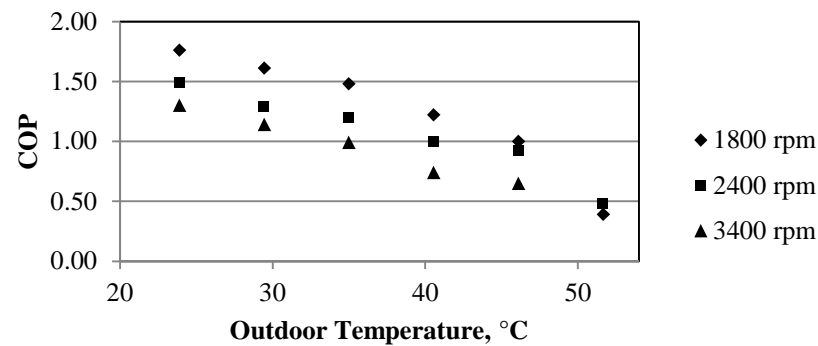
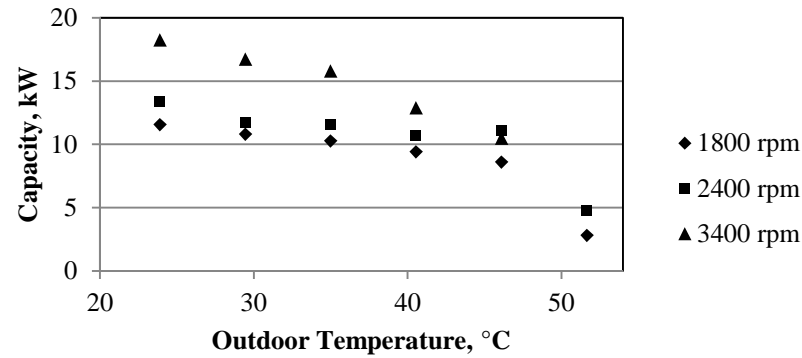




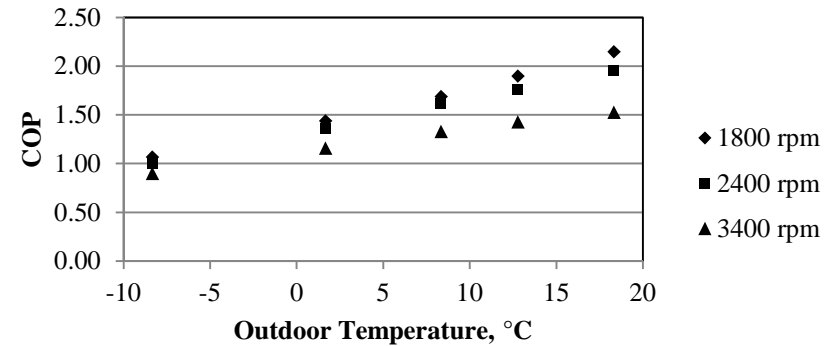
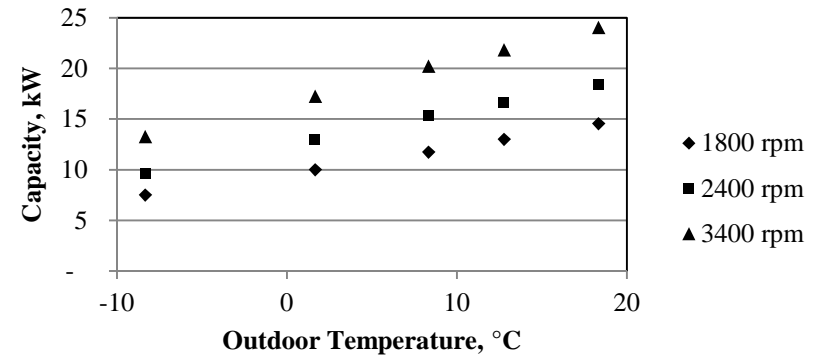
Laboratory Testing Results



Cooling



Heating

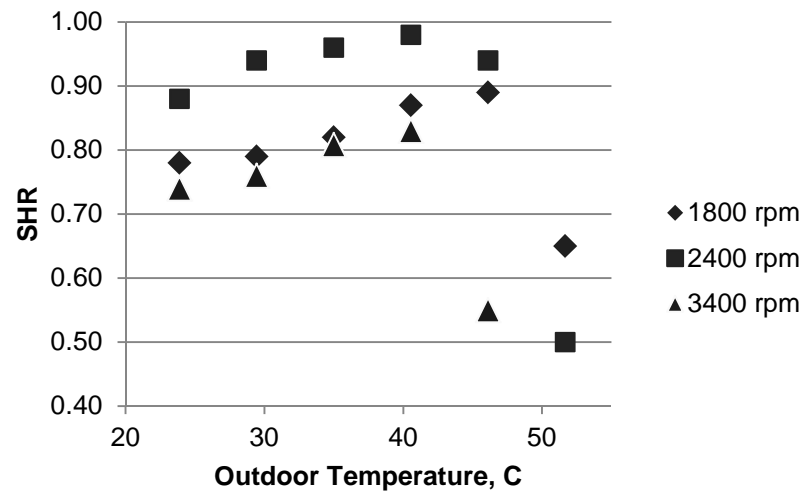




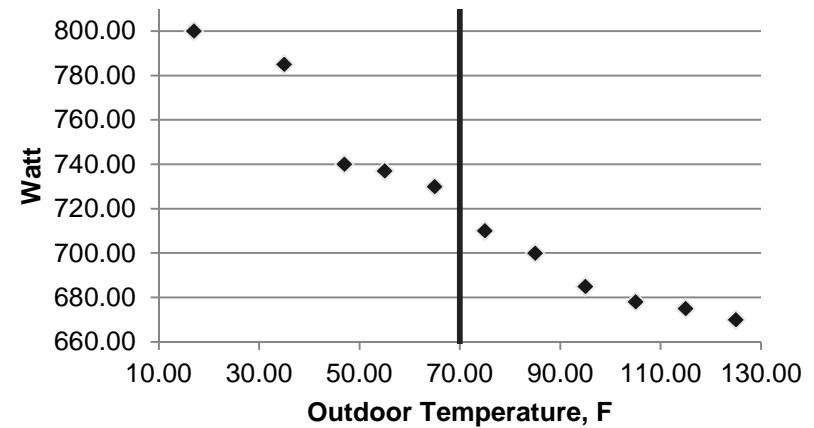
Laboratory Testing Results



Sensible heat ratio



Condensing unit power consumption





Technical and Market Barrier



Low Frequency Noise

- Sound-generating vibrations from engine.
- Noise insulation is costly and not always effective for low frequency band.

Engine Performance

- Limited power.
- Low thermal efficiency.
- Efficiency needs to increase to 28-30% for economic viability.



Technical and Market Barrier



High Initial Cost

- Currently \$14,000.
- Mass production will reduce cost.
- Engine subassembly, compressor, and exhaust to coolant heat exchanger need to be redesigned.

Market Acceptance

- Low awareness.
- Poor perception.
- Greater exposure of the technology to end-users, installers, designers and contractor is needed.



Technical and Market Barrier



Incomplete Valuation

- Better tools needed to evaluate full benefits and better model GHP technology.

Regulatory Issues

- Investment credits.
- Incentives to tie to renewables.
- Continuous engagement with regulators, policy makers, market operators, utilities, and manufacturers is needed.