Smart, Tunable Thermal Energy Storage (TES) as an Enabler for Decarbonized Buildings

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Introduction

The rapid development of renewable energy sources requires **flexible building HVAC** technologies to alleviate the stress on the electric grid. Peak air conditioning loads stress the grid in July/August today, and peak Heat Pump loads in January/February will stress the grid in the *future*.

This study focuses on using multi-source heat pumps integrated with novel, tunable TES to shift loads from peak to off-peak, to improve efficiency, and to absorb abundant/inexpensive renewable power.

Methods



The Energyplus model of Syracuse Center of Excellence was developed to generate the airside load demand. Then a hybrid heat pump (ground-source, air-source) was modeled and integrated with MicroEra Power's tunable Thermal Energy Storage (TES) system to evaluate the energy saving and load shifting potential.

Results

The proposed multi-source heat pumps have a high COP when sourcing from the ground loop, especially during extreme winter or summer weather. This results in energy savings of an estimated 28% for both cooling and heating compared to air source heat pumps. At offpeak times, the TES can be charged with low-cost electricity, and at later peak times, supplies the needed heat or cooling. The price differential for peak vs. off-peak electricity resulted in a 37% reduction in cooling costs and 59% reduction in heating costs. And the peak HVAC load for the Syracuse COE building case study can be reduced by 60% with 2 x 1500 gallons TES tanks.

Conclusion

•Nearly 30% energy consumption can be reduced by ground source heat pump.

•Up to 60% of the peak load can be reduced by integration with two thermal tanks. •32.8% to 73.8% cost savings during the cooling season with different tank capacities. •20.3% to 43.4% cost savings during the heating season with different tank capacities.

- •23 to 75\$ daily cost saving on average.
- •1400 to 4500\$ total savings in a two-month evaluation.



Cent/kWh: On Peak: 18.62Cent/kW Cost saving: 85.1\$/day (73.8%) Cost saving: 37.9\$/day (32.8%)

8

Temperature[°C]

Analysis

60

65

[°C] Temperature



Time of a day

ling Design Day; Utility Company: Con Edison; Off Peak: 1.38Cent/kWh; On Peak: 37.82Cent/kWh



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Discharging during the daytime

Impact

Traditional Geothermal HVAC often has extremely long payback due to the very high cost of drilling the ground loop. Urban applications tend to also be space constrained. A geothermal hybrid system, leveraging MicroEra Power's tunable TES can contribute to efficient, flexible and gridresponsive operation, with downsized ground loop, resulting in an affordable capital cost.

Contact



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TES enabled a 93% peak load reduction for the winter peak day, and 54% for the summer peak day. 23-33\$/day cost saving with one PCM tank; 50-75\$/day cost saving with two PCM tanks.

