Storage Source Heat Pump Feasibility Study

College West Building

ISE Group #5
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1 Purpose

This feasibility study aims to determine if the installation of a thermal energy storage (TES) system with heat recovery in the College West (CW) building at the U of R can reduce energy costs. The proposed system would shift 30% of the daily cooling load energy to night-time hours using ice storage tanks. The tanks would be charged during the night to create ice and the ice would be depleted during the day to cool CW. Any waste heat in the condenser loop of the chiller would be reclaimed in the proposed campus hot water return distribution loop.

2 Project Overview

Scope

- Focus on College West (CW) building
- Consideration of cooling system + heat recovery
- System sizing based on peak cooling loads
- Energy and Economic Analysis
- Complete mechanical design of TES system

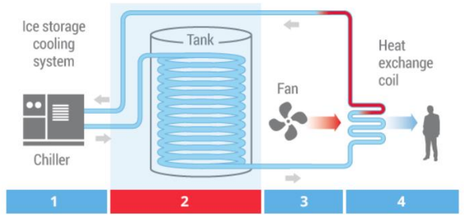
Constraints

- Budget ~ $2 million capital spending
- ROI~ 10 years (5-7 years preferable)
- Airside HVAC in CW remains unchanged
- Central Plant remains unchanged
- Equipment must fit within a proposed location in CW

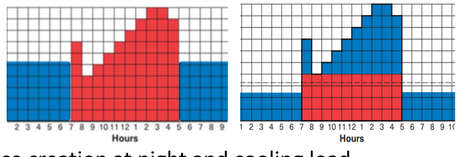
3 Literature Review

Basic TES Operation:

1. At night, water-glycol is cooled by a chiller
2. Ice is generated inside the storage tanks and heat is recovered in condenser loop
3. At on-peak hours, warm glycol solution from chiller is cooled by ice inside the tanks
4. The chilled water-glycol is delivered to cooling coil in AHU to achieve thermal comfort



Operation Strategy: Full vs Partial Storage

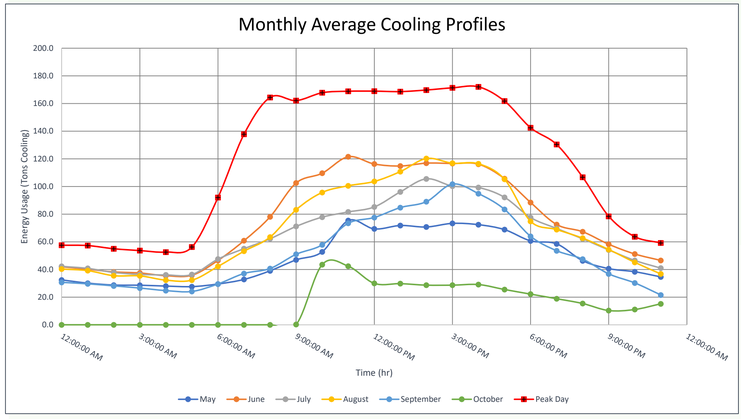


Full Storage: Chiller is dedicated in ice creation at night and cooling load throughout the day is supplied from the storage tanks only

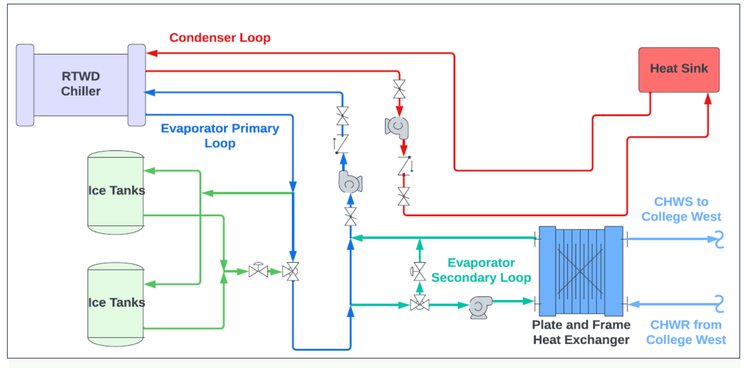
Partial Storage: Cooling load at peak hours is offset by stored energy in the tanks but chiller still operates during the day

4 Mechanical Design

Average monthly CW cooling load profiles were created from historical 2023 central plant data. ASHRAE's Cool Thermal Storage design guide was followed.

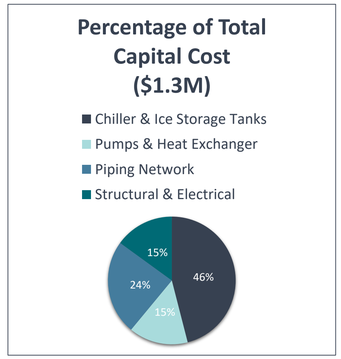


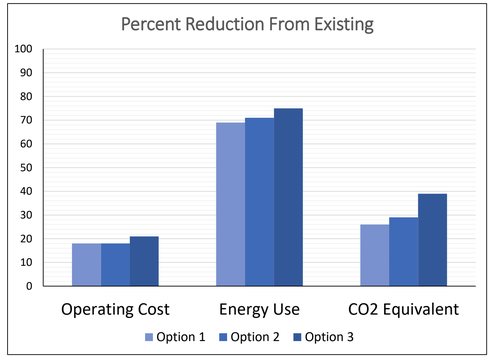
A schematic of the proposed system is shown below. A hydraulic model was generated to simplify the calculation process needed for equipment sizing.



The primary mechanical components of the TES system includes a chiller, modular storage tanks, heat exchanger, pumps, piping, and valving.

5 Energy and Economic Analysis





6 Barriers to Feasibility

Energy costs are reduced but not enough to justify the capital expenditure. An ROI of 70–80 yrs. was calculated meaning a retro fit install is not feasible.

- ❑ Limited heat sinks for heat reclaim. Requires chiller to operate at its mechanical limits.
- ❑ Ice creation chiller efficiency is nearly 4x worse than conventional system
- ❑ No Time of Use (TOU) rates in Saskatchewan limit opportunity for cost savings. ~80% of typical ice storage systems cost savings come from TOU rate shifts which is not possible in Saskatchewan.
- ❑ Natural gas inexpensive when compared to electricity

7 Recommendations

Geothermal Heat Sink	• Lower operating temperature and lift within the chiller • Expensive and will require further investigation
Energy Rates	• Implementation of TOU rates in SK and increased carbon tax would make this project economically viable.
Central Plant Scale	• More heat sink options available. • Replace undersized cooling towers w/ heat recovery system

Acknowledgements

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