Energy Storage for Land-Challenged Campus Facilities

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The Problem – Space for TES

• Summer cooling loads are largest contributor to peak electric demand*
• The electricity market is transitioning to renewable energy generation
  - Tariffs are changing and demand charges are increasing to encourage consumers to have electric load flexibility to maximize renewable energy utilization and provide dispatchability
• Affordable load flexibility solutions need space and many college campuses are land challenged

Load Flexibility Solutions

- Batteries
- Co-generation
- Fly-wheels
- Thermal Energy Storage
  - More affordable energy storage type*
  - Can be designed for specific charging and discharging durations
  - Simple maintenance
  - Long life
  - Proven in hundreds of installations

Source: Ingersoll Rand
Thermal energy storage is 1/3 the cost of chemical battery systems for C&I

Cost advantages

- No inverter expense
- Lower component costs, including balance of system; lower O&M
- No need for capacity addition due to degradation

Lower capital costs mean lower financing costs

Levelized Technology Cost for BTM Applications$^{1,2}$

- Lithium-Ion
- Lead Acid
- Advanced Lead
- 500 kW Thermal
- 1,000 kW Thermal

$ / MWh

$1,200
$1,000
$800
$600
$400
$200
$-

1. Costs represent average of range pulled from LCOS 3.0 for battery technologies.
2. Conservative case that includes full cost of chiller.

Source: Ingersoll Rand
Water Thermal Energy Storage

Advantages
• Potentially use existing chillers
• More efficient charging
• Economies of scale
• Can be incorporated into fire protection system
• Anti-freezing HTF not required
• Fast Discharge Potential

Disadvantages
• Requires large space
• Little or no redundancy
• Difficult to stage growth
• Water treatment requirement
• Stranded Asset
• Complicated Partial Storage scheme
• Larger delta T to reduce costs
• Storage degrades if delta T not maintained
Examples of Water Energy Storage Installations

Photo courtesy of DN Tanks®
Ice Thermal Energy Storage

Advantages
• Less space required
• Modular growth possible
• Faster installation with factory assembly
• Redeployment of assets*
• Cataloged performance
• Redundancy

Disadvantages
• External piping for tank farm more extensive
• Requires Anti-freezing HTF
• Requires low temp (Ice Making Chillers)
• Vertical storage is expensive

* With some types of systems
Ice Thermal Storage

Packaged Thermal Ice Storage Tanks

Site Constructed Thermal Ice Storage Tanks

Photo courtesy CALMAC Portfolio of Trane and Baltimore Aircoil Company®
Case Study

NEW MEXICO STATE UNIVERSITY
Case study

- 1965 – Central Plant (1) 900 Ton (3200 kW) R-11 Centrifugal Chiller installation.
- 1968 – Central Plant (1) 1500 Ton (5300 kW) R-114 Centrifugal Chiller addition.
- 1975 – Central Plant (1) 1500 Ton (5300 kW) R-114 Centrifugal Chiller addition.
- 1984 – Central Plant 3 Million Gallon Chilled Water Thermal Storage.
- 1995 – Central Plant (2) 1500 Ton (5300 kW) Double Effect LiBr Absorption Chiller addition.
- 2001 – Central Plant (3) 1500 Ton (5300 kW) R-134A Centrifugal Chiller installation. (Replaced ‘65,’68,’75 Chillers)
- 2009 – Updates to Utility Master Plan.
- 2010 – Chilled Water Distribution Capacity Improvements. (36”(900 mm) Chilled Water Mains)
- 2012 – Satellite Chiller Plant (1) 2500 Ton (8800 kW), (1) 900 Ton (3200 kW) R-123 Centrifugal Chillers with Ice Storage.
- 2013 – Central Plant (1) 1100 Ton (3900 kW) Steam Driven Centrifugal Chiller. (Replaced 2 Absorption Chillers)
General Arrangement- Modularity

Photo courtesy of GLHN Consulting
Case study

UNIVERSITY OF ARIZONA
Urban Campus

Photo courtesy of GLHN Consulting
Storage Density

Photos courtesy of CALMAC® Corp.
Offsite Construction- Package Solutions

Photos courtesy of GLHN Consulting
Case study

DUQUESNE UNIVERSITY
Urban Campus - Real Estate

- Added 6,000 ton-hr. capacity without adding cooling tower for new Power Center building.
- Utilizes off peak electric rates.
- No change in condenser loop piping.
- More efficient utilization of existing equipment.
Storage density matters

Chiller plant located in parking ramp
Summary

• Land challenged campuses can apply high density TES technologies.
• TES can be modular, and factory packaged.
• Electric load flexibility can help meet future financial and sustainability goals.
• Electricity demand for comfort cooling is typically very large and easy to shift with thermal energy storage.
• Careful analysis of project site and thermal energy storage technology available is key.