Tale of the Tape: A Comparison of Curtailment Impact and Value Streams of Various Technologies in the C&I Sector

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“If you remember nothing else”

- Multi-objective pilots with evaluation can teach a great deal
- There is no single most accurate baseline definition for all DR technologies and programs
- Batteries were extremely reliable and predictable
- Both thermal storage and automated building system controller-based solutions needs a lot of lead time to find matching applications, tune systems and perhaps moderate goals

The Solutions in the Pilot: Bldg. Mgmt. System (BMS), Traditional Dispatch, Battery

Automated BMS controls can alert a customer to the need for DR (e.g., a monthly peak or forecasted system peak) and initiate pre-arranged actions

Traditional Dispatch delivers an agreed amount of load reduction from a facility when called upon through reducing use of systems of participant choice. Activation may be manual or programmed.

Batteries in this pilot were either dispatched daily or targeted to peak periods. All batteries were installed through pilot vendors.

The Solutions in the Pilot: HVAC and Refrigeration Thermal Storage

Thermal storage systems stock thermal energy by cooling a medium off-peak for cooling applications during peak

The HVAC thermal storage system is an ice-water-based thermal storage to reduce peak space air conditioning load.

The refrigeration thermal storage system uses bricks of phase change media (PCM) in warehouse freezers with controls to enable compressor and condenser load reduction during peak hours.

The Solutions in the Pilot: HVAC and Refrigeration Thermal Storage

HVAC

Refrigeration

Demand Response Control Dispatch Strategies

All pilot solutions sought to reduce load during the summer hour when load on New England's grid peaked (the "Installed Capacity" or ICAP hour). Multiple dispatch strategies were pursued among the solutions to achieve this.

Season	Strategy	Vendor/Solution: Manual Curtailment	BMS/ Controls	Thermal Storage (HVAC)	Thermal Storage (Ref)	Battery (Daily)	Battery (Targeted)
Summer	Daily			X	X	X	
	Utility-triggered Event	X					X
	Vendor-forecasted ICAP	X	X				X
	Facility Peak		X				X
Winter	Utility-triggered Event	X				X	X
	Facility Peak						X

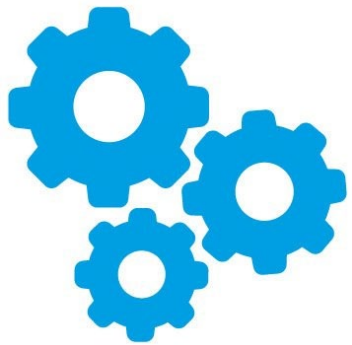
Evaluation measurement data and baseline

Solution	Interval Data Used and Baseline, if Relevant	Event Baseline Basis
Battery 	Battery	No battery
TES - HVAC 	Asset-level (kW and thermal)	All season non-event days regression
TES - Ref 	Asset-level (kW and thermal)	All season non-event days average *(outside temperature didn't drive load change)*
Manual 	Premise-level	10-of-10 symmetric, additive adjustment

BMS was not able to be evaluated due to several reasons, including few participants, magnitude, duration, and frequency of events and software issues.

General Methodological Findings Across Solutions

- Equipment-level metering is needed when expected DR impact is small relative to total load
- Solutions often take many months to optimize, especially BMS but even batteries



- Considering regression and settlement together is ideal
  - Regression offers a whole season perspective and is better for weather dependent loads
  - Settlement is better for weather independent loads and to catch pre-event day shutdowns
- A symmetric baseline is less vulnerable to bias than an asymmetric baseline

Battery Findings

- Batteries are expensive, but from an evaluation perspective, are extremely reliable and easy to estimate impacts from charge and discharge data during event hours when installation is program induced
- When not program induced, the baseline needs to accommodate how batteries are discharged on non-event days
- Targeted dispatch of batteries was effective at curtailing demand during seasonal and daily periods, including ICAP hour.

Caution: For facilities with other DERs such as CHP, attention is necessary to optimize the controls to prevent undesirable interactions

Thermal Energy Storage Findings

TES projects overall were found to need asset level analysis vs premise level analysis

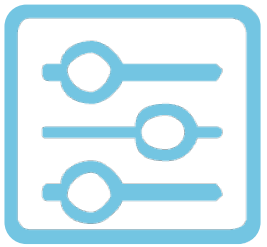
Thermal Energy Storage HVAC

- Need to meter at equipment if small relative load
- Oversized or underutilized HVAC units can result in low demand reduction
- Screen to be sure targeted units are compatible and accessible.
- Despite its potential, HVAC TES did not perform as well as other technologies due to being oversized or underutilized

Thermal Energy Storage Refrigeration

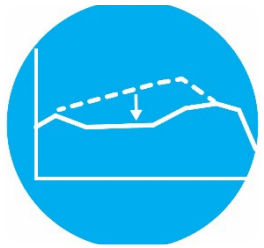
- Refrigeration TES performed well.
- Goals need to reflect limited population (cold storage with large freezers)
- Screen to be sure refrigeration control systems can accommodate the technology and the underlying equipment vintage is adequate

BMS and Traditional Dispatch Findings



Building Management Systems

- Major security concerns to having external entity in BMS
- One (of 2) failed to document any impact; the other unevaluable
  - May require both equipment-level and premise-level metering
  - Data collection during early stages of BMS intervention can help assure project feasibility and effectiveness



Traditional/Manual Dispatch

- Use adjusted settlement baseline for evaluation
- Regression did not work well
- This solution was very effective at curtailing demand during ICAP and the period of targeted dispatch

Conclusions

- Many technologies can work with many ways to profit, benefiting customers, vendor, and the grid
- Good matching of technology, customer and program is critical
- A one-size-fits-all approach leaves potential benefits on the table

- All technologies except BMS have data and impact method combinations that estimate DR with confidence. Batteries were especially reliable.

- The challenges encountered in the study provide valuable guidance on how to position these solutions for implementation and evaluation success.

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