Case Study: Evaluating Demand Savings from Chilled Water Thermal Energy Storage

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IEPEC Denver
Thermal Energy Storage – How it Works:
Key Considerations

- Focus here only on demand (kW) savings
- **Goal**: reduce demand (kW) by turning off chiller plant equipment
- 2 main types: sensible (chilled water), latent (“ice”)
- Systems cannot respond instantly - need to plan for operation
- How does program define demand?
- Not just demand of plant equipment, but how they operate
Savings Formulation – Built-up Model

\[ \text{kW}_{\text{save}} = \text{kW}_{\text{plant (baseline, peak)}} - \text{kW}_{\text{plant (post, peak)}}, \]

\[ \text{kW}_{\text{plant (baseline, peak)}} = \sum_i (\text{kW}_{\text{chiller base, } i}) + \sum_i (\text{kW}_{\text{pump base, } i}) + \sum_i (\text{kW}_{\text{ct base, } i}), \]

\[ \text{kW}_{\text{chiller}} = \sum_i (\text{tons, } i \times \text{kW/ton, } i), \]

\[ \text{kW}_{\text{pump}} = \sum_i (\text{kW}_{\text{pchwp base, } i}) + \sum_i (\text{kW}_{\text{schwp base, } i}) + \sum_i (\text{kW}_{\text{cwp base, } i}); \]

\[ \text{kW}_{\text{plant (post, peak)}} = \sum_i (\text{kW}_{\text{chiller post, } i}) + \sum_i (\text{kW}_{\text{pump post, } i}) + \sum_i (\text{kW}_{\text{ct post, } i}) - \sum_i (\text{kW}_{\text{TES post, } i}). \]

- Best source is direct measurement of equipment
- EMS with trending data ideal
- Understand how plant is sequenced
## Challenges

<table>
<thead>
<tr>
<th>Item</th>
<th>Response</th>
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<tbody>
<tr>
<td>Plant Config. &amp; Sequencing</td>
<td>“On the hottest day of the year, what equipment is running?”&lt;br&gt;“What output of chiller #1 do you switch to chiller #2?”</td>
</tr>
<tr>
<td>No or bad baseline data</td>
<td>Ask for partial metering&lt;br&gt;May need to use judgements – uncertainties likely</td>
</tr>
<tr>
<td>Chiller Efficiency</td>
<td>Code or nominal not the best picture&lt;br&gt;Varies with age, load, etc.</td>
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<tr>
<td>Pump and Fan kW</td>
<td>May be able to use constant values – understand operation&lt;br&gt;For VSD, best to do some metering</td>
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Case Study

- Large office complex, ~2,500 tons peak load
- Ice storage system – all chillers off
- No baseline EMS data
- Very limited baseline metering
- Chillers also replaced – could not meter in post
- Peak Period:
  2 – 6 PM, M-F, 6/1 – 9/30, when “event” called
Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline Value</th>
<th>Post-Installation Value</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Load (tons)</td>
<td>2,500</td>
<td>2,500</td>
<td>N/A</td>
</tr>
<tr>
<td>Chiller kW</td>
<td>1,500</td>
<td>279</td>
<td>1,221</td>
</tr>
<tr>
<td>Condenser Water Pump kW</td>
<td>550</td>
<td>31</td>
<td>519</td>
</tr>
<tr>
<td>Cooling Tower kW</td>
<td>135</td>
<td>40</td>
<td>95</td>
</tr>
<tr>
<td>Total kW</td>
<td>2,185</td>
<td>350</td>
<td>1,835</td>
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</tbody>
</table>

- 10% less kW savings than predicted
- Some CW system load (small effect)
- Able to determine 1 chiller was running for 15 min during 1 event
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