Expanding Delta T in Enwave’s Cooling System
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AGENDA

• Quick Intro to Enwave’s DLWC System
• DLWC Capacity Breakdown and Constraints
• Typical Customer Site Controls
• Hybrid Control Strategy
• Summary & Other Applications
Introduction to Deep Lake Water Cooling
DLWC & “Polishing” Chillers

Diagram showing the process of DLWC and the flow of chilled water supply:

1. Island Filtration Plant
2. EnWave Energy Transfer Station
3. EnWave Simcoe Street Cooling Plant
4. Customer Site
5. Chilled Water Supply to Other Customers
6. EnWave Closed Cooling Loop

Legend:
- Chiller
- Direction of Water Flow
- Heat Exchanger

Keywords:
- Innovation
- Environmental Stewardship
- Health & Safety
- Teamwork
- Respect & Integrity
The Cooling System Today

**DLWC BASELOAD**
- DLWC 42,000 Tons + SSCP Chillers 10,000 Tons
- JSPS Chillers 7,300 Tons

**DISTRICT COOLING NETWORK**
- PSSP Chillers 2,000 Tons
- Future Plant(s) X Tons
- Customer(s)

**Future Plant(s)**
- X Tons
- BACP Chillers 5,200 Tons

**Customer(s)**
Breakdown of Deep Lake Water Cooling (DLWC) Capacity & Constraints
## DLWC Nameplate Capacity

<table>
<thead>
<tr>
<th>Original Nameplate Capacity</th>
<th>Design Capacity (Tons)</th>
<th>CHWR (°F)</th>
<th>CHWS (°F)</th>
<th>Flow (GPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DLWC Capacity</td>
<td></td>
<td>56.0</td>
<td>41.5</td>
<td>69,400</td>
</tr>
</tbody>
</table>

In reality, the Nameplate Capacity is rarely fully utilized in any given hour of the year. Capacity is limited by these variables:

- Increases Variable Operating Costs
- Reduces Total System Capacity

<table>
<thead>
<tr>
<th>Season</th>
<th>Maximum On Peak Capacity (Tons)</th>
<th>Maximum Off Peak Capacity (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>39,500</td>
<td>34,500</td>
</tr>
<tr>
<td>Spring/ Fall</td>
<td>37,500</td>
<td>27,000</td>
</tr>
<tr>
<td>Winter</td>
<td>21,000</td>
<td>17,500</td>
</tr>
</tbody>
</table>
# DLWC Nameplate Capacity

**Original Nameplate Capacity**

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<td>42,000</td>
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Determined by DLWC Heat Exchanger Approach. (Independent) Based on Customer Site Return Temperatures Influenced by:

- City Water Flow Rate
- Lake Temperature

**Objective:**
Explore Opportunities to Increase System CHWR Temperatures from Customer Sites
Typical Customer Site Control
Typical Customer Site Control

Supplier Side

Customer Side

Typically, District Systems Control to Supply or Return Temperatures

Purpose: Maintaining CHW Return Temperatures is CRITICAL to DLWC Capacity

Customer CHWS dependent upon:
- Customer Delta T
- Supplier CHWS Temp
Typical Customer Site Control

ΔT = 16°F

Systems are Operating in Harmony
Realities of Customer Sites

- Good Performers and Bad Performers
- Variations between On-Peak and Off-Peak
- Variations Seasonally
- Buildings are Never in a Steady State
  (Valves fail, Coil & HX performance degrades, etc.)

System CHWR Temperatures as a Result...

<table>
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<th>TARGET</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>On-Peak</td>
<td>Off-Peak</td>
<td>On-Peak</td>
<td>Off-Peak</td>
</tr>
<tr>
<td>56</td>
<td>51</td>
<td>50</td>
<td>53</td>
<td>51</td>
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Realities of Customer Sites

Supplier Side

Customer Side

Control Valve Modulates to Maintain Supplier Side
CHWR = 56°F

ΔT = 16°F

40°F

56°F

ENERGY TRANSFER STATION

~58°F

50°F

ΔT = 8°F

Supplier Side

Customer Side
Realities of Customer Sites

Supplier Side — Customer Side

Customer Conditions are Satisfied

Accomplished By:
- Resetting CHWR Setpoint Down
- Setting up a minimum bypass under Low Load Conditions
Opportunities for Improvement

At Low Delta T Sites
- Adjusted Set-points and Minimum Flow Bypasses are somewhat arbitrarily set to satisfy worst case conditions
- Missing out on opportunities when buildings are performing better

At High Delta T Sites
- Opportunity to realize higher CHWR temps than 56°F on Peak
- Seasonal Customer side CHWS requirements can be leveraged to drive building CHWR temperature higher
Hybrid Customer Site Control Strategy
Hybrid Control Strategy

**Supplier Side**

**Customer Side**

**AS LONG AS** Supplier Side CHWR is Above a Minimum Threshold

\[ \Delta T = 16^\circ F \]

\[ 60^\circ F \]

\[ 58^\circ F \]

\[ 44^\circ F \]

\[ 40^\circ F \]

\[ \Delta T = 18^\circ F \]

Control Valve Modulates to Maintain Customer Side CHWS at Set-Point
Control Strategy Advantages

At **Low Delta T Sites**
- CHWR set-points below typical (ie. 56°F) become minimum thresholds instead
- The lower CHWR temperatures only occur when the building performance dictates

At **High Delta T Sites**
- Increased Supplier Side CHWR Temperatures are realized when building performance dictates
Benefits to Each Party

Customer Benefits
- Stability in Customer Side CHWS Temperatures
- Enwave has a vested interest in the delta T performance of the building
- Additional Customer Side monitoring

Supplier Benefits
- Customers CHWS temperature requirements are satisfied
- Higher CHWR temperatures are realized when available
Summary & Other Applications
In Summary…

- To maximize DLWC Capacity at all times
- Supplier Side CHWR Temperatures need to be maximized
- CHWR Temperatures can be improved through a Hybrid Control Strategy

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Reducing District CHWS Temperature adds Capacity

- Added benefit of realizing higher Supplier Side CHWR temperatures when the district temperature is reduced
- Due to LMTD on the heat exchanger, approach narrows between the CHWR temperatures as the CHWS temperatures part
- DLWC Capacity increases as a result
Other Applications & Considerations

Increasing Heat Recovery in Hot Water Systems
- The inverse of the control strategy can be applied to Hot Water systems coupled with heat recovery or economization sources
- HWR temperatures would be minimized while maintaining Customer HWS temperatures at setpoint
Questions?