Chilled Water System Optimization

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Chilled Water System Optimization

Topics to be covered

• How is this approach to chilled water system optimization unique?
• How does it work?
• Compatible plant types
• Metering considerations
• System performance and test results
• System benefits
• Documentation
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How is this approach unique?

• It takes a holistic approach to chilled water system optimization and considers the energy use of the entire chilled water system (supply and consumption)

• The algorithm automatically adapts to changes in environmental and system conditions that occur over time

• It is scalable and can optimize the chilled water system alone, the condenser water system alone, or both
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How is the technology deployed?

- The optimization technology is deployed via a patented, self-adapting control algorithm, packaged in an application specific, native BACnet control module.

- It is designed as an overlay on top of existing equipment controls that are already in place.
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What is meant by an overlay??

- The logic in the optimization system works in conjunction with the incumbent control system.

- It reads electrical consumption and other system data, then computes optimized chilled water and condenser water setpoints to lower the overall system kW/Ton.

- The CWSO does not have hardware points; all optimization I/O functions are via network communications.
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How does it work?

• The CWSO improves overall system efficiency (kW/ton) by \textit{intelligently} resetting the CHWS & CWS temperatures and reducing chiller lift.

• In order to provide the lowest total energy consumption, the reduced chiller plant energy MUST be balanced with any increase in power that occurs on the load side pumping systems and fans.

• Any energy savings must also be accomplished WITHOUT adversely affecting building comfort or causing equipment problems.

![Energy Use vs Chilled Water Supply Temperature](image1)

![Energy Use vs Condenser Water Approach Temperature](image2)
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How does it work?
Chilled Water Reset

• It seeks out the lowest kW/ton by incrementally raising and lowering the chilled water supply temperature while measuring equipment energy consumption

• It is an **adaptive** algorithm that constantly searches for the lowest system kW/ton

![Energy Use vs Chilled Water Supply Temperature](image_url)
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How does it work?

Condenser Water Reset

- It operates like chilled water reset, except it provides ideal condenser water temperature *without* excessive tower fan power consumption. Setpoint reset is based on OA Wet-Bulb temperature, tower approach and chiller load.

- User configurable condenser setpoint limits prevent refrigerant stacking due to excessively low condenser temperatures at higher loads, or chiller surging at high condenser temperatures and low loads.

![Energy Use vs Condenser Water Approach Temperature](image)
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How does it work?

Simplified I/O Block Diagram

Either a BACnet Point or BACnet Value

- Plant ON
- OA Temp
- OA RH
- kW (typ.)
- Chiller On (typ.)
- Chw flow
- Chw temp
- Chws temp
- Plant Load (tons)
- Cws temp
- Cooling Requests

- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer
- Read by Optimizer

- BAV
- BAV

- Read by CHWS Setpoint ANI
  In chiller or chiller manager

- Read by CWS Setpoint ANI
  In tower or tower manager

- ANI
- ANI

- CHWS Setpoint
- CWS Setpoint
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How does it work?

- On initial start up, the algorithm totalizes all available power inputs and also calculates the cooling load.
- It then calculates the current total system usage per unit of cooling in kW/ton.

Optimization block diagram
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How does it work?

- Small setpoint adjustments (upward for CHW, downward for CW) are then sent in sequence to the plant control system.
- After a system specific delay, the kW/Ton is then recalculated.
- If kW/Ton decreases, additional incremental setpoint increases/decreases will be sent.
- If kW/Ton increases, the direction of the setpoint resets will be reversed.

Optimization block diagram:

The process repeats continuously, raising and lowering setpoints while verifying the effect on overall system energy consumption, continuously seeking out the lowest possible kW/Ton.
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Ideal plant types for system applications

• Applicable to a wide range of systems, but ideally suited for comfort cooling applications in commercial facilities and campuses
• Supports a maximum of eight chillers
• Water or air cooled plants
• Types of chiller systems:
  – Parallel plants
  – Electric chillers including (centrifugal, scroll, reciprocating, screw). Absorption chillers not currently supported
• Variable flow chilled water systems
• Variable flow condenser water system
• Variable volume air handling units
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System Metering

- The optimization logic requires metering on major system equipment

- The more system devices that are metered, the more effective the optimization calculations can be

- Sub-metering of system mechanical equipment can typically come from three sources:
  - Communicating Equipment with Variable Frequency Drives
  - Communicating Chiller Controls
  - Field Installed Sub-Meters
Potential Efficiency Improvements:

• Potential energy savings are expected to range from 3 -15% based on field tests and simulations.

• Actual energy savings will depend on many variables; plant size, existing equipment selection, duration of use, how well it is controlled, climate zone, tolerance to setpoint adjustments, and other considerations.

• The more system equipment that is metered, the more effective the optimization algorithm can be.
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Summary of Benefits

• Works with the mechanical system you have today; system modeling and pre-installation mechanical and control upgrades are not mandated
• Adapts to changing conditions in real time
• Scalable – additional plant equipment can be easily assimilated into the optimization scheme
• One time purchase vs. subscription based
• Minimal post sales maintenance
• Localized optimization - Doesn’t depend on cloud connections
• Can be enabled & disabled without interruption to the plant
  • *Minimal risk of system disruption vs. systems that assert direct control of mechanical equipment*
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2017 GSA Proving Ground Participation

The technology being presented today was selected to participate in the 2017 GSA Proving Ground program, where it will be tested in one or more US facilities and evaluated by GSA and a team of engineers from the National Labs. The program is currently undergoing site selection.
Available documentation consists of:

- PD Sheet
- White Paper
- Guide Spec
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QUESTIONS?