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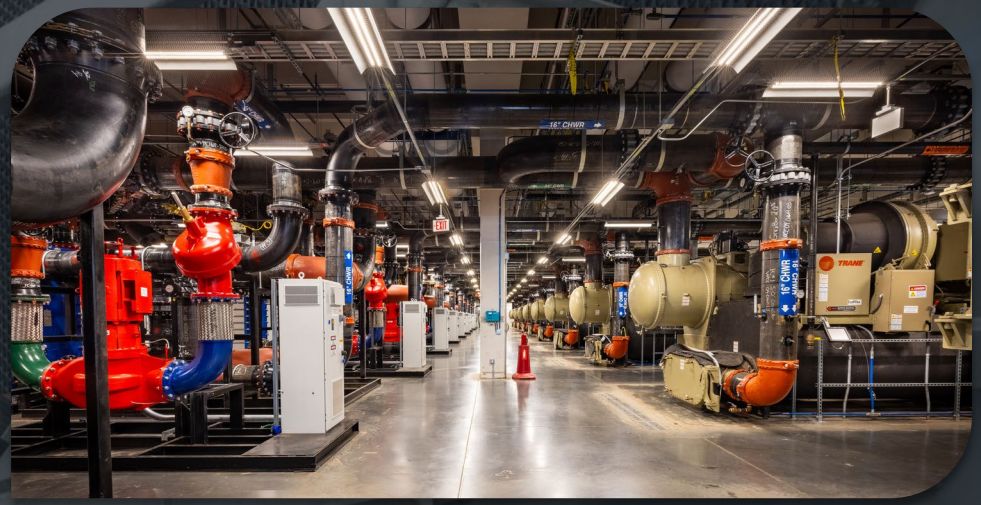
Central Plant Optimization



July 21, 2026

What is a Central Plant:

Equipment and distribution systems used to generate and deliver heating and cooling from **one central** location to the building(s) or spaces it serves.

Central Plant Optimization:

The act of efficiently coordinating the management of **equipment**, **load** requirements, and the **distribution** of energy.

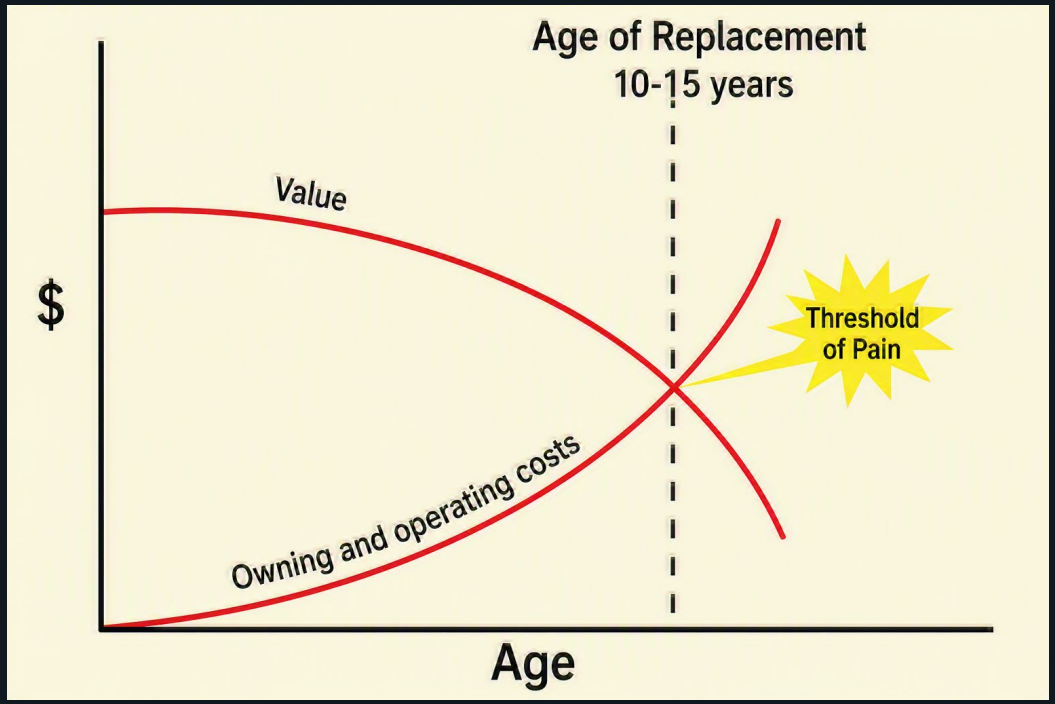
Equipment

- Chillers – Water / Air Cooled
- Cooling Towers
- Boilers – Fire Tube / Water Tube
- Pumps – Condenser / Chilled & Hot Water
- Air Separators
- Chemical Treatment System
- Variable Frequency Drives (VFDs)
- Heat Exchangers
- Buffer Tanks
- Thermal Energy Storage
- Valves – Manual & Automatic
- Controls / Building Automation Systems
- Cogeneration or Combined Heat & Power (CHP)

Condition Assessment

Understand the System

- Specific equipment information
  - Manufacture, Model/Serial No., Capacity, Refrigeration Type, Electrical, Efficiency Rating, Maintenance History
- Condition
- Age
- Useful life expectancy
- Operational costs (history)
- Hours of operation
- Comfort or humidity purpose… or both
- Redundancy



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Common Performance Challenges

- Poor equipment staging
- Fixed temperature setpoints
- Low CHW or HW Delta-T
- Excessive pumping energy
- Inefficient chiller loading
- Poor cooling tower performance
- Inefficient condenser water control
- Boiler short cycling (dry cycling)
- Not meeting condenser boiler efficiency
- Simultaneous heating and cooling
- Equipment operating when not needed
- Sensor and meter inaccuracies
- Inaccurate or inadequate metering
- Poor BAS sequences
- Manual overrides
- Heat exchanger fouling
- Poor water treatment
- Oversized equipment
- Deferred maintenance
- Poor Insulation
- Lack of performance tracking
- Offline equipment not hydraulically isolated

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Optimization Hierarchy

Reduce the load

Improve scheduling, reduce reheat, correct ventilation, improve envelope performance, address process loads.

Improve distribution

Reduce pumping. Improve Delta-T, reset pressures, fix valves, and bypasses.

Optimize production

Stage chillers and boiler correctly, optimize temperatures, improve tower performance, and use heat recovery.

Replace equipment when necessary

Understand the equipment, useful life, history, current challenges, and expansion expectations.

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Optimization By Cost (Lowest)

- Equipment and BAS maintenance service
- Correct schedules and remove unnecessary overrides
- Repair failed sensors
- Resets
  - Chilled and hot water temperatures
  - Differential pressure
- Improve equipment staging
- Isolate offline equipment
- Reduce simultaneous heating and cooling
- Retro-commissioning
- Trend plant performance – Keep Track!!

Optimization by Cost (Moderate Capital)

- Adding
  - Variable frequency drives (VFD)
  - Differential pressure sensors
  - Automatic Isolation valves
  - Accurate flow and power meters
  - Fault detection hardware
  - PICV (Valves)
- Replace leaking valves
- Repair tower fill and nozzles
- Remove 3-way valves, replace with two-way, VFD, and bypass valve
- Improve BAS sequencing
- Clean heat exchangers
- Boiler burner replacement – improve turndown efficiency

Optimization by Cost (Capital Intensive)

- Replace equipment
- Convert constant primary to variable primary flow
- Install thermal energy storage
- Add waterside economizers
- Convert steam heating systems to heating water
- Install combined heat and power
- Add heat recovery chillers

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The Benefits of Retro-Commissioning (Lower Cost)

- Reduced Energy Consumption
- Lowered Operating & Maintenance Costs
- Refined Operation
- Extended Equipment Life
- Increased Asset Value
- Improved Equipment Performance
- Improved Indoor Air Quality
- Increased Occupant Comfort

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Retro-Commissioning (RCx)

The systematic process of evaluating and improving an **existing building's systems** so they operate as efficiently and reliably as possible.

The top 10 most common issues found during a retro-commissioning include:

Simultaneous Heating and Cooling
Building zones may fight each other by cooling the air (e.g., at the chiller) and then reheating it before delivery, which wastes immense amounts of energy.

Defective Outside Air Economizers
Dampers become stuck, sensors fail, or control logic is faulty, causing the system to bring in too much outside air or fail to take advantage of free cooling.

Improper System Scheduling
Equipment runs continuously during nights, weekends, or holidays instead of shutting down or going into unoccupied setbacks.

Incorrect Air and Water Flow Rates
Air Handling Units (AHUs) supply more or less outside air than designed, and hydronic systems suffer from out-of-balance flow, causing hot/cold spots.

Sensor Calibration Errors
Temperature, pressure, and CO_2 sensors drift over time, sending false data to the Building Automation System (BAS) which results in inappropriate system responses.

Faulty VAV Box Minimum Settings
Variable Air Volume (VAV) boxes have incorrect minimum airflow limits or overridden setpoints, causing rooms to be over-conditioned or starved for air.

Leaking Valves and Dampers
Chilled water or hot water valves fail to close fully, or outside air dampers leak when they should be sealed, degrading overall thermal control.

Improper Static Pressure Setpoints
Duct static pressure or chilled water loop differential pressure is set higher than necessary, forcing pumps and fans to work harder than required.

Ductwork Leakage and Blockages
Leaky ducts or undersized return pathways cause building depressurization, unwanted infiltration of outside air, and unbalanced airflow.

Compromised Control Sequences
Legacy DDC control programs have been overridden over the years, leading to sequences of operation that do not match the current building usage or energy efficiency.

Retro-Commissioning Process Overview

- Review HVAC Original Construction Documents and Tenant Improvement Documents
- Provide Design Review
- Develop Retro-Commissioning Plan
- Review Trends
- Conduct Owner/Occupant and Maintenance Interviews
- Review Energy and Water Usage Records

- Assess Major Building Systems
- Investigate Condition, Operation, and Performance of Equipment/Systems
- Provide Site Investigation and Test Report Documentation

- Determine Issues Affecting Building Performance
- Provide Technical Analysis of Defined Issues
- Develop Energy Management Opportunities (EMOs)

- Develop Retro-Commissioning Report
- Discuss EMOs with Owner
- Validate Facility Performance Following Implementation of Corrective Actions

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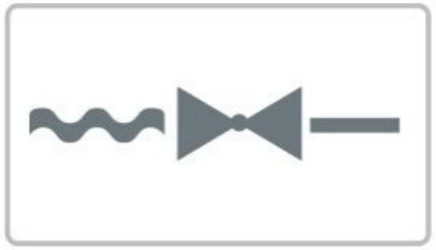
Pressure Independent Control Valves (Moderate Cost)



Dynamic Balancing

Energy Savings

Zero Leakage

Conventional Control and Balancing Valves

Challenges

- Building falls out of balance
- Dirty coils
- Variable system pressures
- Balance valves are set at design or full flow
- Valve position vs flow is NOT linear
- Valves overfeeding coils
- Higher flow rate (GPM) = less BTU transfer

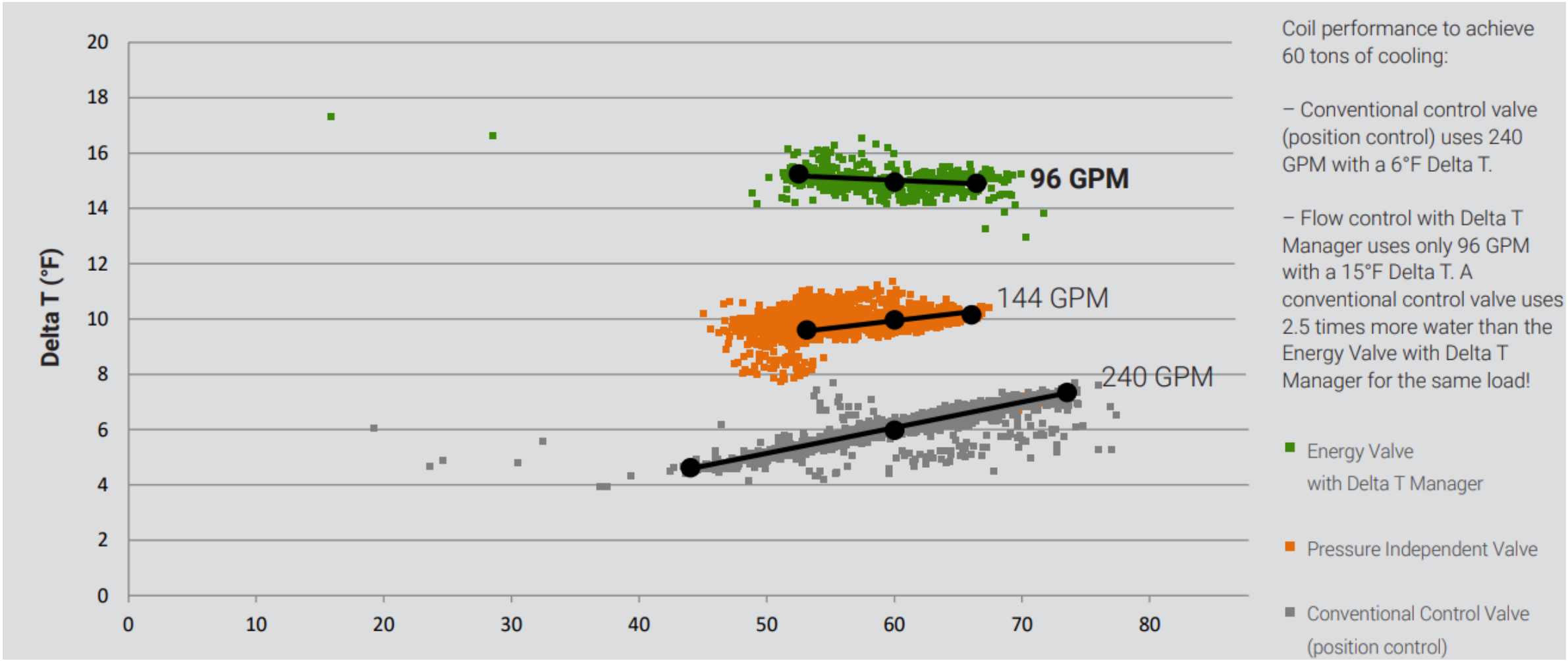
Pressure Independent Control Valve

Advantages:

- No dependence on a set hydronic differential pressure
- Fixes low Delta-T Syndrome
- Hydronic balancing is not necessary
- Eliminates the need for manual balancing valves
- ASHRAE-36 compliant
- Energy Savings:
  - Prevents overflow at coils
  - Improves **central plant** efficiency
  - Reduces pump energy

Pressure Independent Control *ENERGY* Valve

Pressure Independent Control Valve



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Chillers (Capital Intensive)

- **Absorption:** Uses heat instead of electricity (**)
- **Scroll:** Simple, reliable, less efficient at larger loads
- **Screw:** Good part-load performance and robust
- **Heat Recovery:** Recovers condenser heat, using it for heating needs (**)
- **Centrifugal:** Excellent full-load efficiency
- **Mag. Bearing Centrifugal:** Great efficiency at part load

In Summary…

- **Do the simple things first**
  - Utilize your partners
  - Understand your equipment
  - Don’t wait to address the little things
- **Think outside the box**
  - Be aware of new and emerging technology
  - What’s downstream that could be affecting overall operation
- **Develop a plan**
  - 5-year and 10-year layout
  - Understand the long-term impacts of a plan
  - Internal selling

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Let's Talk

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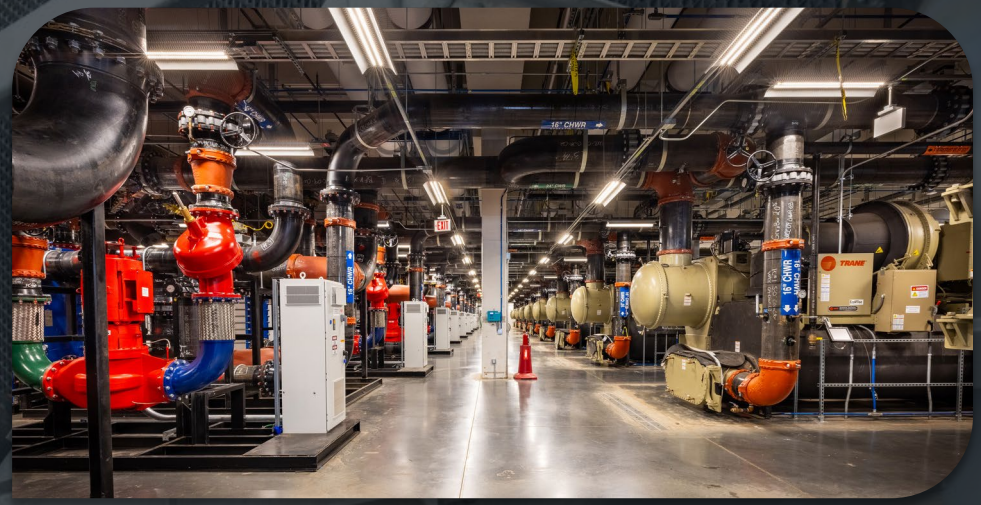

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