Johnson Controls

OpenBlue
Central Utility Plant

Yes, You Should Consider Central Utility Plant Optimization

Seven steps to high-efficiency performance and sustainability

The push to net-zero carbon is on—and the logical starting point for most facilities is the central plant. After all, buildings are the world's largest consumers of energy. Within a building, the most energy is used by the HVAC systems. And among all HVAC systems, the most energy is used by the chiller plant.

Central utility plant optimization enables facilities teams to better deliver mission-critical utilities while minimizing utility costs. Whether you have a simple chilled water plant or a complex heating, cooling and power generation plant, you can drive down costs, increase reliability and advance your sustainability goals. You may also have access to rebates and government incentives for plant improvements, creating a path toward autonomous, artificially intelligent, decarbonized buildings.

To get there, start with a fresh look at efficiency.

Think beyond components

HVAC thinking today is driven by bills of materials. Optimal chiller? Check. Energy-efficient pump? Check. The latest cooling tower? Check. Yet even best-in-class components cannot deliver the energy and operational savings stakeholders and regulators demand, for two reasons.

First, the industry is approaching the limit of individual component efficiency. Manufacturers have made great strides in the past 30 years, boosting HVAC component efficiency as much as 40%. We can't expect that pace to continue. Engineers and building owners facing increasingly aggressive energy efficiency goals must look beyond the component level to system-level efficiency.

Second, even the most efficient central plants can drop below their promised efficiency over time. This performance drift happens because traditional plant operation and maintenance treat the plant as static, disparate pieces of equipment. In reality, today's high-efficiency components are designed to work optimally when they're part of a networked system.

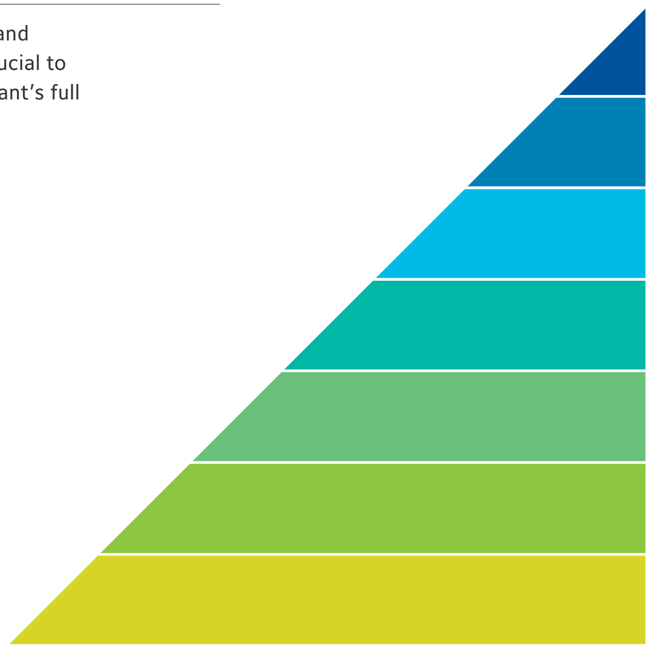
As a result, the focus is shifting from component-based efficiency targets toward a broader approach to persistent, peak performance. This philosophy is known as central utility plant optimization. And it has the potential to deliver sustained energy savings of up to 60%.

What is central utility plant optimization?

Ask 10 people to define "optimization," and you'll likely get 10 different answers. It's an algorithm. It's a software application. It's an energy-efficient component.

In truth, central utility plant optimization is a process. As shown in the pyramid below, its seven key steps encompass everything from infrastructure design and component selection to measurement and maintenance. Here's how you can use these steps to reach the pinnacle of efficiency—whatever the size of your central plant.

Making the right design and operating decisions is crucial to achieving your central plant's full efficiency potential.



Optimization Step 1: Design a flexible system infrastructure

The foundation of any optimization plan is a well-designed infrastructure that supports central plant efficiency. Plant simulator applications, aka digital twins, offer powerful comparisons of design and lifecycle costs.

In new construction, the key is to design with operational flexibility in mind. For example, in a chilled water system, consider combining a headered pumping system with variable primary flow. Variable speed drives increase efficiency potential, and headered piping allows for operational flexibility.

In existing buildings, consider steps like these to improve infrastructure and achieve similar results:

- Upgrade system configurations
- Add VSDs to chillers, pumps and cooling tower fans
- Automate the plant, if it's operated manually
- Review and improve automation sequences
- Replace equipment at the end of its life

Installation may be more expensive, but well-designed infrastructure typically pays for itself. The plant runs at a higher level of efficiency over its entire lifecycle, for improved return on investment.

Optimization Step 2: Select the right components

The next step is to choose components that will perform efficiently in real-world operating conditions.

Well-intentioned consultants and building owners often choose components based on future growth or the worst-case scenario—for example, seeking maximum efficiency at full-load kW/ton or on the hottest day in summer, at full occupancy. Instead, best practices call for selecting plant components that operate most efficiently at their most common load. A chiller with a more favorable part-load efficiency profile is the better performer in the real world.

Also consider smart equipment and telemetry. Smart connected chillers use dozens, even hundreds, of sensors to gather and analyze data from your equipment. They recommend optimal timing for maintenance and upgrades, and quantify operational efficiencies and savings. You gain unprecedented insight into current operations and potential issues, enabling you to identify and address problems faster. It's estimated that smart connected chillers can reduce unplanned and emergency repairs by as much as 66%—and cut the time from issue identification to resolution by 65%.

Ensuring proper metering of plant energy sources and production delivered to the campus is key. You can't manage what you don't measure. Leverage variable speed drives to measure electric power inputs to all equipment. Use three-phase investment-grade meters for the largest energy consumers. And apply chilled water, condenser water, and hot water flow meters at headers and, ideally, throughout primary equipment.

Optimization Step 3: Properly apply components

Have you ever used a screwdriver to pound nails? It gets the job done, but not as efficiently as a hammer. The same principle holds true for energy-efficient components. To achieve peak performance, the equipment must be properly applied and operated.

When installing or evaluating the performance of components, follow these best practices:

- Run the plant at its designed chilled water temperature. If the plant was designed to run at 44 degrees, running it at 42 degrees reduces its optimization potential.
- Don't push too much or too little water through the chiller. Too much water decreases pumping efficiency; too little diminishes the efficiency of the chiller itself.
- Take advantage of the environment. Install equipment that can use colder condenser water, when available, to make the plant run more efficiently.
- Ensure that key sensors such as flow meters are installed in proper locations with enough straight pipe to allow accurate measurements.

Improper component application reduces system efficiency, although the impact may go unnoticed unless central plant performance is effectively monitored. (See Step 7.)

Optimization Step 4: Automate building systems

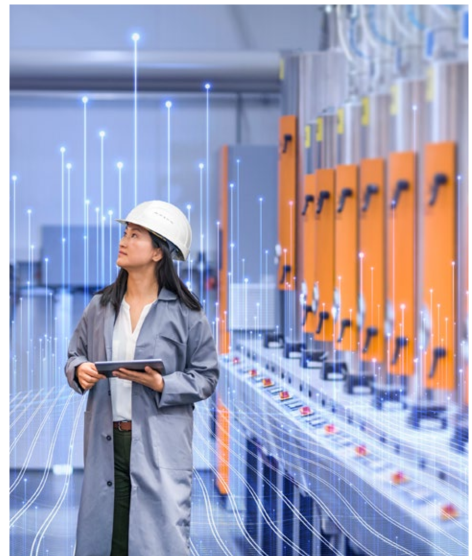
Building automation is a prerequisite to optimization, providing a reliable foundation of control. If you don't have a building automation system (BAS) in place, it's time to make the shift; you'll see efficiency gains that are otherwise unattainable by even the most skilled human operators. Scalable, easy-to-use control systems bring BAS benefits to commercial buildings of all sizes.

Today's BAS doesn't just start and stop equipment to maintain set points. It starts the right equipment at the right time to maximize efficiency, based on run history and efficiency profile. It selects the right speed at which to operate variable speed drives for pumps and tower fans. It uses algorithms to continually adjust control routines based on system dynamics and seasonal changes. And its monitoring and reporting tools show how to sustain efficient performance.

In our increasingly connected world, a modern BAS can help enhance cyber security through IT-standard protocols. And BAS field controllers keep your system running if a power outage cuts off connection to the cloud.

Optimization Step 5: Apply supervisory control and optimization software

Advanced supervisory control software is the brain behind the operation—intelligence layered on top of automation systems. Supervisory control uses techniques such as machine learning, adaptive control and model predictive control to select system setpoints,



determine mode changes and command the local control loops managed by the BAS.

Today's optimization software works in tandem with the BAS to maximize central utility plant efficiency, taking into account the specific energy characteristics of your plant's equipment. The software can reside on-premise in smart edge devices or in the cloud. It's standardized and scalable, offering even small plants benefits that were out of reach just a few years ago. Building owners can test drive the optimization software at one location, then scale it across an entire enterprise or portfolio of buildings.

The leading software monitors thousands of variables, gathering data from your connected equipment and from external sources such as weather forecasts and utility rates. It uses that data to determine the best combination of equipment and set points to achieve minimum utility cost. And it can automatically implement optimization decisions, as you choose.

Optimization software also enables grid-interactive efficient buildings (GEB) that are smarter about the amount and timing of energy use. Smart technologies and automated communication with utilities or power markets can "remake" buildings into clean and flexible energy resources by creating electric demand flexibility. As buildings continue to be digitally transformed, plant owners will see growing opportunities for price-based demand response revenue.

Comprehensive apps streamline monitoring and can also enhance asset performance, maintenance operations, occupant comfort and tenant satisfaction. These networked solutions deliver real-time measurement and management of central plant operating performance, making it possible to increase and sustain energy savings month after month, year after year.

Optimization Step 6: Maintain the system

Just as central plants have become more sophisticated over time, so has the role of maintenance. It's no longer a "set it and forget it" proposition. Advanced control sequences or optimization software rely on key sensors to remain calibrated.

Base maintenance on the plant equipment's actual condition rather than fixed schedules. A smart connected chiller can regularly report on its performance, including any problems or malfunctions. Service technicians and facility managers are up to date on trends and diagnostics, and can plan corrective action before a problem occurs. Plus, you eliminate the costs of unnecessary inspections and maintenance.

Fault detection and diagnostic (FDD) platforms that quantify and prioritize the value of each fault and integrate with work order management systems are good complements to supervisory control and optimization software. FDD tools identify additional energy savings, and even more important, improve system reliability to avoid unplanned downtime by enabling predictive condition-based maintenance.

A planned service agreement (PSA) brings you all the benefits of regular maintenance without the hassles. Look for providers offering a range of PSA tiers, from digitally supporting your in-house team to having professionals handle all chiller inspection, monitoring, maintenance, and repairs.

Optimization Step 7: Measure and verify savings

With real-time data available anytime, anywhere, you can identify issues such as performance drift long before they cause significant inefficiencies or equipment failure. Prompt detection and response can account for up to 40% of optimization savings.

Cloud-based tools create a 24/7 feedback loop, empowering operators to quickly detect, diagnose and resolve system faults. Data is made visible via easy-to-read graphs and charts. Alerts and notifications are sent automatically.

Remote operations centers and third-party monitoring can help you take full advantage of these capabilities, freeing your staff to focus on other priorities while ensuring central plant reliability.

Move your plant to the pinnacle of performance

Central utility plant optimization delivers the energy and operational savings today's consulting engineers and building owners require. Use the seven steps above as a guide to assess where your system is today, determine what's missing, and clarify next steps.

About OpenBlue

OpenBlue is a complete suite of connected solutions that serves industries from workplaces to schools, hospitals to campuses, and many more. This platform includes tailored, AI-infused service solutions such as remote diagnostics, predictive maintenance, compliance monitoring, and advanced risk assessments. A dynamic new space from Johnson Controls, OpenBlue is how buildings come alive. To read more about OpenBlue, visit: **www.johnsoncontrols.com/OpenBlue**