White Paper

Seven Steps to Maximizing Central Plant Efficiency

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Buildings are the largest consumer of energy worldwide. Within a building, the HVAC system consumes the most energy. And among the various HVAC systems such as airside, chillers and boilers, the chiller plant uses the most energy.

Central Plant Optimization

A holistic approach that allows central plants to reach and sustain their high-performance, high-efficiency potential

Are you getting the most from your central plant?

As commercial building owners search for ways to be more competitive, earn green building certification and anticipate government mandates for higher levels of energy efficiency, growing attention is being paid to the central plant. It's a logical place to turn. Buildings are the largest consumer of energy worldwide. Within a building, the HVAC system consumes the most energy. And among the various HVAC systems such as airside, chillers and boilers, the chiller plant uses the most energy. As a result, there is mounting pressure to increase plant efficiency through something called optimization.

Optimization is generating quite a buzz in the industry, but because the concept is still in its infancy, there's been a great deal of confusion about what it means. Is it hardware? Software? A third-party add on? Truth is, Central Plant Optimization is all those – and more. Central Plant Optimization is an *approach*. A *philosophy*. A *methodology*. And when fully implemented, it will allow a chiller plant to reach and sustain its high-performance, high-efficiency potential.

To get there, however, the industry is going to have to change the way it thinks about efficiency.

A Shift in Thinking Will Deliver Results

Today, the HVAC industry is a world 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 levels of energy and operational savings today's consulting engineers and building owners demand. The reason is twofold.

First, the industry is quickly approaching the theoretical limit of how much efficiency can be expected from individual components. Granted, HVAC equipment manufacturers have made great strides in the past 25 years, increasing the efficiency of components by as much as 40%. But we can't expect the same gains in the future. Moving forward, engineers and building owners will have to look beyond the component level to reach increasingly aggressive energy-efficiency goals.

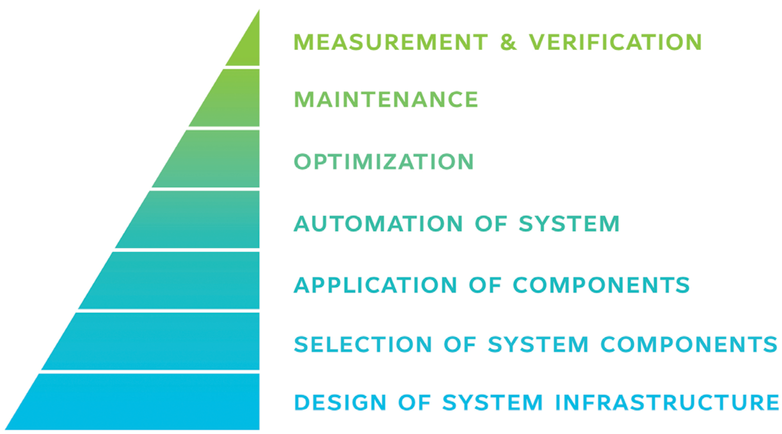
Secondly, even the most efficient central plants often fail to maintain their promised efficiency over time. This performance drift happens because traditional methods of plant operation and maintenance are based on a static operating model that treats the plant as a series of disparate pieces of mechanical equipment. In reality, today's high-efficiency components are designed to work optimally when they are part of a networked, interrelated system.

For both of these reasons, the focus is beginning to shift away from component-based efficiency targets toward a broader, holistic approach to achieving persistent, peak performance. This emerging, 'whole-building' philosophy is known as Central Plant Optimization and it has the potential to deliver energy savings previously unattainable.

What is Central Plant Optimization?

Ask 10 people to define "optimization" and you will likely get 10 different responses. It's an algorithm. It's an application. It's an energy-efficient component. Don't be fooled by those who claim any one of these pieces is the silver bullet that leads to optimization.

Central Plant Optimization is a process. As shown in the pyramid below, there are seven key steps to achieving Central Plant Optimization, encompassing everything from infrastructure design and component selection to measurement and maintenance. **When implemented holistically, Central Plant Optimization can deliver sustained energy savings of up to 60%.**



Achieving your plant efficiency potential is determined by both the design and operating decisions you make.

This 'whole-building' philosophy is garnering industry attention. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) is developing new energy targets based on the performance of a building *as a whole*. According to a recently-released committee report, one of the Society's goals is to develop standards for the calculation of building-wide energy use so that ASHRAE 90.1 can include system-level efficiency targets beginning in 2016.

Even as those new energy targets are being defined, however, consulting engineers and building owners can take advantage of the opportunities presented by Central Plant Optimization. This whitepaper will demonstrate how, by implementing each of the seven steps to optimization, it's possible to reach the pinnacle of efficiency today.

Optimization Step 1: Design of System Infrastructure

The foundation of any optimization plan is a well-designed system infrastructure that supports central plant efficiency.

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

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In existing buildings, it is possible to correct design deficiencies to achieve similar results by taking steps such as:

- Upgrading system configurations
- Adding VSDs to chillers, pumps and cooling tower fans
- Automating the plant, if it is operated manually
- Reviewing and improving automation sequences
- Replacing equipment at the end of its life

It may be more expensive to install this type of infrastructure, but the up-front cost of well-designed infrastructure typically pays for itself because it enables a plant to run at a higher level of efficiency over its entire lifecycle, leading to improved return on investment.

Optimization Step 2: Selection of Components

The next step to achieving optimization is the smart selection of system components. Here, the primary objective is to choose components that will perform efficiently *in real-world operating conditions.*

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Well-intentioned consultants and building owners will often purchase the most efficient components available, sized for the worst-case scenario or to accommodate future growth, and believe they've made the smartest choice. Components are chosen, for example, based on full-load kW/ton or the efficiency of the plant on the hottest August day with the mall full of shoppers. Instead, best practices call for selecting plant components that will operate most efficiently at the load *where they are going to run the most.* A chiller with a more favorable part-load efficiency profile will be the better performer in the real world.

Optimization Step 3: Application of Components

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

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 will reduce its optimization potential.
- Don't push too much or too little water through the chiller. Too much water will decrease the efficiency of the pumping; too little will diminish the efficiency of the chiller itself.
- Take advantage of the environment. Install equipment that is capable of taking advantage of colder condenser water temperatures, when available, to make the plant run more efficiently.

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

Optimization Step 4: Automation of the System

The next step in the pyramid is a prerequisite to optimization: building automation. Owners who already have a building automation system (BAS) in place are well-positioned to take advantage of optimization. Those who don't must make the shift, because even the most skilled human operators in the world would have a hard time operating a plant as efficiently and effectively as a current BAS.

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 its run history and its efficiency profile. With variable speed drives, the BAS also selects the right speed at which to operate pumps and tower fans. Top-tier building automation systems enhance plant efficiency further with tuning algorithms that continually adjust control routines based on system dynamics and seasonal changes.

Today's best-in-class building automation systems also offer monitoring and reporting tools so that a central plant's efficient performance can be sustained over time.

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Optimization Step 5: Networked Optimization Software

Networked optimization software is the intelligent logic that holistically operates the plant in the most efficient manner. It's the brain behind the operation, and step five in the strategy to achieve Central Plant Optimization.

Today's optimization software takes advantage of building automation systems to maximize central plant efficiency. It is standardized and scalable yet takes into account the specific energy characteristics of a plant's equipment.

The most advanced optimization software offers relational-control algorithms that optimize all the equipment so each component uses the least amount of power required to maintain occupant comfort. Control set points are automatically calculated based on real-time building load information inputs received from the building automation system, and the optimization software then evaluates that data and makes recommendations back to the BAS to improve performance.

Until recently, such state-of-the-art software was available only as a custom-built solution. But today, optimization software is standardized, documented, tested and proven – decreasing both cost and risk for the purchaser. Top-tier solutions are also scalable. Building owners can test drive the optimization software at one location, then scale it across an entire enterprise or portfolio of buildings.

These networked solutions also deliver web-based, real-time measurement, verification and management of central plant operating performance, making it possible for building owners and operators to increase and sustain energy savings month after month, year after year.

Optimization Step 6: Maintenance

With Central Plant Optimization, service is no longer a "set it and forget it" proposition. Just as central plants have evolved and become more sophisticated over time, so has the role of maintenance.

A century ago, uptime was the critical measure of system success. For the most part, maintenance was reactionary; if cold air wasn't being delivered, something got fixed. That was followed by a focus on maintaining occupant comfort and increasing efficiency, which meant maintenance became more routine, more proactive. With today's ultra-efficient components and optimized central plants, maintenance is *predictive*. In fact, predictive maintenance – the ability to identify issues before they become problems – is essential to maintaining the optimization of today's central chiller water plants.

Predictive maintenance also places an inherently-different responsibility on the people who are providing service. To make sure efficiency levels are being maintained over the plant's entire life cycle, performance data must be regularly measured, verified and managed as part of a continuous commissioning process.

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Optimization Step 7: Measurement, Verification and Management

The pinnacle of the optimization pyramid is measurement, verification and management.

When real-time data is available anytime, anywhere, issues such as performance drift can be identified long before the degradation results in significant loss of efficiency or, at worse, equipment failure.

Today, web-based tools are available 24/7 and act as a continuous feedback loop by providing detailed, real-time and historical performance data so operators can quickly detect, diagnose and resolve system faults. Data is made visible via easy-to-read graphs and charts and analysis tools allow for the quick diagnosis of faults. Alerts and notifications are sent automatically.

Sophisticated yet simple to use, these emerging measurement tools enable continuous commissioning to be more effective. Early adopters say they're amazed at the level of available, actionable data these tools provide.

ASHRAE is taking notice of the value delivered by real-time measurement, verification and management data. The Society is considering the development of a building classification system that would require owners to continuously measure the performance of the central plant, and regularly post updated efficiency levels.

Taking the Steps to Achieve Central Plant Optimization

As shown in this whitepaper, it takes a holistic approach, a "whole-building" philosophy known as Central Plant Optimization, to provide the levels of energy and operational savings today's consulting engineers and building owners require. Anything less delivers disappointing results. Don't be fooled by those who claim that any one step, or any subset of these seven steps, provides the silver bullet that leads to optimization.

Instead, take the time to think critically about your current situation. Perhaps you've already implemented some of these seven steps to optimization. Use this as a guide to show you what's missing, so you can maximize the investments in efficiency you've already made to achieve peak performance. Once fully implemented, Central Plant Optimization can deliver central plant energy savings of up to 60%.

Achieving true Central Plant Optimization will also require partnering with a provider who embraces this holistic approach, offers standardized, scalable solutions and can demonstrate proven performance.

With the right partner, the right mindset and a commitment to take each of the seven steps to Central Plant Optimization, you can reach the pinnacle of efficiency today. Why wait? Today's opportunity may be tomorrow's mandate.

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