

Optimizing Buildings Using Analytics and Engineering Expertise

by Brandy Moore

Executive summary

When fully utilized, Building Management Systems (BMS) offer facility managers many advantages. Harnessing building data to help correct root-cause energy inefficiencies is one area that is increasingly important yet challenging. This paper shows how leveraging BMS data through building data analytics software and combining it with expert engineering services creates actionable intelligence that can reduce HVAC energy costs by up to 30%.

Introduction

Building Management Systems (BMS) offer facility managers many advantages, including intelligent information about a facility's operational performance and energy use that can help identify root causes and correct deficiencies in buildings.

By harnessing building data properly, facility owners and operators can better realize the full return on their BMS investment as they save energy, reduce operating and maintenance costs, and improve building comfort. But in order to realize these returns and leverage the full power of their BMS, building operators need significant training, in-depth understanding of their facilities, and often additional tools to aggregate and make sense of the growing volume of data in a timely manner.

Over the past decade, several types of tools have come onto the market to fill this need, from dashboards to automated analytics to machine learning optimization engines. Each of these tools fulfills a different objective to help facility managers in their day-to-day operations and long-term planning. However, much like the sophisticated BMS platforms available today, each tool requires training and time to learn how to use it, along with an investment in IT infrastructure and support, to achieve its full benefits.

Research shows that only about 20% of facility managers use 80% of the available capabilities in their BMS. The remaining 80% use a very limited amount (20%) of the potential functionality in their system.¹ Personnel turnover and competing facility-management responsibilities (janitorial, construction management, and general repair) leave many facilities without the luxury of well-trained teams with adequate time to learn the full capabilities of these tools. Outsourcing different functions is one way to overcome these issues. But vendors must be managed closely in order to ensure effectiveness, and outsourcing can be expensive if vendors spend significant time on site.

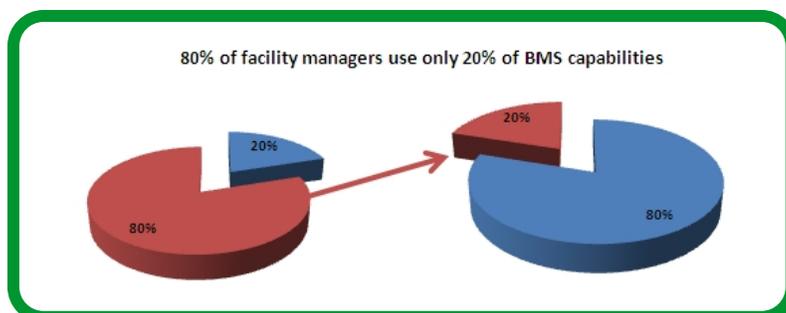
Combining the right tools in a remote, cloud-enabled managed software as a service (MSaaS) may be a better fit. The combination of the right diagnostic data and expert engineering insight can help facility managers:

- better understand how their buildings are performing
- maximize the return on building management and metering investments
- overcome training challenges
- reduce outsourced vendor management and costs

80% of facility managers use only 20% of their BMS capabilities.

Figure 1.

About 80% of facility managers use only 20% of the available capabilities of their BMS.



Today's building management challenges

Today's facility managers face a myriad of challenges that not only make it difficult to operate a building efficiently but also increase the risks to the facility, especially in aging buildings. It is estimated that 75% of the buildings that will be occupied in 2050 have already been built

¹ PikeResearch, Smart Building Managed Services, page 12, 2012

today.² This means that with little or no new construction on the horizon, building managers must create greater efficiencies in existing facilities.

The benefits of recommissioning

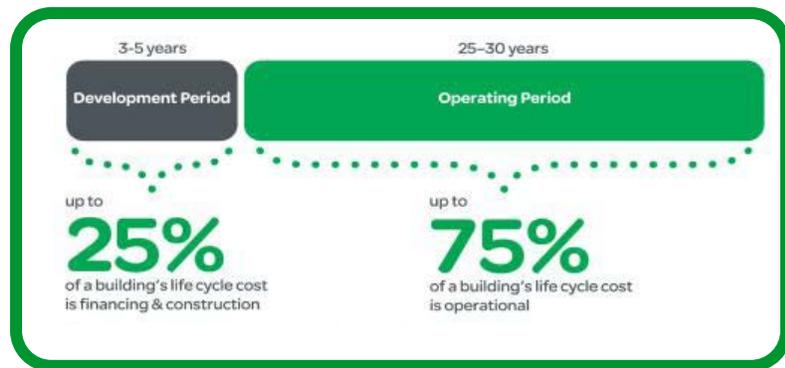
Recommissioning can result in energy savings of 5–15%, with a typical payback period of less than 2 years. For full details, see Schneider Electric's white paper [How Recommissioning Saves Energy in Buildings](#).

Reduced budgets force building owners to manage sophisticated building systems with fewer resources, an issue further aggravated by older systems becoming inefficient over time. And even when there is sufficient budget, it is increasingly difficult and time-consuming to hire, develop, and retain staff with the skills and knowledge to take advantage of BMS capabilities.

Facility managers also face the challenge of an immediate and continuous decline in existing equipment performance. Components break or fall out of calibration, and general wear and tear often leads to a rapid decline in a building's operational efficiency. Changes in building use and occupancy can contribute to indoor air-quality problems, uncomfortable environments, and higher overall energy costs. These changes begin immediately after construction is complete.

Figure 2.

75% of a building's life cycle cost is operational—with utility and maintenance typically the two largest cost components.



Building owners often undertake recommissioning projects to fine-tune their building in order to bring the facility back to its best possible operation level. But recommissioning is often done as a reactive measure, and traditional maintenance may not identify all areas of energy waste. Operational inefficiencies that are not obvious, or do not result in discomfort, may go undetected.

And finally, with 42% of the world's energy consumed by buildings, facility managers are constantly challenged by the escalating demand for environmentally friendly, high-performance buildings that are efficient and sustainable.

Benefits and limitations of BMS data dashboards

Technology has become an important part of building management, as building management systems play an ever bigger role in how facility managers perform their jobs and operate buildings.

Today's sophisticated BMS integrate with other building systems to provide alarm notifications and otherwise allow facility managers to react to current-state conditions and perform control tasks.

Newer technologies like BMS data visualization dashboards let facility managers view the building's performance metrics, manually spot trends, and gather insights. Dashboards can also generate reports and provide data for public kiosks that share information about buildings' performance.

By seeing visualization of the data in terms of graphs, charts, and conversion to different equivalents—for example, kW to dollar cost, kW to carbon footprint—an experienced building operator can manually identify areas of concern for closer inspection. While dashboards can

² Pacific Standard, Energy and the Empire State, May 2010

be quite helpful in understanding building behavior, the data is often complex and challenging to understand and use. In fact, even if building staff have the time and skills to review and understand the data, dashboard information alone tells only part of the story about how a building is performing. Facility managers can identify *where* inefficiencies exist but usually not *why*, which requires additional troubleshooting and investigation.

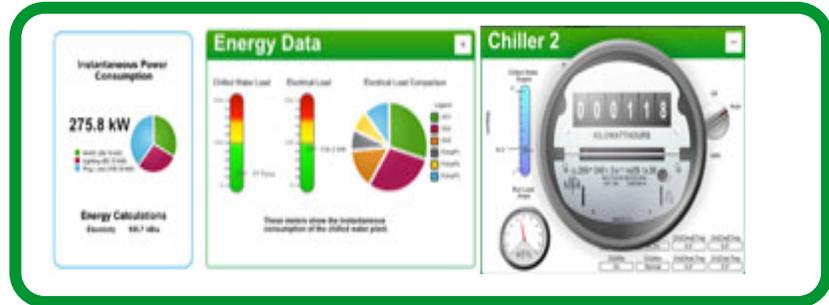


Figure 3

Data visualization dashboards let facility managers view the building's performance metrics.

Therefore, dashboards are most effective for simple monitoring and where there are enough trained staff to further troubleshoot and identify the root causes of issues.

So what other options exist to help facilities become part of the 20% that get more out of their investment in building management systems?

Turning BMS data into actionable information

Many facility managers are turning to data analytics software that allows them to interpret massive amounts of BMS data. Best-in-class software automatically trends energy and equipment use, identifies faults, provides root-cause analysis, and prioritizes opportunities for improvement based on cost, comfort, and maintenance impact. Data analytics software complements BMS dashboards because it takes the additional step of interpreting the data—showing not just *where* but *why* inefficiencies occur. Engineers then convert this intelligence into “actionable information” for troubleshooting and preventative maintenance, as well as for solving more complicated operational challenges. The software augments building management staff, helping to fill knowledge and resource gaps. More important, it allows facility managers to proactively optimize and commission building operations more effectively than with a BMS alone. Understanding why a building is operating efficiently (and why it is not) leads to more-permanent solutions.

What is hierarchical, rule-based FDD?

A rule calculates an “if- then” relationship and flags a deviation from the expected condition. An MSaaS analytics solution utilizes many interrelated rules within larger analyses, as well as model-based fault detection and diagnostics (FDD) to identify root causes in plain English and graphical illustration, monetize the energy waste/avoidable cost, and track maintenance and comfort impacts.

A core feature of the most advanced data analytics software is a process referred to as automated fault detection and diagnostics (aFDD), which identifies problems and recommends opportunities for savings without any human intervention. The most effective aFDD platforms use robust hierarchical, rule-based diagnostics to identify faults, diagnose mechanical systems, and determine the cost or savings incurred through making repairs, improvements, or upgrades to a building's systems or operations.

The actionable intelligence from data analytics provides facility managers with clear, prioritized recommendations for optimizing assets. The recommendations are based on statistical analysis, performance trending, and automated diagnostics. This approach drives results that are designed to maximize building performance and comfort with cost savings that further maximize the return on investment (ROI) associated with a BMS.

“If you do [preventive] service too early . . . it cost too much money. Too late, it’s no longer service—it’s repair.”
 —Daniel Doimo,
 Executive Vice President,
 Schneider Electric

For instance, with data analytics, facility managers can proactively identify operational problems such as equipment that needs to be repaired or replaced before critical failure. Building managers can schedule repairs before an emergency arises, thus eliminating costly replacement and avoiding failure and downtime. With this proactive approach, equipment becomes more reliable, the cost of replacement and repair can be much lower, and occupants are assured of optimal comfort.

The use of data analytics helps facility managers keep maintenance objectives on track and provides transparency into the performance of aging and upgraded equipment. Maintenance becomes more predictive, and operations and performance become more reliable—creating greater peace of mind. In addition, aFDD findings and documentation can be used for measurement and verification (M&V) to meet green building certifications.

Figure 4
 Data analytics reports give building managers insight into how their facilities are performing.



SaaS: a cost-effective, more efficient option

Some facility managers choose to build their own on-site building data analytics system that can be customized specifically for and integrated into their building's systems. This gives building managers the greatest flexibility with the system, as they have exclusive access to all the servers, software, and tools. But a custom-made solution can be a costly option.

On-site software can be expensive because a library of automated rules and diagnostics needs to be built from scratch for the specific equipment, environments, and situations of a particular building's operations. Since every facility is unique, this makes the system more difficult to deploy across multiple buildings or sites: the library of rules would need to be constantly updated to accommodate different equipment and situations. Not only does a custom-built solution require an investment in the IT infrastructure, it also calls for highly skilled staff or vendors to build the diagnostics and maintain the data systems. Further, customized systems rarely allow remote access or utilize web browser interfaces because of the high cost of keeping up with web browser versions and rapidly changing IT to combat security threats.

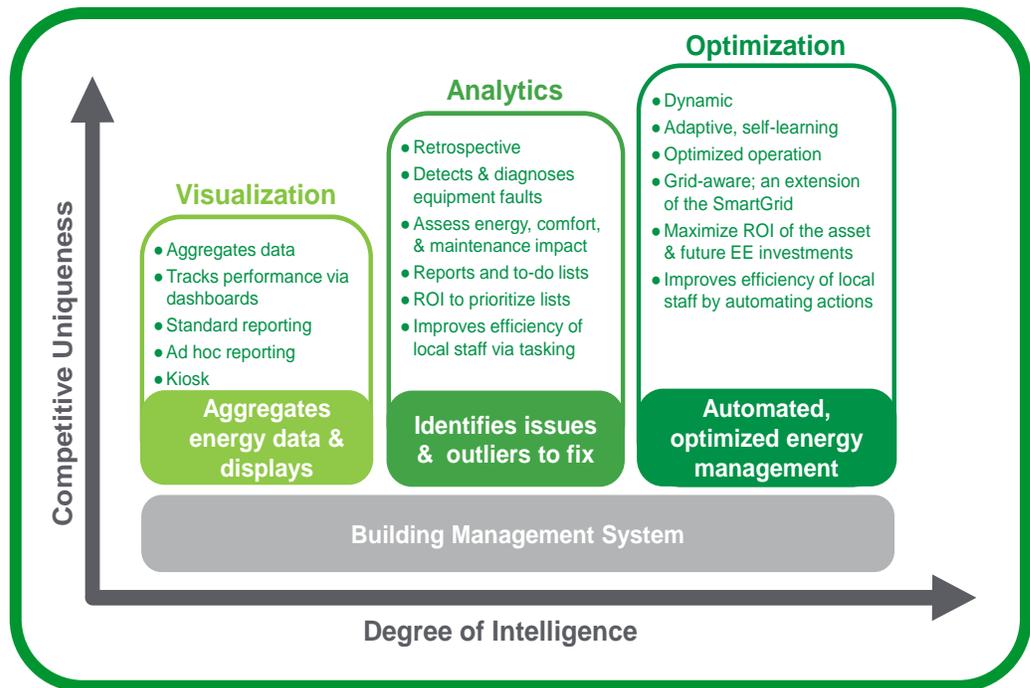
A more cost-effective and efficient option is a cloud-based software as service (SaaS) data analytics solution. Data is automatically pulled from building management systems and analyzed in a virtual cloud environment. This gives building managers both the powerful insights of data analytics and the flexibility of remote access and control—anytime, anywhere.

Leveraging a “mass-customization” approach, these subscription-based solutions cost less to deploy because an existing, fully built library of complex diagnostics can be customized to individual buildings very quickly. Additionally, the pace of technology change is so rapid today that on-site solutions may become antiquated very fast. Cloud-based SaaS solutions can react to customer feedback and constantly deploy new versions with added features and functionality continuously, at no additional cost to the user. Software upgrades and diagnostic improvements are also cost-effective and predictable, budgetable expenses because they are included in the subscription.

An emerging option is to fully embed and integrate analytics into existing BMS hardware and software. Embedding analytics is particularly challenging with retrofits or building upgrades, but it works well in new construction. Because this option is still in the early stages, there is limited functionality and availability today.

Figure 5

Dashboards help visualize where inefficiencies are, data analytics help identify why inefficiencies exist, and cloud-based SaaS solutions help optimize efficiency.



MSaaS: add expert insights and support for a complete solution

SaaS-based data analytics solutions reduce setup and ongoing maintenance costs, but they still require staff to manage the software, interpret and analyze the data, and, most important, act on the opportunities identified. In order to maximize their investment, facility managers have the option to choose a managed software as a service (MSaaS) as an analytics solution, which combines the SaaS analytics solution with the oversight of remote engineering experts.

Remote engineers work with facility managers to fully understand their priorities, budgets, financial goals, and performance objectives so building management can be viewed within the context of the overall business. Using insights from the analytics, remote engineering analysts monitor, detect, diagnose, and identify energy savings opportunities and use building data to understand why building issues are happening and deliver recommendations for upgrade/repair/maintenance based on business priorities.

The combination of analytics software and engineering expertise can drive measurable results—such as up to 30% reduction in HVAC systems energy costs—while enhancing building comfort and preventing premature equipment failure. Persistent, costly inefficiencies can be resolved, which drives a greater return on investment. Remote engineers also

eliminate the need for additional staff resources, allowing internal teams to focus on their core day-to-day responsibilities and also focus on repairs/maintenance with highest impact.

Additionally, an MSaaS analytics solution can increase the efficiency of vendors and partners by consolidating and integrating data from various building systems. This data can then be made accessible to all vendors, saving them time and making building services more effective. The data can be leveraged to improve vendor management by ensuring issues are fully resolved by utilizing analytic findings and monitoring capabilities to ensure issues do not reappear.

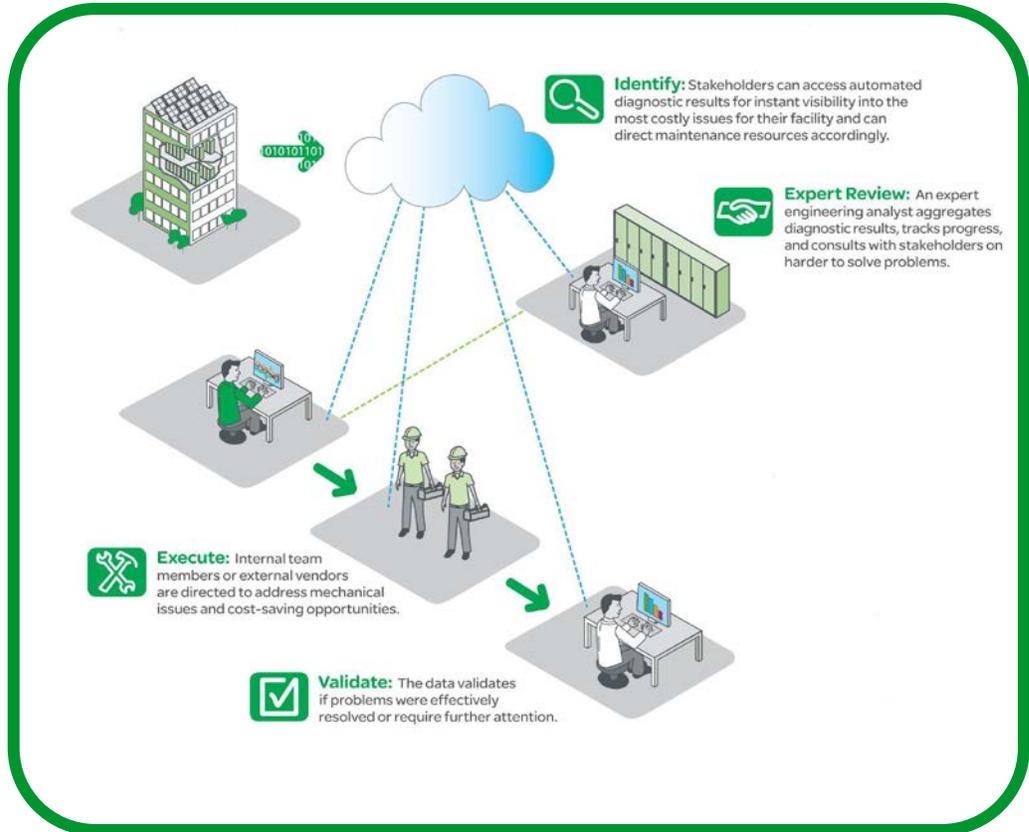


Figure 6
 Information flows from data to results. Analytics reduce facility operating costs over time by targeting maintenance efforts.

Data analytics solution	Pros	Cons
Custom-built system	<ul style="list-style-type: none"> flexibility tailored specifically to exact needs 	<ul style="list-style-type: none"> high cost highly trained staff limited remote access typically not web-based difficult to deploy across multiple sites responsibility for cyber security left with local IT staff
Embedded analytics	<ul style="list-style-type: none"> low cost to deploy on-site, typically no subscription 	<ul style="list-style-type: none"> limited functionality, availability difficult for retrofits capabilities are quickly outdated without regular, labor-intensive updates
SaaS	<ul style="list-style-type: none"> always up-to-date automated remote access web-based lowest cost to deploy easy to deploy across multiple sites 	<ul style="list-style-type: none"> highly trained staff potential cyber security concerns
MSaaS	<ul style="list-style-type: none"> always up-to-date expert engineering analysis automated remote access web-based lower cost easy to deploy across multiple sites 	<ul style="list-style-type: none"> potential cyber security concerns

MSaaS savings in action: customer success stories

The customer success stories below show that considerable cost and energy savings can be derived from minimal investments in MSaaS analytics solutions.

Recommended repairs save hundreds of thousands

A city in Nevada will soon be using automated fault detection and diagnostics for forecasted energy and cost savings in 13 municipal buildings totaling 903,000 ft² (83,891 m²). Through the use of an MSaaS analytics solution, the city will be able to identify and prioritize repair recommendations based on their impact on cost, comfort, energy savings, and maintenance.

The city's operations employees will have a proactive maintenance tool for all HVAC equipment, which is expected to lower annual operating costs. Data will be collected and processed in the cloud, and experienced technicians and engineers will access it to provide maintenance recommendations and detailed reports. The city has set up an annual budget for fixing faults identified by the analytics and the MSaaS provider has been tasked with ensuring a positive return on investment.

The city has made a 10-year commitment to its MSaaS analytics solution, which will monitor more than 1,200 pieces of equipment for performance and fault detection through over 12,000 data points. Additionally, savings from this project will cover the cost of a full BMS upgrade across all facilities. The estimated cumulative net savings including all projected costs over 10 years, based on making the identified recommended repairs, is expected to exceed \$364,000 (€264,000).

Monitoring services lead to major annual savings

A research laboratory in the greater Boston area used the fault detection analytics in an MSaaS solution to ensure optimal HVAC operations in its state-of-the-art laboratory. The five-year-old, 450,000 ft² (137,160 m²) facility includes a mix of laboratory, office, and educational space served by energy-efficient HVAC systems. The HVAC systems compromise 10 ventilation units (each with a capacity of 50,000+ CFM) and several hundred variable-air-volume (VAV) boxes.

The MSaaS analytics solution provided monitoring services in which analytics identified and recommended repairs for several major problems. It uncovered leaking and malfunctioning cooling valves in three air-handling units, and leaking heating coil valves in nearly 200 VAV boxes. The building analytics data, plus insights from expert engineers, helped the operations team prioritize actions and fix the most wasteful leaks first. Additional repair work will help accelerate retro-commissioning and automate verification of energy initiatives.

The fault-detection monitoring services have already helped identify \$286,000 (€219,000) in verified annual savings.

Justification for energy incentive program

A multi-tenant office building in Massachusetts used monitoring and verification services from an MSaaS solution to justify a utility incentive program. The operations team in this facility deployed data analytics diagnostics and reporting to help discover efficiency opportunities, as well as facilitating participation in the Massachusetts Pay for Performance (P4P) utility incentive program.

The diagnostics in this solution reported on the building's central air handlers, chilled water loop, and hot water loop. Because of the findings, the building's management committed to

A mixed-use (laboratory, office, education) research facility realized \$286,000 (€219,000) in verified annual savings through its MSaaS analytics solution.

six low-cost energy conservation measures (ECM) for pre-ECM and post-ECM monitoring to prove the energy savings targeted in their P4P project application. Other equipment issues found by the diagnostics are being corrected as they are discovered.

The anticipated incentive award will be \$32,000–\$44,000 (€17,600–€33,700), while the projected savings will be \$60,000–\$75,000 (€46,000–€57,400) annually. The simple payback of this project is less than 6 months.

Schneider practices what it preaches — and saves money

A Schneider Electric manufacturing facility in Seneca, South Carolina, realized an 83% decrease in avoidable HVAC energy costs through its own building analytics solution, for an annual savings of \$9,000 (€6,525). The solution paid for itself during the first year by providing automated, sophisticated analysis of root-cause inefficiencies.

Instead of facility managers relying primarily on monthly checkups to track performance, comfort levels, and maintenance and energy data, the solution automatically analyzes the 280,000 ft² (26,013 m²) plant's data every five minutes. The analytics was able to diagnose and troubleshoot HVAC problems the facilities staff didn't even know they had.

The Seneca plant has seen a 29% reduction in the number of maintenance incidents, and comfort incidents decreased by 33%.

To achieve these kinds of results, building managers can partner with an MSaaS analytics provider and maximize the value of their data analytics technology. The following checklist outlines the critical functionalities and capabilities to look for in an MSaaS analytics solution vendor.

- **Advanced FDD Library** A robust library of hierarchical, rule-based fault detection and diagnostics (FDD) that can be quickly adapted through mass customization is a key feature in MSaaS analytics solutions. Adding these essential functionalities later may result in significant additional costs.
- **Detailed Reports** A comprehensive solution offers regular detailed reports that prioritize fault findings based on comfort, energy savings, and maintenance impact.
- **Scalability** A flexible software platform that can consume billions of data points—from a single building to an entire enterprise—enables cost efficiency and better building management as an organization grows.
- **Open Protocols** Open software protocols allow integration with all third-party building automation systems to maximize efficiency and ease of installation.
- **Global Presence and Service Support** Proven industry expertise in efficient building management, along with a global presence, enables seamless services across an enterprise. BMS, building analytics data software, and MSaaS analytics solutions are continually evolving, so it is important to partner with a market leader that understands and evolves with industry demands.

“Building Analytics diagnosed HVAC issues we didn’t even know we had . . . and paid for itself in the first year.”
—Joshua Coale, Facilities Technician

Choosing a MSaaS analytics provider

Conclusion

Facilities owners have made significant investments in sophisticated BMS systems that generate a wealth of data about a building's performance. Data dashboards help facility staff visualize all this data, but dashboards tell only *where* inefficiencies exist—not *why*. Data analytics software can interpret this data and convert it into “actionable information” so facility managers can prioritize and proactively address issues for long-term solutions. The most cost-effective and efficient option is a cloud-based software as service (SaaS) data analytics solution

But an SaaS solution still requires staff with the skills and time to manage the software, interpret and analyze the data, and, most important, act on the opportunities identified. A managed software as a service (MSaaS) analytics solution combines the power of SaaS analytics with the oversight of remote engineering experts.

The combination of data analytics, managed services, and ongoing support from experienced building engineers can have a real impact on energy consumption, operational efficiency, occupant comfort, and the financial well-being of buildings. The right MSaaS analytics solution will proactively help facility managers achieve performance-based utility incentives and build a lower carbon footprint—all while driving a positive ROI, increasing portfolio value, and maximizing BMS investments.



About the author

Brandy Moore is Offer Management Director for Schneider Electric's Global Field Services for Buildings. Ms. Moore is responsible for industry-leading global services offer strategies, remote technology-driven and traditional service offer development, and worldwide service product launches. An industry expert, writer, and blogger on high-performance green buildings, energy solutions, and infrastructure solutions, Ms. Moore has held several positions at Schneider Electric, including director of global education solutions prior to joining the services team. A Certified Energy Manager, she holds a Bachelor of Science degree in Industrial Distribution from Texas A&M University.