WHITEPAPER

The new era of energy management

How to reduce your OpEx while achieving sustainability

Most companies today are lacking an effective strategy to manage their energy consumption and keep costs under control. This white paper will help energy and facility managers understand why data-driven energy management solutions are gaining traction for optimizing energy efficiency, availability and environmental sustainability.

Table of contents

The growth of energy consumption

To compete effectively, organizations must adopt revolutionary plans to manage and optimize their operational performance, utilizing cutting-edge digital technologies and leveraging the power of the Internet of Things (IoT).

The buildings where we live, work and entertain absorb more than 42% of the world's energy consumption due to heating, cooling and lighting systems.[1] Over the next 25 years, worldwide energy demand is expected to grow by over 40%, calling out an urgent need for energy efficiency and sustainability.

This strong growth in energy demand is shaping the complexity of power distribution systems at all levels. Power grids are becoming more dynamic in order to manage distributed energy resources (DER), while private and public companies are taking up the challenge by creating environments capable of self-sustaining.

Additionally, more than half of power-outage events in buildings, both commercial and industrial, can be attributed to problems with equipment and poor electrical distribution systems that absorb more power than required. Given this situation, the need to optimize energy consumption and costs along with power reliability is more prevalent now than ever.

This especially applies to critical sectors such as public health buildings, data centers, public infrastructures and continuous-process manufacturing facilities.

Digitalization enabled by the IoT is pivotal to support the growth of energy demand and the challenges associated with it. Turning data into productivity gains while lowering consumption and costs could help organizations achieve environmental sustainability through reduced emissions.

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Transforming data into actionable insights can uncover potential pathways to improvements and support organizations to identify efficiency gaps, while mitigating risk.

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Figure 1: A conceptual smart city that utilizes distributed energy resources such as solar and wind power

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[1] IEA.org/data

Measuring and monitoring electrical systems

Often, organizations do not have control over their energy consumption, nor an accurate methodology to inform them on how their site or building is operating. In order to reap the full benefits of digitalization, organizations must first understand how much energy is being consumed and how it is consumed. Thus, the first and most important step in energy management is to clearly identify a baseline and the behavior of the electrical system.

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By visualizing data in real or aggregated time, customers can better understand their electrical distribution system as well as identify where the inefficiencies are.

Metering provides energy managers and operators reliable information, real-time or aggregated, on energy usage. Most often, an energy data and analysis backbone coupled with a robust plant-energy model will reveal patterns of energy waste that would be impossible to see otherwise. Moreover, depending on the organization's needs, adding more measuring points can significantly increase the accuracy of the reading, thus providing better insights about installation and more data on which to base optimization actions. Meters should be installed at different levels of the installation to enable the measuring of individual loads or group of loads (homogeneous) to cover at least 70% of power consumption.

Improvements based on metering have been shown to reduce energy consumption by as much as 45%.[2] But while most organizations understand the importance of measuring and monitoring, only a small number of organizations implement an effective strategy for energy management. In fact, organizations typically undertake independent and uncoordinated projects, mostly small and short-term, due to lack of knowledge and methodology. Such an approach leads to outcomes that are well below expectations. Energy monitoring is seen of little value, even though a well-organized system of measuring and monitoring would pay back in a short period of time due to lower energy and maintenance costs and negligible power outages.

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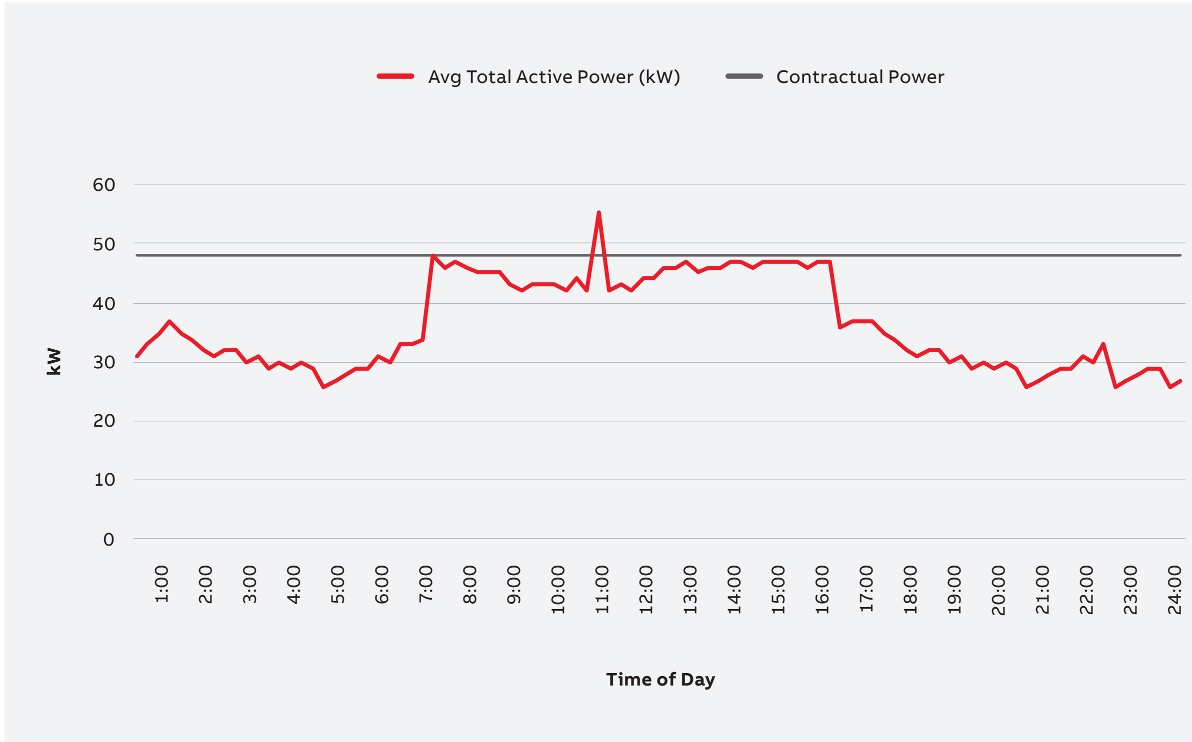
Figure 2: Hypothetical representation of a building's power absorption over a typical day



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[2] EIA – Energy Efficiency Report

Measuring technologies, applied to the monitoring of a building for efficiency purposes, can be extended to water, gas and heat metering, providing a comprehensive visualization that could give an overall picture of operating conditions. Sensors that read conditions such as temperature, pressure or humidity, coupled with analytics and in some cases machine learning (ML) technologies, are also starting to play a crucial role, unlocking the potential to understand more in-depth, unexpected behaviors.

Benchmarking energy consumption and electrical-system parameters is generally based on annual history, while observation is most relevant in a year-over-year comparison. Short-term analysis, such as month-over-month comparison, could also be valuable for identifying specific events occurring in a determined period. But benchmarking cannot be accurate without constancy: continuous monitoring is necessary in order to tell if a sample represents a good or poor status. Such an approach is also the base for energy-efficiency processes and strategies in production environments.

For example, Energy Performance Indicators (EnPI) used mostly to acquire certifications, or as a base for energy audits, provide the highest potential to identify paths and the effects of interventions - but only if they are continuous and structured.

In numbers, let's assume that a 5% energy efficiency improvement - quite easy to achieve with a metering system installed[3] - can reduce electricity consumption by approximately 5%. Let's assume as well that the organization's industrial production site (which include a solar rooftop) incurs an average energy cost of EUR 800.000 per year. By measuring and monitoring the electrical distribution system, the organization can save thousands of Euros, if not hundreds of thousands annually. In our hypothetical example, the cost savings on the energy bill amount to EUR 40.000 per year.

Without access to data, organizations are subject to inefficiencies in diagnosing and fixing problems. For example, if a piece of equipment is not behaving correctly, the plant or energy manager sends a maintenance crew to investigate the issue. If the problem with the equipment is mechanical, it can be fixed. But if the nature of the problem is different (such as voltage imbalances), it could lead to a lot of guesswork, as well as effort and money wasted without results. Data accessibility and reliable information will decrease the time it takes to identify the problem and remediate the issue.

Figure 3: ABB Ability™ Energy Management interface

[3] Carbon Trust Organization - Reports

Intelligent Energy Optimization
Energy monitoring is not the only solution to maximizing energy efficiency. Intelligent energy optimization also plays an important role. In general terms, energy optimization means optimizing energy usage to maximize benefits for people as well as the environment, and consists of three concurrent strategies: saving energy, managing demand response and using renewable energy sources. Thus, energy optimization solves multiple challenges that impact not only the electrical distribution system but load management. An advanced energy optimization solution enables sustainability through active management of site equipment (which helps reduce CO_2 emissions) and decentralizing the generation of energy.

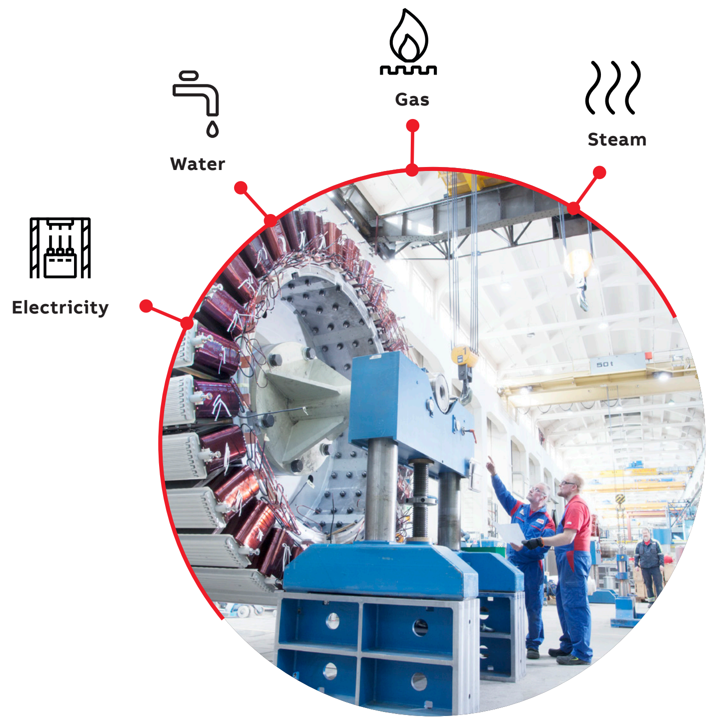
Intelligent energy optimization can help customers use energy in concert with a dynamic power grid and distributed energy resources while enhancing a shift from fossil fuels to greener energy sources. It can therefore support the creation of smart grids (and eventually "smart cities") within commercial and industrial sites and decentralize the responsibility of generating energy and contributing to the market. Several studies[4-5] predict that energy optimization solutions can lead to as much as 25% energy and cost savings - by shifting or shedding loads, for example - dramatically shrinking an organization's investment payback period. In our hypothetical example, adopting an intelligent energy optimization solution could lead to a lower energy bill - approximately EUR 200.000/year - as well as potential revenues whenever energy surplus is shared with the grid.

Facility management beyond electricity
As a complex system, a commercial or industrial site will have sources of energy other than electricity, such as fuels, steam, heat, compressed air and other media[6], as well as other utilities (water, gas). These sources should also serve the purpose of efficiency.
Key performance indicators (KPIs) for these sources are often included in energy audits (inspection surveys that seek to prioritize the most effective opportunities for energy and other utilities savings).

In a multi-energy/utility building, efficiency can be achieved by coordinating the different sources, as well as by utilizing storage technologies such as batteries, TES and supercapacitors, thus potentially creating independent micro-grids. Therefore, facility optimization as a whole provides a leading approach for the effective peak-shaving of electricity or heat demand, efficient use of renewable energy, low-cost carbon capture and distributed energy systems.[7]

Most organizations, however, are still far from implementing a monitoring and optimization strategy for their facilities. Barriers include the high cost of optimization systems as well as still-present technological limitations. To be sure, exploiting data from multiple energy sources and utilities could help organizations achieve their most challenging environmental and sustainability targets. The good news is that digitalization enabled by the IoT is continuing to evolve, making adoption of reliable and low-cost cloud or hybrid offerings easier than ever.

Figure 4: Facility optimization requires energy efficiency across all energy sources



[4] Energy Foundation - Reports

[5] European Online Journal of Natural and Social Sciences 2014; Vol.3, No.3 Special Issue on Environmental, Agricultural, and Energy Science

[6] ISO50001 - 2018

[7] Capacity Optimization for Electrical and Thermal Energy Storage in Multi-Energy Building Energy Systems, ICAE 2018

The benefits of power monitoring and energy management

As we mentioned, companies with power monitoring and energy management systems can achieve important cost and maintenance savings by continually assessing their operating data. In most cases, these savings directly impact the P&L bottom line. That said, there could also be under-evaluated benefits that are less obvious:

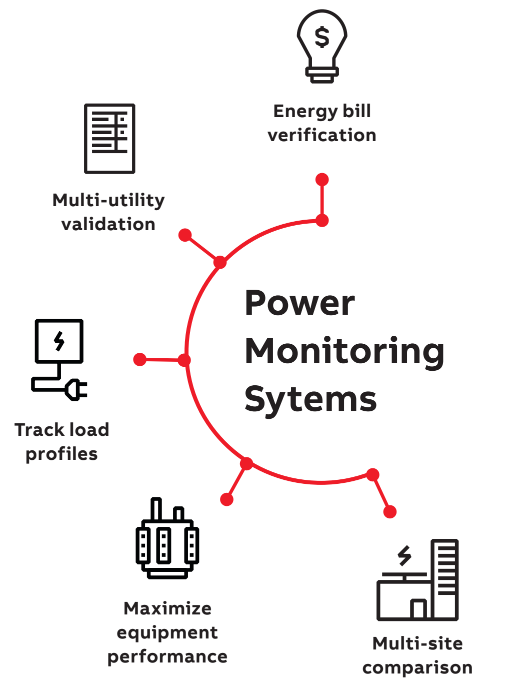
Energy bill verification
A commercial bill usually provides only bottom-line power usage and penalty charges. Often there is no way for the user to verify the correctness or make an analysis of these values. Installing an energy management system can provide simple but robust intelligence. For example, the ability to read kilowatt hours and active/reactive power, and to compare that data with tariffs published in the contract, will help identify errors or misreadings.

Multi-utility validation
A commercial or industrial site generally has different providers for energy, water and other utilities. The bills (i.e. water) are usually based on different timeframes (i.e. monthly, bimonthly, quarterly, etc.) and are often not checked or controlled accurately. Small but continuous leakages often go undetected for long periods of time, leading to unexpected high charges. Data monitoring can support the alerting and early detection of leakages, thus allowing for timely intervention and cost savings.

Track load profiles
Tracking the load profiles helps to identify early signs of poor equipment health. Let's assume that, from the time of installation, a typical power load peaks at 6 a.m. and drops off at the end of the day. Tracking the load will immediately help spot a change in that pattern, thus revealing an underlying potential problem - for example, a malfunctioning compressor or equipment left running overnight. Data comparison can support the energy / facility manager in assessing the situation and planning for a correction before the problem becomes severe.

Multi-site comparison
Better quality and continuous flow of information will have a significant impact on organizations with a multi-site structure. Having a more accurate comparison between different facilities that might be similar will allow a harmonization of operations and costs. Let's say there are two equivalent production lines in two different facilities. One production line is performing below par, consuming more energy than the other due to poorly functioning equipment. Multi-site comparison of power consumption and power quality helps pinpoint where the problem is, allowing for the appropriate corrective action.

Maximize equipment performance
Harmonic distortion caused by nonlinear loads is a common issue that can damage electrical components. In the same way, transients, swells and under/over voltage events can have a harmful effect on equipment. For example, a mere 5% harmonic distortion within transformers can result in a 25% loss of capacity. Similarly, large motor imbalances will cause inefficient performance, potentially leading to a large amount of wasted energy[8] and increased probability of failure. Power-quality management features coupled with general device information can help identify the problem early so that damage and downtime can be minimized, if not eliminated entirely.



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[8] Energy Management Handbook, The Fairmont Press, Inc.7th Edition

Energy management as SaaS (Software-as-a-Service)

Just a few years ago, building and facility operators were limited to basic on-premise power monitoring systems, while most advanced energy management systems were based on complex and expensive solutions. Few systems allowed upgrading and almost all required the on-site intervention of a dedicated team. Also, few smart devices were available, with connectivity limited to a small amount of data and almost no ability to upgrade once installed. Additionally, especially in brownfield projects, measuring points along with smarter devices were selected based on loads dimension rather than usefulness in strategically monitoring the system.

Lately, however, the market has seen a steady increase of smart devices with higher accuracy and more monitored parameters. Operators, supported by new regulations and certifications, are becoming more focused on identifying the correct measuring points to yield the best and most accurate information.

New digital technologies are strongly shifting the market toward affordable hybrid/cloud-based solutions supported by a SaaS model, thus providing flexibility in terms of upgrades, add-ons and pricing.

The market for energy management and power monitoring systems is changing radically. IoT platforms for energy management are quickly emerging for industrial, commercial and residential applications with their defining characteristics. By unlocking the potential of cloud infrastructure, these platforms are making possible the instantaneous, unlimited and global access to information anytime, anywhere, at an affordable price. More complex analytics can run smoothly with a higher quantity of data processed in a shorter period, dramatically accelerating feedbacks and outputs resulting in increased efficiency, innovation and value creation.

With a few clicks and minimal investment, operators can migrate from a simple and basic energy management solution that offers dashboards for real-time visibility of energy usage, alerts for anomalous conditions and detailed reports, to a more sophisticated version with features like advanced power analytics, power quality analysis, power forecasting and intelligent alerting. These "smart" capabilities give operators the valuable information they need for their specific application or system.

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Figure 5: ABB Ability™ Energy Management interface

Seizing the future of energy management

Energy's future will embrace new value chains interconnected by digital technologies with continuous, multi-directional data flow. All stakeholders will add their own value to the system, ensuring a higher overall efficiency at all levels, from production to the final consumer. Simple or complex energy management systems will play a pivotal role in this changing ecosystem, promising to generate huge ROI through improved efficiency, yield and asset availability.

Digital transformation will also include artificial intelligence (AI) and machine learning (ML) technologies. These advanced technologies are being developed to help commercial and industrial buildings predict unplanned behaviors related not only to energy consumption, but also power quality and asset reliability, leading to even greater energy efficiency. The most advanced applications will include industry-specific solutions, which will offer the possibility of adopting future technology.

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Energy efficiency is becoming more of a strategic asset every day – an important competitive differentiator and a strong added value to boost growth and profitability.

For most organizations, a substantial shift in thinking, along with changes to their existing energy infrastructure, will be required in order to capitalize on next-generation digital technologies. The time for that change is now. After all, organizations have a social responsibility to become more efficient, greener and more sustainable. As demand for energy grows, it is undeniable that integrated energy management is a fundamental component of that future.

To learn more about ABB and its comprehensive portfolio of energy management solutions, visit our webpage.

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