



# Reducing Costs & Achieving Superior Plant Energy Performance

Using Real-time Information & Best Practices  
in Energy Management



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## ABSTRACT

After years of attempting to streamline operations in an effort to reduce operational costs, many industrial manufacturers are turning to strategic energy management as a potential money-saving strategy. In their efforts, managers face a number of significant barriers such as low awareness and expertise, elevated financial hurdle rate, lack of capital allocation and procurement constraints. In addition, energy efficiency efforts may be hampered by traditional “single point” energy reduction methods such as reviewing utility bills, getting equipment upgrade suggestions from vendors or one-time energy audits. Research demonstrates that these techniques have neither the visibility nor continuity to achieve energy reductions that are consistent and persistent. With the right Best Practices, however, using new methodologies and technologies unavailable only a few years ago, enterprises can achieve dramatic energy reductions and their resulting cost savings. These Best Practices are founded on 1) application of a systematic methodology for understanding where energy is used and how to reduce it; and 2) achieving visibility into sufficiently granular real-time information on key performance indicators; 3) integrating new technology into overall corporate strategy and processes to change behavior.

## INTRODUCTION

According to 2009 study by Aberdeen Group (Ref. 1), the U.S. industrial sector accounts for about one-third of total energy consumption – more than any other sector including residential, commercial and transportation. Globally, the industrial base accounts for nearly half of all energy consumed. A McKinsey Global Energy and Efficiency Report (Ref. 2) states that the U.S. industrial sector will consume 51 percent of the 2020 baseline end-use energy in the United States, equivalent to 20.5 quadrillion BTUs of end-use energy. At the same time, the report says that the industrial sector offers 3,650 trillion end-use BTUs of NPV-positive energy efficiency potential. This is equivalent to 18 percent of the industrial energy consumption forecast for 2020. If it was possible to capture this energy efficiency potential, it would save industry \$47 billion per year in energy costs. How that number translates to each individual industrial plant depends on many factors, but represents an incredible opportunity to reduce costs and increase competitiveness across the entire sector.

The Aberdeen Group study revealed that the top pressure driving companies to focus on energy efficiency, selected by 80 percent of their respondents, was the need to reduce costs in manufacturing operations (eclipsing sustainability pressures by a wide margin). Companies are looking at energy management because they have already attempted to streamline operations and reduce expenditure through reduction of unscheduled downtime, improving overall yield, increasing quality or reducing inventory among many other strategies.



But Aberdeen researchers discovered that executives managing industrial plants often underestimate the ability of effective energy management to reduce costs. This was particularly true in energy-intensive plants where energy cost is a large percentage, often upwards of 25 percent of the total operational costs of the plant. In such scenarios, even the ability to cut a small percentage of total energy consumption can result in significant savings.

The McKinsey study points out the five principal barriers to capturing energy efficiency:

#### **Low Awareness and Attention**

Since energy may represent a relatively low percentage of operating costs as compared to other expenditures, it may receive very little attention from executive management, resulting in limited investment in developing the required technical expertise. Efficiency opportunities often require technical analysis that on-site employees rarely perform because of insufficient training, awareness, or management concern. The savings potential varies by site, ranging from 10 to 40 percent even for sites within the same sub sector, highlighting the need for site-specific analysis.

#### **Elevated Hurdle Rate**

Industrial sites work within very tight operational budgets and management tends to focus on quarterly targets, potentially at the expense of projects that pay back over longer periods.

#### **Capital Allocation**

Non-core projects such as energy efficiency must compete against core projects for limited capital budget. Often energy-efficiency projects face an elevated hurdle rate and executives are reluctant to raise debt even for desirable projects for fear of adversely affecting balance sheets and credit ratings. In addition, the separation of the plant operations and maintenance budget from capital improvement budgets can create an organizational challenge since the costs of energy efficiency reside in one budget while the savings reside in the other.

#### **High Transaction Cost**

Executives' perception of transaction costs associated with energy efficiency include space constraints, invested resource time, process disruptions, potential effects on product quality, and safety concerns.

#### **Procurement and Distributor Availability Constraints**

Many procurement systems contain limited inventory and focus on up-front costs rather than total cost of ownership. In addition, plant managers are risk adverse which will often create demand for in-kind rather than more efficient replacements.

On top of these barriers, some executives may have attempted energy efficiency projects and received results that were not consistent and persistent. A 2009 study by the Lawrence Berkley National Laboratory (LBNL) reports that energy savings achieved through a retrofitting process "can degrade without an explicit effort to monitor and maintain them." (Ref. 3)

The positive side of the message, however, is that the deployment of energy management Best Practices can result in consistent and persistent energy reductions. In fact, each of the



five barriers to energy management can be overcome efficiently and cost-effectively through Best Practice methodologies.

In its Energy Intelligence study, Aberdeen takes into consideration how well companies reduce energy and how well this reduction translates to the bottom line. They categorize enterprises according to the top 20 percent, middle 50 percent and bottom 30 percent. The Best-in-Class Top 20 percent achieved a 15 percent real reduction in energy usage which corresponded to a 14 percent gain in operating margin above the corporate plan. The industry average players managed a seven percent reduction in energy use and a two percent improvement in operating margin, while the bottom 30 percent experienced a six percent increase in energy usage and a nine percent drop in operating margin as compared to their corporate plan.

Clearly, the question becomes, “How can Best-in-Class results be achieved?” McKinsey states, “What appears needed is an integrated analysis of energy efficiency opportunities that simultaneously identifies the barriers and reviews possible solution strategies.” While McKinsey is talking about the development of a nationwide strategy for energy management, they might well have been addressing the Best Practices of an individual enterprise. Achieving consistent and persistent energy reductions requires:

- Applying a systematic methodology for understanding where energy is used and how to reduce it
- Achieving visibility into real-time information on key performance indicators (KPIs)

Energy must now be treated as a raw material that needs to be carefully and wisely managed against standards for maximum results.

## THE TRADITIONAL APPROACH TO ENERGY MANAGEMENT

Before Best Practice techniques and strategies can be developed, it is necessary to examine and understand the typical energy management cycle, potential results and shortfalls to avoid confusion. Frequently, industrial plants will be led to a “point in time” energy view method for finding “Energy Reduction Opportunities.” This will generally involve one or more of the following tactics:

### **Review of Utility Bills**

While this approach may seem logical, in fact it provides little meaningful data except to highlight that the cost is higher than the company would like. Utility bills are too macro in view and provide insufficient granularity for meaningful analysis. They do not allow comparisons of different resources such as contrasting gas and electricity or electricity and water since all of these utilities report in different systems on a different timeframe and basis. Equally important, utility bills alone do not identify usage by process or by subsystem, making it difficult to pinpoint the sources of energy usage meaningfully.

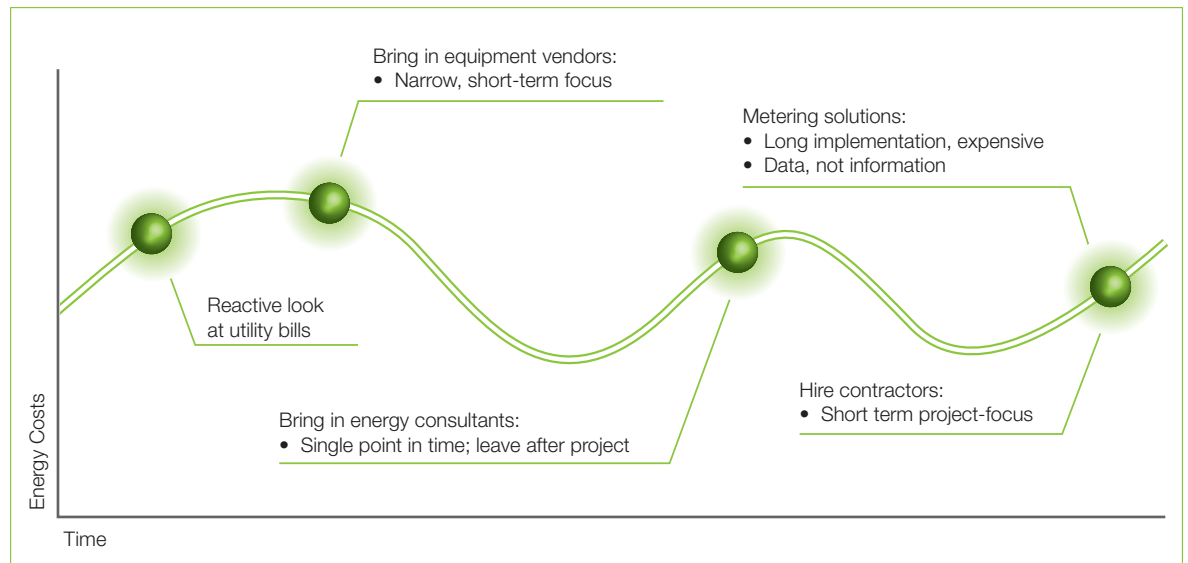


Figure 1.

Traditional approach to energy management

### Equipment Vendor-suggested Upgrades

Most plant managers have had an equipment vendor suggest an equipment upgrade as a method of reducing energy usage. The problem is that such analyses are narrow in scope since their focus is only on one or two pieces of equipment, and often do not factor for interaction with other equipment or processes in the plant. Vendors, of course, have a vested interest in selling new equipment and may not explain or even understand how old equipment might be made more efficient with minor upgrades. Finally, once the new equipment is installed, vendors often leave the responsibility and methodology for ongoing monitoring of the energy efficiency of the equipment with the company.

### Energy Audits

When energy consultants do an assessment and recommend changes, the limitation is that they are capturing the situation at a given moment in time. In addition, the consultants often do not handle the implementation of suggested changes, so the end result may fall short of the predicted energy savings.

After companies have used one or more of these “point in time” methods to identify savings opportunities, they may undertake some level of project or equipment-specific monitoring. These approaches are rarely sufficient to make a significant impact since they tend to be conducted right after the energy efficiency project and, due to limited resources, budget or lack of integration into manufacturing operations and corporate culture, the results fade over time.

As Aberdeen has observed, the first recommended action in creating “Best-in-Class” energy reduction is the establishment of a formal corporate strategy focused on reducing overall operational costs through improving visibility of energy usage and optimizing operations based on costs and efficiency. Unquestionably, single-point energy efficiency initiatives may have some positive results when first implemented, but even a few months later, efficiency levels can degrade significantly due to improper maintenance or control.



The key takeaway from an examination of traditional methods of identifying energy efficiency opportunities is this: energy savings left to human and equipment entropy causes inconsistent results. A series of case histories on energy efficiency in buildings described in the Lawrence Berkeley National Laboratory benchmarking study give examples in the commercial sector of similar problems.

In one case, a building experiencing high nighttime natural gas and electricity usage was traced to the fact that the chiller and the heater were both operating overnight along with much of the lighting despite the fact that the building was unoccupied. While these meters were read monthly, no personnel noticed or reported this very obvious problem – a clear case of human entropy. The simultaneous and excessive heating and cooling wasn't discovered until the building was put on a continuous monitoring system.

Equipment entropy is just as common, as indicated by the LBNL study. As an example, the case study indicated significant instability in the direct digital control system which regulated air temperatures in two air handlers. Trending data showed that the preheat valve cycled every 15 minutes between 75 percent open and full closed which produced a supply air temperature variation of 10° F. The chilled water valve had a similar instability resulting in unnecessary heating and cooling. While such problems might be solved once, they continue to arise in new and the same locations like the proverbial Hydra.

Such equipment entropy can lead to expensive and unnecessary decisions. One company was experiencing dramatic shifts in temperature from room to room and was considering replacing its chiller with a more efficient unit. When monitoring showed that many thermostats and actuators were out of calibration or even inoperable, it became clear that there was inadequate electrical load to justify the replacement of the chiller saving the company a considerable expense.

The typical energy reduction from traditional energy efficiency methods might be described as a sinusoidal curve. The manager looks at the utility bills and realizes change is needed. Often, equipment vendors are called in and focus only on their own systems, so results improve briefly and then decline. Occasionally, energy consultants produce a large list of projects that the company must implement themselves or find another consultant to accomplish. The complexity is discouraging, contractors are costly and management has more pressing responsibilities so, again, results decline. When nothing else seems to work, management may consider a metering solution, but these systems are expensive, require lengthy implementation and provide the company with data not information. No one at the firm is trained to interpret the data and performance declines. In addition, since continuous monitoring is not provided, the combination of entropy in human behavior and equipment further degrades performance. This sinusoidal wave of incremental improvement and decline in efficiency might be thought of as the “yo-yo diet” of energy management. Countless companies are on this frustrating regimen, shedding some energy expenditure for a short time but losing those savings over time and ending back where they began or worse.



## BEST PRACTICES IN ENERGY MANAGEMENT

Fortunately, achieving persistent energy savings is both simple and cost-effective.

### Determine Energy Cost Per Unit

According to Aberdeen (Ref. 4), Best-in-Class companies are using actual energy consumption, at the unit level, to make real-time decisions for optimizing production, maintenance and energy delivery processes among others. Best Practices, then, begin with a detailed understanding of where energy is used in each individual plant and across the enterprise. Managers need to know what their energy cost is per unit of production and what systems comprise that cost. This necessitates a full view of electricity, natural gas, water, etc.

### Develop Standards and Targets

The next step is to establish standards for energy that cover each of the areas of use. This determination will be individual to the industry and enterprise. Unlike commercial build-

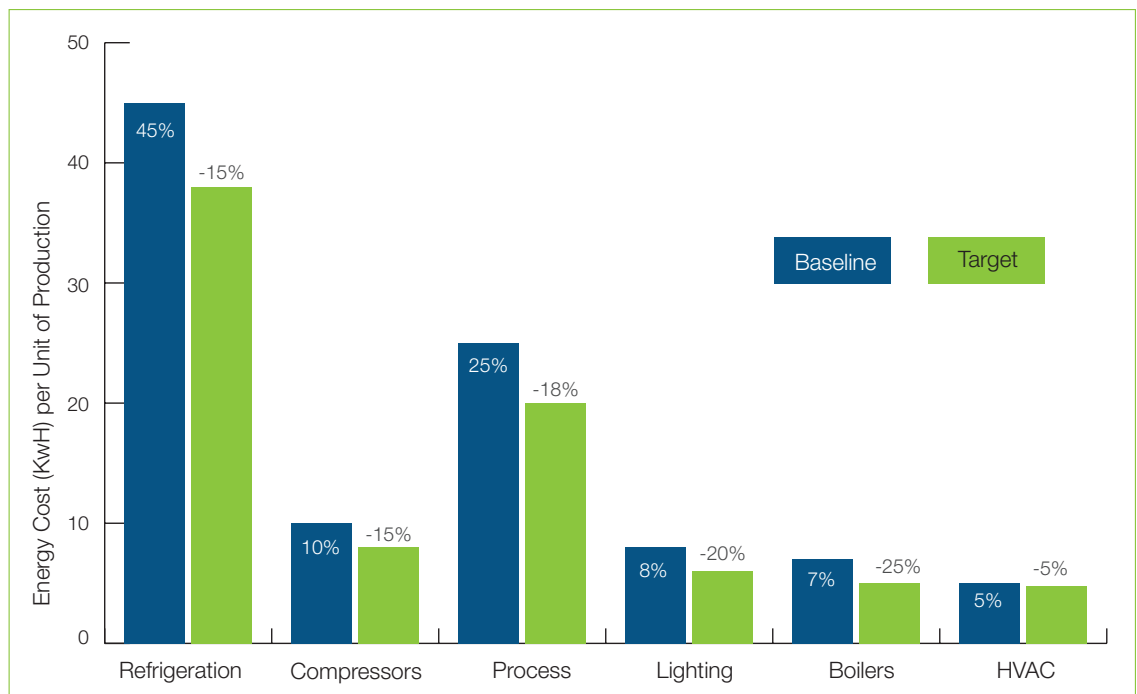


Figure 2.

Sample baseline energy usage and target reduction levels

ings where many standards have been established for processes like HVAC use, industrial manufacturing is more challenging. Each plant is a unique mix of products, processes, environmental conditions and equipment sub-systems and there are few established industry standards. Manufacturers may know that steam systems including boilers, distribution and condensate recovery processes are typically large consumers of energy, but whether the boilers in an individual plant are over-consuming cannot be easily assessed. It may be argued that the establishment of formalized standards for industrial markets is desirable, but since they do not presently exist, enterprises must establish their own. To determine standards and Best Practice targets, manufacturers can turn to neutral third parties and experts to determine what their energy cost-per-unit-of-production is and what the Best-in-Class target



should be. If energy cost today is \$.20 and an identified target is \$.15, then a 25 percent reduction is the goal. Most manufacturers, however, will require expert assistance to arrive at a realistic target.

### Enterprise-wide Energy Visibility, Intelligence and Management System

Aberdeen states that the most common component of what they call Energy Intelligence being deployed by Best-in-Class companies is the automated collection, and centralization, of energy data (Ref 4). This automated data collection is the foundation of real-time decision-making enabling the optimization of operations. It is essential that this automated data collection be integrated with a formal corporate strategy that is focused on reducing operational costs, as well as with the operations and maintenance strategies of the plant. It should not be treated as an isolated system.

Also key to the success of the energy visibility and management is adoption of Alerts and Event Management, Energy Dashboards and Energy Analytics. These business-intelligence tools enable organizations to effectively leverage collected energy data to contextualize real-time events and make optimal decisions based on historical trends. This real-time approach facilitates optimal energy usage and provides notification when critical conditions are approaching so that actions can be taken to prevent over-usage.

### Utilize Real-time Data to Understand Gaps in Plant Standards

Organizations use enterprise-wide visibility, intelligence and management to understand why and how the plant is using more energy than required. This, in turn, leads to steps in real-

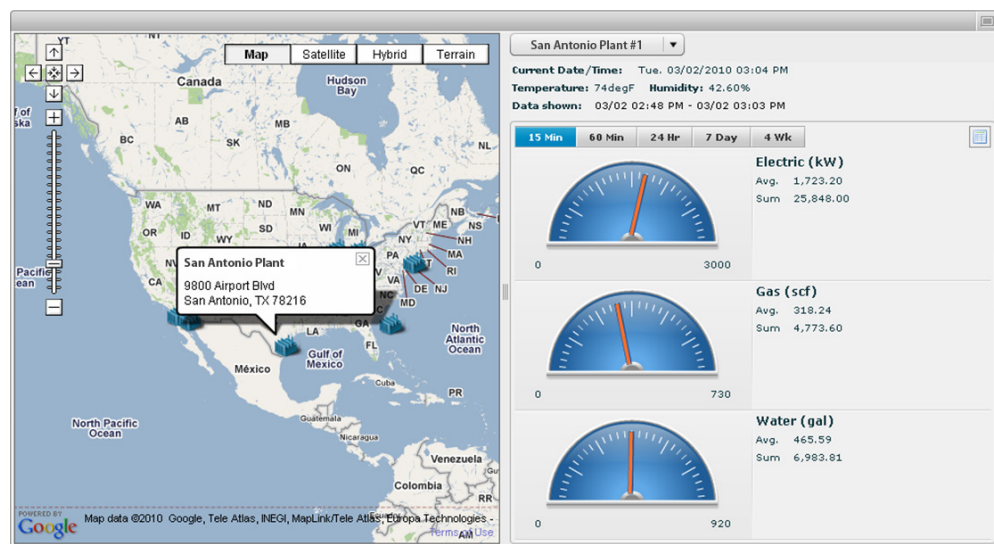


Figure 3.

*Dashboard visibility facilitates real-time energy intelligence*

time to proactively narrow the energy gap. The use of alerts is critical in this strategy, notifying personnel when energy usage is too high or the plant is approaching a critical energy threshold. Such enterprise-wide visibility lets managers see the occurrence of entropy in behavior and equipment and allows that degradation to be reversed before it can impact energy usage.



Aberdeen gives an example of a leading U.S. dairy producer. Dairy is the third highest energy consuming sector in the food industry. This particular company was facing intense market pressure to measure and reduce their carbon emissions in order to maintain shelf space and market share at a leading retail customer. They needed to lower energy usage in their production processes throughout their facilities and to reliably measure and verify their energy consumption and carbon emissions to meet the customers' standards. The company set an aggressive goal of 20 percent reduction over five years.

To accomplish this goal they rolled out a pilot program deploying a real-time energy monitoring system with alerts, energy dashboards and energy analytics. At each site, they collected near real-time data on electric, fuel and weather. The system provided visibility into the performance of the most energy-intensive sub systems which included refrigeration, compressed air, steam boilers and waste water. In the first 90 days one plant discovered that the waste water meter was out of calibration and the utility fresh water meter was overstating consumption by 150 percent. This discovery resulted in a savings of 1.2 million gallons of water per month at a cost of \$3,000 per month.

Additionally, the system identified that by monitoring and shutting down non-critical loads, another plant could lower their electrical demands by 200 to 300 KW translating to a cost savings of \$3,000 per month.

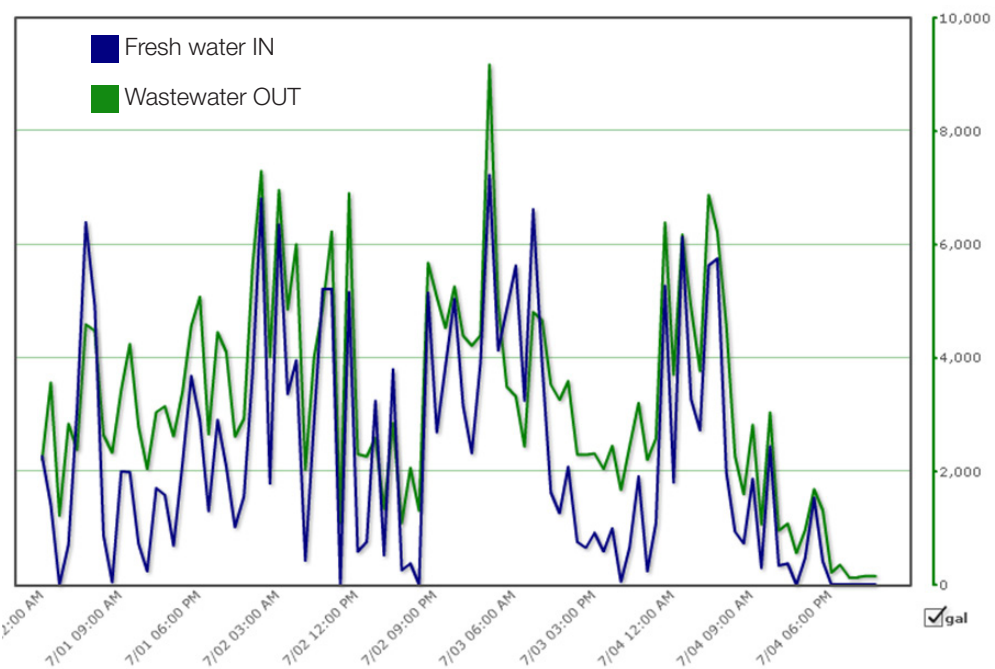


Figure 4.

Energy monitoring identifies simple, low-cost opportunities for significant savings

### Reduce Gaps by Systematically Planning Reduction of Energy Usage

With information in hand, the next step is to deploy and take advantage of the Best Practices developed at each of the plants, implementing projects that deliver ongoing, persistent energy savings. Deployment will involve changes in both people's attitudes and behavior, and technology and equipment (Ref. 5).



The first steps will generally be behavioral, identifying ways in which people can change in order to reduce energy. Such changes often result in quick improvements with little or no investment. For example, one company discovered that the spread between its natural gas flow and boiler feed water was larger than desired. These differences turned out to be periods of non-production. Sending automatic e-notices to personnel reminding them to shut off boilers on non-production days reduced natural gas usage by 20 percent and saved \$1,130 per month as shown in Figure 5. Technology such as electronic alerting can be used effectively to avoid peak pricing, schedule preventative maintenance or remotely manage behavior and equipment.

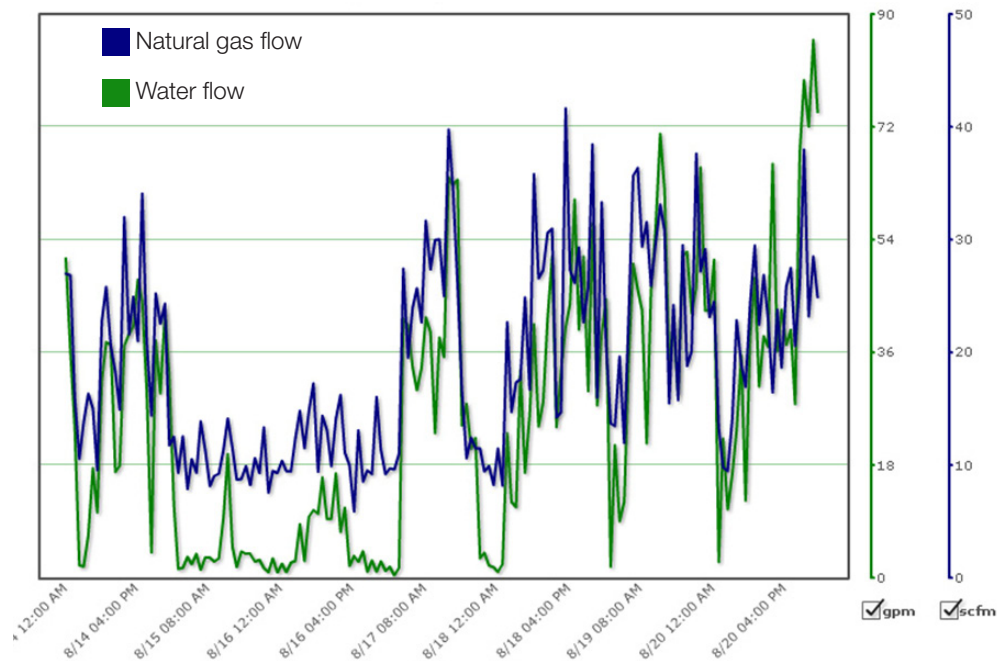


Figure 5.  
Alerts & event management modifies behavior for energy savings

Today's effective energy management software goes far beyond what was available only a few years ago. One key enhancement is the ability to compare results and characteristics such as resource usage across plants within an enterprise enabling the company to observe the effectiveness of Best Practices at one plant and apply those practices to other plants as appropriate. This is in real contrast to the traditional method of looking at individual pieces of equipment or single plants in isolation. The fixes to over-utilization may be a change of equipment or a change of behavior or both, but the bottom line is rapid response and cost savings.

A logical, systematic approach first addressing low-cost / no-cost opportunities such as process and behavioral changes (based on intelligence gained from real-time performance and energy consumption data) before investing in capital expenditures can provide a quick reduction in energy costs. It can also help foster cultural 'buy-in' to paying more attention to behavior and factors that affect energy consumption and treating energy like any other material resource. This can be an important factor in building the business case for then investing



in upgrading, repairing or replacing any energy-inefficient equipment to achieve even greater savings.

Perhaps the single most critical Best Practice in energy intelligence is to employ the energy management system to continually monitor both personnel behavior and equipment so as to avoid the degradation that is so often a problem in traditional energy usage strategies. As the Lawrence Berkeley National Laboratory report states, “By virtue of the continuous nature of the monitoring – new problems can be identified that emerge after the initial retro-commissioning investigation stage.”

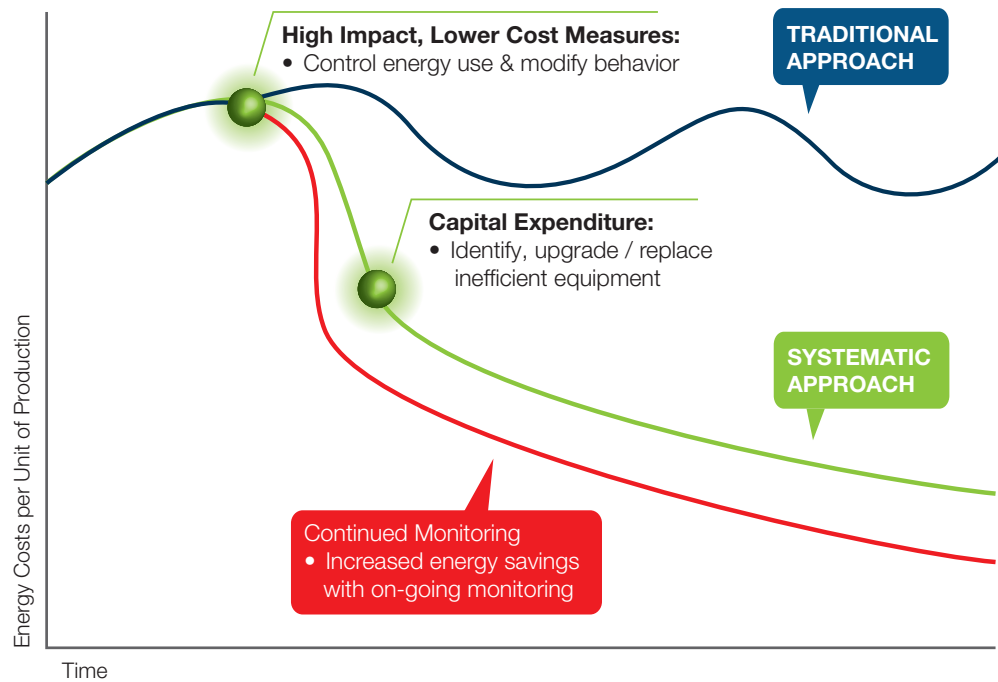


Figure 6.  
Continuous monitoring facilitates greater energy savings

Continuous Systematic Monitoring can not only prevent degradation of energy saving practices, but also continue reduce energy consumption and costs. Equipment, controls and personnel change over time, influenced by alterations in environment, addition or removal of equipment, degradation in calibration or optimization. Simple alterations to processes, staffing, training and maintenance (performed at the right time through intelligence provided by ongoing monitoring) can significantly impact energy reduction practices, and effectively lower per-unit-of-production energy costs.



## CONCLUSION

Traditional energy management methods too often lead to inconsistent savings and disappointing long-term results. Improvements in controls and information technology, combined with systematic and analytical Best Practices approaches to energy management, are creating a new breed of tools and solutions that promise to enhance corporate-wide sustainability efforts and ensure more persistent and measurable savings. By recognizing energy as a material resource and correcting existing entropy in equipment, along with modifications to human behavior when implementing energy management programs through full integration of the technology into the processes and the corporate strategy, enterprises can begin to treat energy management as a vast resource for cost savings that has not yet been fully realized.

## ABOUT EPS CORP

EPS Corp is a leading energy intelligence company that develops and implements analytic, efficiency, and clean-generation solutions for Fortune 1000 companies. The company's integrated product and services suite is delivered using The EPS Way<sup>®</sup>, an innovative three-step process that maximizes energy and carbon reductions through financially compelling solutions. EPS delivers the right information – at the right time – to enable decisions that improve energy efficiency, reduce costs, and achieve sustainability goals. An Accredited Carbon Calculation Partner with the Carbon Disclosure Project, EPS was founded in 2001 and is headquartered in Costa Mesa, California. Visit [www.epsway.com](http://www.epsway.com) for more information.

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