ARC BEST PRACTICES

By Allen Avery

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Best Practices for Energy Management

	People	Processes	Technology	Information
Leader	Considers energy management a core competence Corporate energy coordinator or "czar" directs and coordinates energy management activities across plants Devotes a higher percentage of staff to energy management activities	Energy management initiative in place Performs regular energy audits to measure progress against benchmark Capital projects justified based on energy savings expected	Relies on advanced process control, simulation, or homegrown applications to manage energy Open to applying new technologies to the problem of energy management More likely to invest in R&D to change the production process and reduce energy requirements Has integrated electrical automa-tion with process automation system	Shares information across all sites Closely monitors processes and equipment to track energy use and identify problem areas Energy management metrics often linked to business systems Consistently monitors energy prices and energy consumption Has adopted more granular accounting methods for energy
Competitor	Usually has a dedicated staff member or group for energy management Some consider energy management to be a core competence	Energy management initiative in place, or planned Energy usage assessment performed to benchmark, some perform regular energy audits Some projects have ROI based on reduced energy consumption	Open to applying new technologies to the problem of energy management Has integrated electrical automation with process automation system Applies automation technology to adjust plant energy mix	Shares energy management information across most sites Has adopted more granular accounting methods for energy use
Follower	Fewer have a designated energy coordinator Less likely to dedicate staff to energy management activities	Initiative may be in place, but many do not have plans Less likely to perform initial energy assessment or regular audits Few capital projects justified by energy savings	Slightly less receptive to applying new technologies for energy management applications. Less likely to use technology to optimize plant energy mix	Energy management usually handled on a plant-by-plant basis

Best Practices Maturity Matrix

Executive Overview

Energy can be the largest component of a manufacturer's cost structure. Despite a recent drop in energy prices, costs are still trending upward over the long term, and the days of relatively cheap energy are long gone. Certainly, manufacturers have always strived for energy efficiency, but it has become an imperative. Energy management practices must be realigned for the current climate of expensive energy.

Energy can be the largest component of a manufacturer's cost structure. As costs increase, users must work to manage their energy use. Effective programs largely rely on adopting new processes and practices, but need not entail large capital investments to get up and running.

Many manufacturers, particularly those in the refining and chemical industries, have been focused on meeting demand in recent years. Increasing capacity and upgrading automation systems to maximize production has taken precedence during the recent economic expansion. Now that the economy has cooled, it may be a good time for manufacturers to take stock of their energy use and how best to align their operations to manage energy use and cost.

ARC's research, which included an internet survey and interviews with industry luminaries, has unveiled some of the practices users employ to address the problem of energy management in their organizations. We set out to learn how companies are organized to tackle the problem of energy management and what projects or initiatives they undertake (or choose not to) to improve energy efficiency.

Our research examined how energy efficiency programs are managed, looking at how companies implement initiatives, staffing arrangements, and how they make investment decisions about projects designed to improve energy efficiency. Leading energy management practitioners have both formal programs in place and dedicated staff with centralized authority in charge of their programs.

We also investigated how users benchmark performance and measure the success of their energy management initiatives, plus some of the tactics used in the plant to optimize efficiency, and how users apply automation technologies to improve performance. Successful programs regularly assess performance and thus are more consistent in meeting energy reduction quotas. Leading companies apply rigorous criteria before making decisions on capital investments and upgrades. Increasingly, these criteria include an

energy management component and a return on investment closely coupled with energy savings.

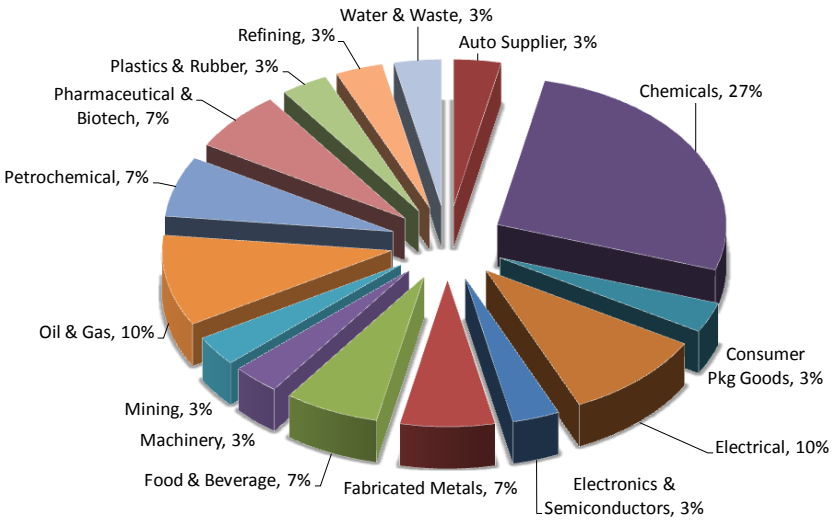
More than technology, adopting an optimal set of practices for energy management is one of the key factors for success. Companies that improve visibility into plant processes and energy use, set goals for energy reduction, and empower workers to have an impact on energy consumption, tend to achieve the best results.

ARC Best Practice Study Methodology

To learn how manufacturers approach energy management, ARC conducted research to gain an even greater understanding about current practices and emerging trends. The current research consisted of a survey and a series of in-depth interviews with several process manufacturing firms.

Ranking	
Leader	Top 20%
Competitor	Next 50%
Follower	Last 30%

Where appropriate, ARC best practice reports group responses into the categories of Leaders, Competitors, and Followers. We used six separate performance criteria to rank the responses. For each survey response, we gave each performance criterion a quantitative measurement and used the total as a ranking demarcation according to a 20:50:30 distribution of Leaders, Competitors, and Followers.



Vertical Industries of Respondents

Respondents

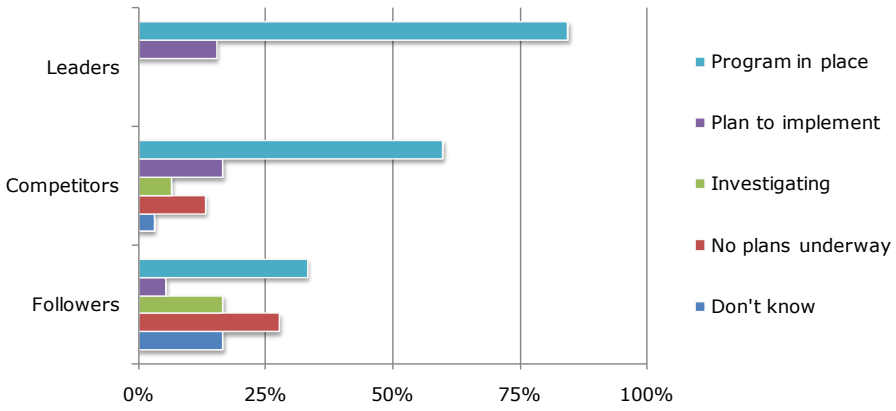
The majority of survey respondents come from a mix of process and discrete industries. Two-thirds are process manufacturers. More than a third of respondents are chemical and petrochemical manufacturers and an additional 13 percent are from the oil and gas and refining industries. These industries are among the largest energy consumers. Other respon-

dents from the process sector included users from food & beverage, pharmaceuticals, mining, plastics & rubber, and water & wastewater. Respondents from the discrete sector came from several industries, including electrical, electronics & semiconductors, fabricated metals, machinery, and automotive.

ARC conducted in-depth interviews with several users in the refining and chemical industries. Each person interviewed plays a strong role in directing energy management activities at their companies.

Energy Management Initiatives

Overall, a little more than half the respondents had an energy management initiative in place and roughly 10 percent plan to implement one. Leaders and Competitors were more likely to have an energy management program; 85 percent of leaders and 65 percent of Competitors have a program in place, while only a third of Followers do.

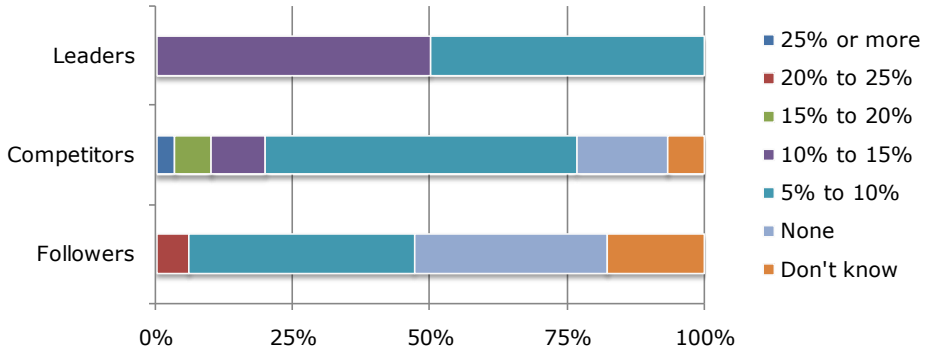


Energy Management Initiative Status

Progress on Energy Efficiency

The industry made progress last year in terms of units of energy consumed per unit of product produced. All Leaders saw consistent improvements, with half seeing a 10 to 15 percent reduction in energy consumption, and the rest netting a 5 to 10 percent improvement. A small number of Competitors were able to make gains of 25 percent or more, and others saw energy consumption fall by 20 percent. This is likely because their energy man-

agement programs are ramping up, and the companies are experiencing rapid gains in efficiency as they implement new practices. Gains among Leaders are more modest, but also more consistent, because their programs have probably been in place longer. Some Followers reported significant improvements in energy efficiency, but more than a third showed no improvement.

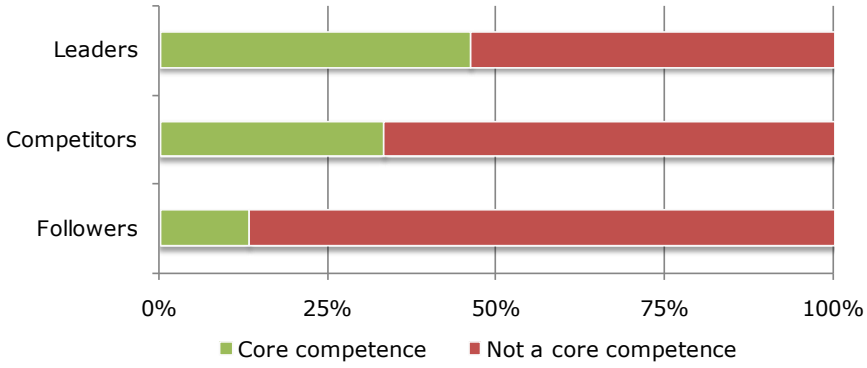


Reduction in Energy Consumed per Unit Produced within Last Year

Organizing for Energy Management

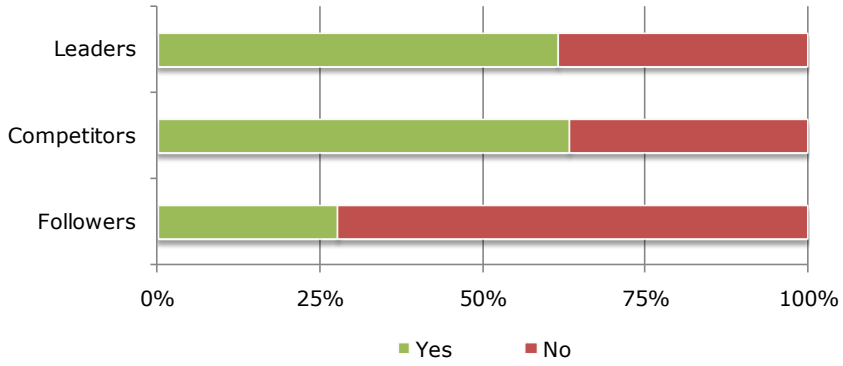
Perhaps the most important aspect of an effective energy management program is how company resources, particularly staff, are organized around getting it accomplished. Having a program in place is largely a prerequisite, but having dedicated staffers who focus on energy management, and involving people and groups from across the plant and functional areas are vital to a successful energy management program.

A high level of attention to reducing energy consumption can provide competitive advantage, particularly in industries like refining, petrochemical, and chemical, where oil and natural gas are feedstocks, and energy can represent up to half of a company's cost structure. An interviewee from a major global chemical company summed it up nicely: "Energy costs can swing earnings, now." More may be at stake; a respondent from a major refining company told us: "We anticipate that energy costs will continue to rise. In 10 or 15 years, only the best will survive in the refining business." Leaders and Competitors are more likely to consider energy management to be core competence for their organizations. Nearly half of Leaders feel that energy management is a core competence; but only slightly more than 10 percent of Followers.



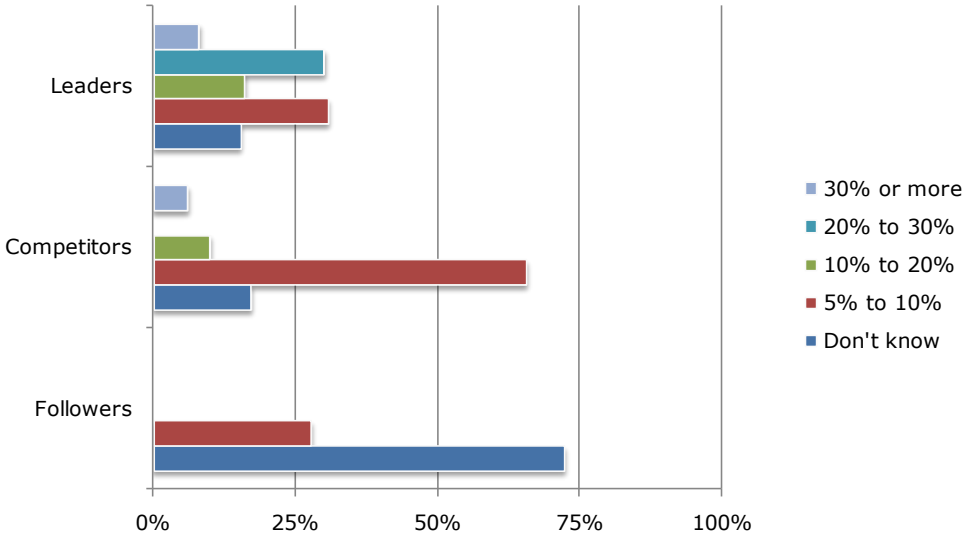
Energy Management as a Core Competence

Leaders and Competitors are more likely to have dedicated staff members or groups that manage and coordinate energy efficiency activities across their companies. More than 60 percent of respondents in each group reported having an energy coordinator, while only slightly more than a quarter of Followers have centralized management for energy management initiatives.



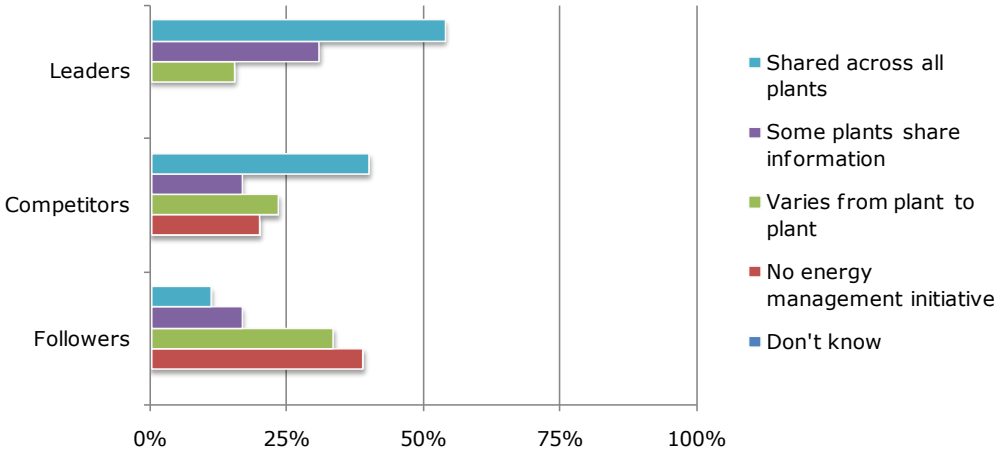
Dedicated Staff Member or Group for Energy Management

And what about the people they manage? Overall, Leaders involve more of their staff and plants in energy management initiatives. Nearly 40 percent of Leaders report that 20 percent or more of their plants or staff (full time employees) are focused on energy management activities. Only six percent of Competitors devote as many resources; most reported that between five and 10 percent of their people are involved with energy management. Only about a quarter of Followers muster even that many for energy efficiency activities.



Percent of Plants or People Focused on Energy Management Activities

Coordinating energy management activities across multiple sites can help ensure that all plants a company operates are up to speed on the best known methods to improve energy efficiency. This also helps plant operators replicate energy management successes across the organization for maximum effect. More than half of Leaders share information across all plants, and about a third share between at least some of their plants. Among Competitors, 40 percent share information between all plants, while a mere 10 percent of Followers coordinate energy management information and practices across their organizations.

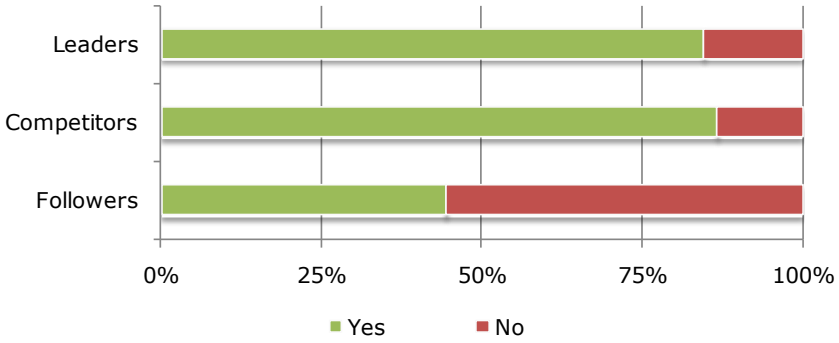


Sharing of Energy Management Information and Practices

Measuring Energy Efficiency Performance

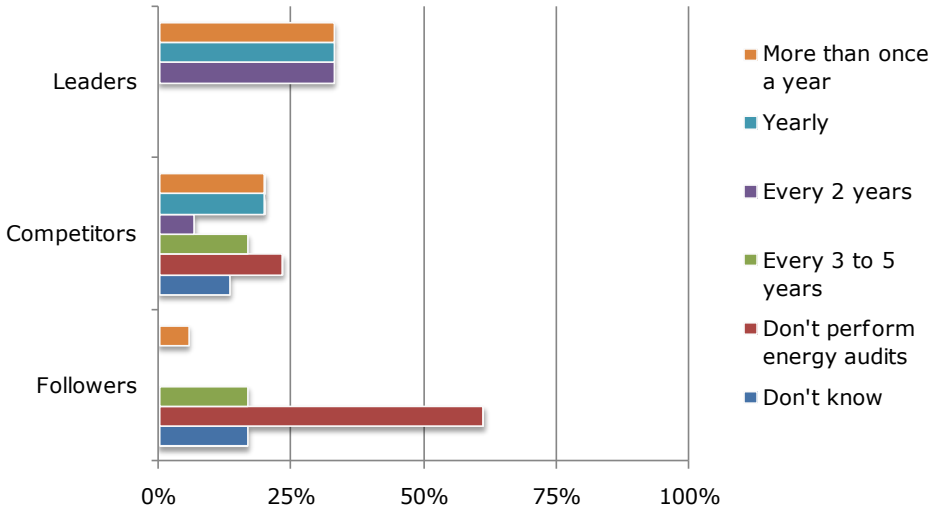
Benchmarking Performance

A comprehensive energy assessment or audit forms the basis for benchmarking the progress of an energy management program. It can also help to identify the most inefficient equipment or processes at the plant, the "low-hanging" fruit that, when addressed, can help users make big gains in energy efficiency. More than 85 percent of Leaders and Competitors have performed an energy assessment, but less than half of Followers.



Has Your Company Performed an Energy Assessment or Audit?

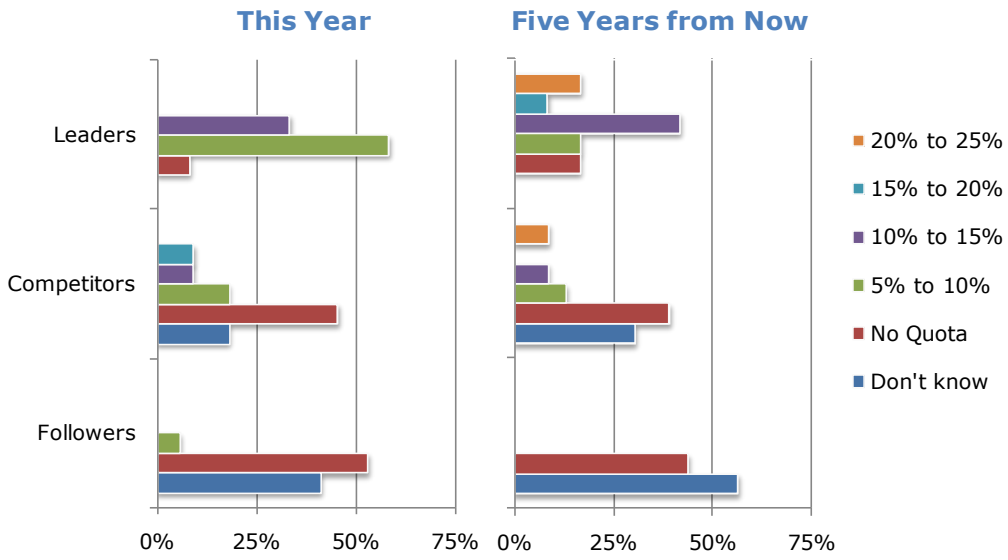
Performing regular energy audits allows users to assess the effectiveness of energy management programs relative to past performance and to measure progress in reaching energy reduction targets. Leaders and Competitors perform regular energy audits, with shorter time intervals in between. Followers, for the most part, do not regularly audit energy use, and those that do only examine it sporadically.



Does Your Company Perform Regular Energy Audits?

Leaders tend to set more ambitious goals for reducing energy intensity (the amount of energy consumed per unit of product manufactured). For the upcoming year, more than half of the Leaders hope to reduce energy intensity by five to 10 percent, while a third aims for a 10 to 15 percent reduction. A small number of Competitors are looking to drop energy intensity by 15 to 20 percent, likely because they have more ground to cover. More than half of Followers reported having no quota for the next year, while a few hoped to reduce energy consumption by 5 to 10 percent.

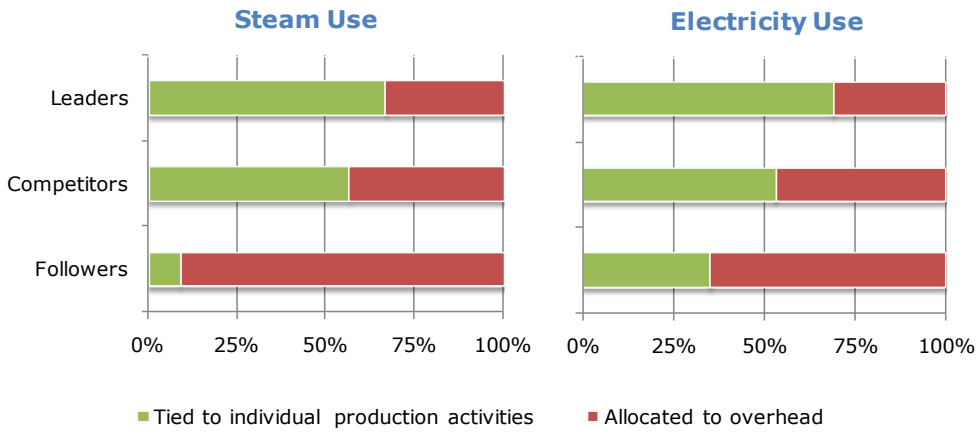
Looking ahead five years, about 25 percent of Leaders hope to reduce energy intensity 15 percent or more, while 40 percent plan reductions of five to 10 percent. Followers tend to have no quota, or are unsure of their targets. Setting a lofty energy reduction quota provides a strong incentive in itself, putting energy management at the forefront, and driving organizations to find methods, even unconventional ones, to achieve it. For example, rather than make incremental improvements or investments in more efficient plant equipment, forward-thinking companies may instead look at the fundamental production process, and implement cutting edge technologies to develop new a new approach that uses less energy.



Energy Reduction Quotas

Allocation of Energy Costs

Leaders and Competitors are more likely to tie steam and electricity use to individual production activities. This is probably a direct outgrowth of energy assessments and having systems in place to closely monitor energy consumption, such as intelligent field devices, upgraded control systems, or advanced process control systems. Followers are more likely to allocate energy use to plant overhead.

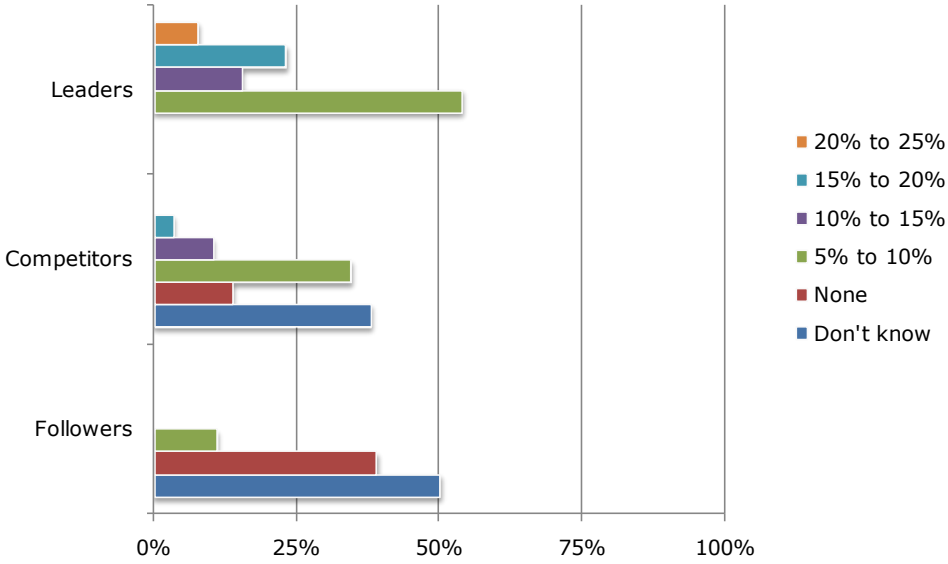


Accounting for Energy Use in the Plant

Investing for Energy Management

Energy Management and Capital Investments

Energy management programs require some level of funding. Leaders also devote more capital spending to energy reduction initiatives. All report some level of investment, with many Leaders reporting that they allocate between 15 and 25 percent of capital funds to energy management. Competitors and Followers are more restrained with their spending, and a greater number do not fund energy management initiatives.



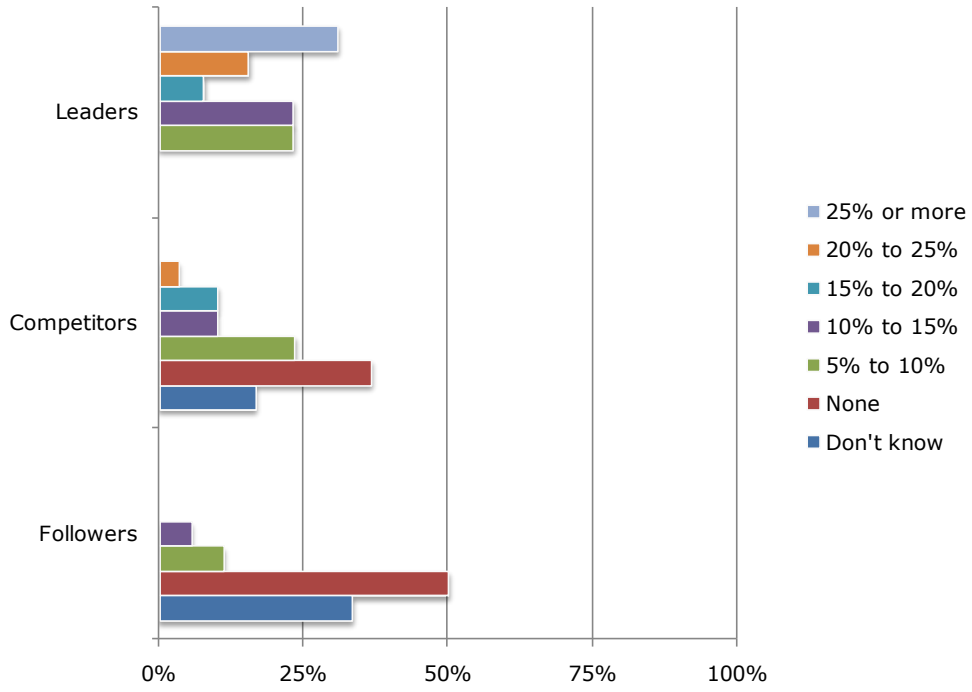
Percent of Capital Expenditures Focused on Energy Management

Given that energy can be one of a manufacturer's largest costs of production, it follows that financial metrics are closely tied to energy use metrics. Both are key variables in determining when to make investments in equipment that impact energy efficiency, reduce capacity utilization, or perform maintenance to existing equipment. Indeed, in many cases, large capital projects are justified by having an energy savings component—reduced energy costs are a major factor in calculating ROI.

Justifying capital projects in energy-intensive industries can be a complex exercise in finance. In addition to expected revenues, users must factor in expected energy costs in their projections for energy savings in a project. The price a company expects to get for its product also factors into the equation.

Energy savings can have a big impact on the bottom line. One interviewee at a large chemical manufacturer estimated that his company's energy management program had saved $7 billion on fuel costs over 12 years.

According to our survey, energy savings plays an increasing role in the justification for capital projects. Among Leaders, nearly half report that more than 20 percent of their company's investments in capital equipment are justified by having an energy savings component. Competitors and Followers have a smaller number of projects backed up with energy savings, but many do not.



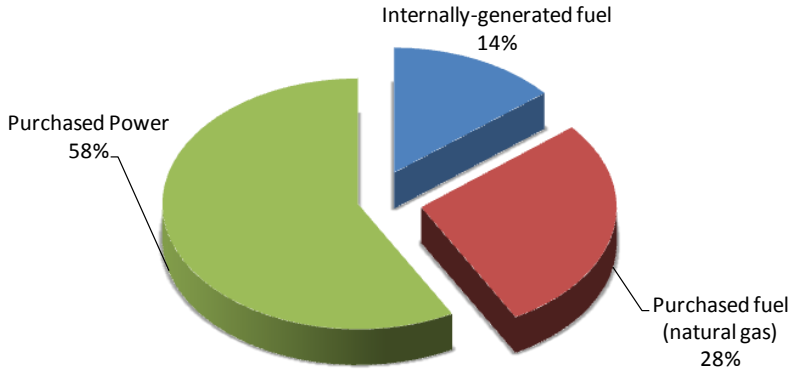
Percent of Capital Projects Justified by Having an Energy Savings Component

Energy Management Tactics

The day-to-day business of energy management, by and large, consists of making operational decisions about running the plant and minimizing energy costs by balancing the use of purchased and internally generated power. Tactics used include optimizing electric power purchasing, boiler optimization, and peak shaving.

Plant Energy Mix

Overall, respondents rely on purchased electric power and fuel to run their plants. Internally-generated fuel, or gases which are a byproduct of production, make up an average of 14 percent of the plant energy mix. Leaders in the study used more purchased power (65 percent on average) and less purchased fuel (21 percent), while the use of internally-generated power fell in line with other respondents. A substantial number in each category rely exclusively on purchased fuel or electric power



Average Plant Energy Mix

Optimizing Electric Power Purchasing

Survey respondents were asked about how their plants optimize the purchase of electric power and balancing internally-generated power and electric power purchased from a utility. When the cost of purchased electric power rises, those with internal resources maximize their use of homegrown fuel or power.

Those that rely on purchased power try to reduce their costs through contract management. The sheer size of some companies and the amount of energy they purchase can put them in a stronger bargaining position. One respondent from one of the world's largest chemical companies explained that his plant is the utility's single largest customer. Small wonder that the company's strategy is to leverage its size to negotiate the best price for the power it buys.

Respondents with co-generation facilities or access to internally generated fuels as a byproduct of production can easily switch to these resources when the price of external power or fuel exceeds a certain threshold. One respondent, a Competitor from the chemical industry, reported that his

company's strategy is to produce as much internal power as possible, and sell any excess to the utility. This effectively eliminates the need to switch between external and internal power. Others rely on automation to shift to internal sources as needed. One company, a Leader in the petrochemical industry, has an operations control center that monitors power continuously to choose when to buy power from the outside, generate it for internal use, or sell any surplus power. The system is connected to relays that are armed to shut down equipment and switch power sources during periods when external power is more expensive.

An effective energy mix strategy requires that users put systems and procedures in place to closely monitor the price of energy and analyze the economics of using external versus internal power sources for production. Many have energy optimization software packages, either developed internally or purchased from automation suppliers, that help to automate the process. As one interviewee from a major chemical company put it, "With the way energy prices fluctuate these days, any business that doesn't watch them on a day-to-day basis is in trouble."

Peak Shaving

Those that cannot negotiate a better price have to modify production schedules to consume power when it is less expensive, a practice called peak shaving. A Competitor in the chemical industry reported that his plant would perform some production activities at night to get lower rates, but that the need to run at higher capacity makes this difficult. Other peak shaving strategies involve running some energy-hungry equipment, such as high horsepower pumps, during non peak hours, and automating process equipment to modulate power consumption.

Optimizing Boiler Efficiency

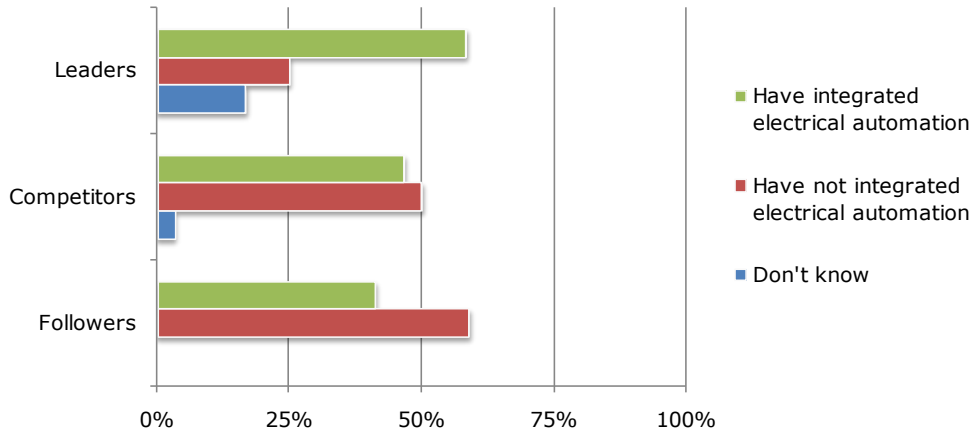
Boiler efficiency optimization, for many respondents, entails close monitoring and control of operating conditions and process variables, looking for heat losses, maximizing heat recovery, and minimizing carbon fouling in the boiler. Users rely on field instrumentation to monitor stack temperatures, analyzers to measure excess oxygen in stack gases, and thermography to view how evenly heat is distributed in the boiler. In general, maintenance and corrective action follow. To improve efficiency, many respondents have upgraded boiler controls, instruments, or even the boilers themselves. Some have converted boilers to use alternative fuels.

Some users have installed combustion analyzers, upgraded combustion controls, or employ advanced process control packages.

Technology for Energy Management

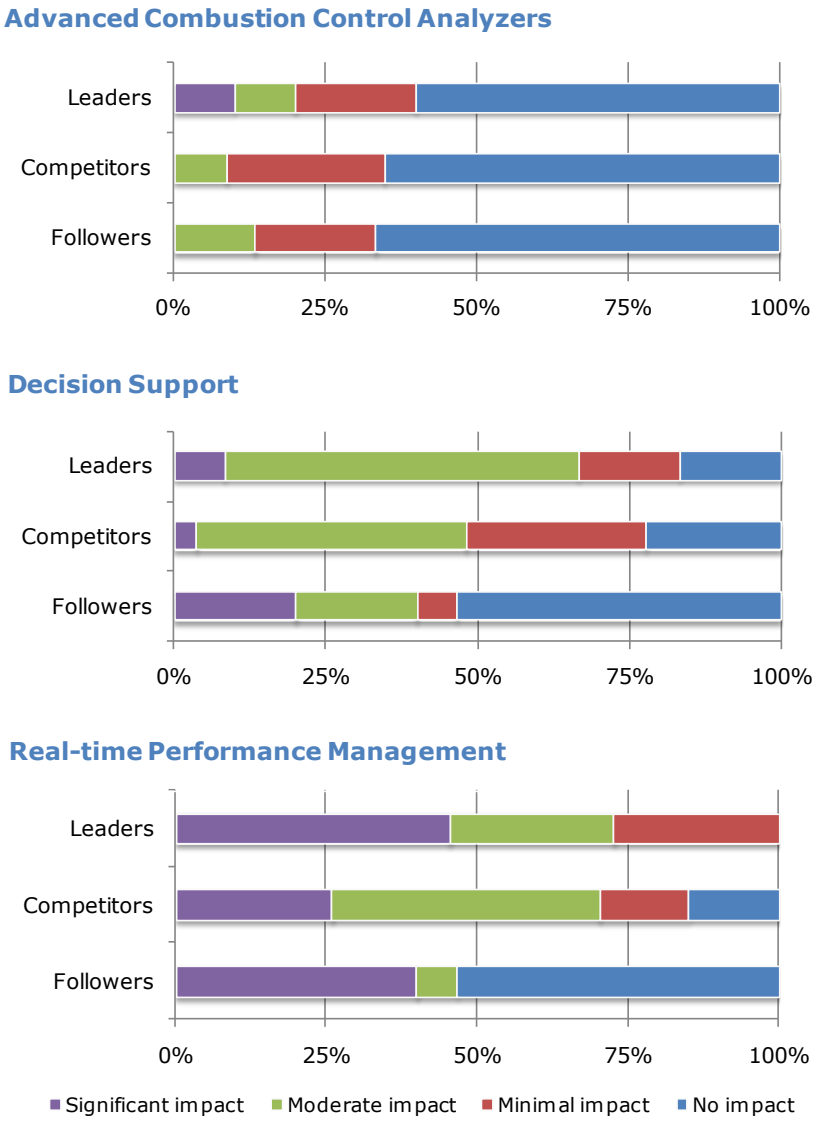
A willingness to apply state-of-the-art information and automation technologies can have a major impact on the success of energy management programs. Applications such as advanced process control, energy management software packages, and decision-support can be used to optimize processes and coordinate energy management activities across functional areas in the plant. Judging from our survey, Leaders are more likely to apply new technologies to the problem of energy management and to invest in technology upgrades such as boiler control systems, digital control systems, and intelligent field devices. They are also more likely to leverage information technology to collect, manage, and analyze energy management information. As mentioned earlier, Leaders also try to envision ways to fundamentally change the process itself to reduce energy consumption, and are more willing to put their R&D departments to work on the problem.

Many survey respondents have integrated electrical automation with their process automation systems. Nearly 60 percent of Leaders and 50 percent of Competitors have done so. About 40 percent of Followers reported that electrical and process automation systems are integrated at their plants.



Integrating Electrical Automation with Process Automation Systems

Leaders tend to be more receptive to applying technology to the problem of energy management. Some, about 20 percent, feel that advanced combustion control analyzers, which are used to measure oxygen and carbon monoxide concentrations for combustion control applications, will have a significant or moderate impact on energy management activities. Competitors and Followers are more skeptical. All expect that decision support, giving decision makers and plant personnel access to information about energy and best practices, will have a more substantial impact. Nearly 75 percent of Leaders and Competitors feel that real-time performance management has a significant or moderate impact on energy management.



Assessing the Impact of Technology on Energy Management

Best Practice Recommendations

Successful energy management programs take a long-term approach to the problem. Ideally, the process should never end. Rather than let initial successes give them a false sense of security, manufacturers should treat energy management like a continuous improvement program. Energy management programs need not require a large capital outlay to get up and running. Users can implement their initiatives in stages, and save major expenses for after new practices are put in place.

The age-old credo of process control, "you can't control what you can't measure," translates to the realm of energy management quite nicely. For all who want to control their energy costs, the starting point should be a comprehensive energy assessment of the plant, to determine how much energy is consumed, and how much could potentially be saved. Regular energy audits should be done at least yearly to measure the progress of energy management initiatives based on established metrics and KPIs. Having a system to collect, manage and analyze energy usage data can also greatly impact the effectiveness of energy management programs, while supporting a company's effort to assess and, ultimately, reduce its overall carbon footprint. (Reduced emissions are a byproduct of increased energy efficiency.)

Users must adopt a pervasive energy efficiency culture in their organizations; one that empowers the executives who manage the program, the managers who administer it at the plant level, and the operators and technicians who must actually implement the program. To enable them to have a direct impact on plant energy use, is important to give all stakeholders -- decision makers, plant operators and other personnel -- visibility into energy metrics through role-based dashboards, along with tools and procedures.

Above all, successful practitioners of energy management treat it like a business, no less important than the company's primary business. Energy consumption can substantially affect a manufacturer's cost structure, enough to have a direct impact on earnings. Investments in energy management initiatives and projects should be treated like every other capital equipment investment, with energy savings playing a significant role in returns.

Analyst: Allen Avery
Editor: Paul Miller
Distribution: MAS-P and MAS-H Clients

Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Research/IndustryTerms/

BPM	Business Process Management
CAGR	Compound Annual Growth Rate
CMM	Collaborative Manufacturing Management
CPG	Consumer Packaged Goods
CPM	Collaborative Production Management
DCS	Distributed Control System
EAM	Enterprise Asset Management
ERP	Enterprise Resource Planning
HMI	Human Machine Interface
IOp	Interoperability
IT	Information Technology
OpX	Operational Excellence
PAS	Process Automation System
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
ROI	Return on Interest
RPM	Real-time Performance Management
SCM	Supply Chain Management
WMS	Warehouse Management System

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