Executive briefing

Information technology, advanced automation, and the adoption of practices for energy management are much needed elements to garner quality improvements in energy efficiency.

To do this, organizations need to gain greater visibility into energy consumption and then pass it along to operations so the entire organization can benefit from energy reduction.

The industrial sector is the leading user of energy in the United States each year, consuming 33 percent of the country's energy according to the U.S. Energy Information Administration (EIA). For manufacturers to increase profitability, they will need to learn new ways to lower their energy expenditures. Of that energy consumption, an estimated 37 percent, or $60 billion is lost each year. The sectors that consume the most energy are chemical production at 22 percent, followed by petroleum refining at 16 percent and metal smelting/refining at 14 percent.

What the numbers show is no secret: There is a greater need for energy in the industrial sector and costs are not going to get any lower. There is, however, a way to improve the bottom line by reducing the incredible amount of wasted energy the sector creates every year.

This is where an energy efficient solution comes into play. While one efficient part of the solution, like a motor, drive, gearbox or even coupling, will help, having all components working together to control a process will give the ultimate in energy efficiency.

The old way of doing things needs to be pushed aside. Like continuous quality improvement, the quest for the ultimate in energy efficiency will never end. Evaluate and then identify the biggest energy consumer, do a system implementation, improve the energy efficiency, and keep monitoring and evaluating.

That needs to be today’s mindset.
Survival for any manufacturer today calls for strict efficiency in energy usage. Costs keep going up and reducing energy usage, while increasing production, is now becoming one of the most vital aspects in improving operating margins.

The productivity gains of the late 1990s and early 2000s brought automation to the point of increasing capacity, but those gains are now being offset by the increased costs of energy. The need now is for all manufacturers is to cut down on energy usage, making that one of the core tenants to drive the company's strategy.

It is incumbent on manufacturers to cut extraneous costs in this economic climate and energy is one of the largest components in an operation's cost structure. Energy costs are not going down to the point where manufacturers will not have to think about it anymore; rather, energy efficiency will remain a lifetime commitment to ensure the enterprise's profit margin keeps rising.

**Big user of energy**
The industrial sector is the leading user of energy in the United States each year, consuming 33 percent of the country's energy according to the U.S. Energy Information Administration (EIA). For manufacturers to increase profitability, they will need to learn new ways to lower their energy expenditures. Of that energy consumption, an estimated 37 percent, or $60 billion is lost each year. The sectors that consume the most energy are chemical production at 22 percent, followed by petroleum refining at 16 percent and metal smelting/refining at 14 percent.

When it comes to global energy consumption, the world's total primary energy consumption was 483 Quadrillion Btu in 2009, and the U.S. was about 20 percent of this according to the EIA.

Changes in energy consumption in energy-intensive industries from 2010 to 2035 will range from almost nothing to 0.8 percent per year, according to the EIA's Annual Energy Outlook 2012. While that shows stability in usage, it does not show the other side, and that is where costs are going up.

In addition, energy consumption by the industrial sector will reflect changes in shipments. Starting from low levels of economic activity in 2010, shipments from all industries will grow through 2035. The report states that industries like steel will grow by 23 percent but energy use declines by 12 percent due to a shift in technologies. The only industrial sector that shows an increase in energy intensity is refining.

At the same time, energy efficiency improvements and changes in manufacturing methods and requirements will affect energy consumption, according to the outlook. Those changes have the potential to allow for greater profitability and stronger advantages for manufacturers.
Information technology, advanced automation, and the adoption of practices for energy management are much needed elements to garner quality numbers for energy efficiency. That is why organizations need to gain greater visibility and understand what their levels of energy consumption are and then communicate that knowledge to operations so the benefit of that information flow will lead to greater energy reduction.

What the numbers show is no secret: Energy consumption in the industrial sector is not going to get any lower and costs will not decrease. There is, however, a way to improve the bottom line and cut back on wasted energy.

Energy efficient solutions
It is not enough to have one efficient device operating in a total system. While an efficient motor, drive, gearbox or even coupling, will help, having all components working in unison to control a process will give the ultimate in energy efficiency.

The control scheme a user employs is often more important than the components. That means energy efficiency must become a mindset, where the manufacturer is always looking for opportunities to improve efficiency. It should to be like continuous quality improvement, where the search for efficiency never ends. The manufacturer will need to go through an evaluation and identification stage, look at the energy uses, and then evaluate how much energy consumption is going on. Once the manufacturer finds the largest energy abuser, there will need to be an analysis of the system to improve energy efficiency, and then keep monitoring and evaluating.

Roadblock to efficiency
After creating a plan, the next step is to execute the program. Oftentimes, manufacturers identify these roadblocks:
- Payback time is indeterminate, or too long
- Shortage of capital
- Reluctance to change a working process
- Lack of correct definition of system efficiency
- Not all parties in the supply chain are motivated
- Lack of management time
- Confusion about top line vs. bottom line
- Poor definition from management, regarding the importance of energy efficiency

View of the machine
One way for a manufacturer to save energy is to look at the machine itself. Using the correct drive system technologies, or knowing which motor is the right one for the process is important. However, looking at optimizing the overall system’s mechanics to get the most out of the process is vital to the whole energy picture.
Within any process, there are enormous differences in the amount of electrical energy required during individual stages. There are times when machines need to run at full acceleration and then brake suddenly, which will spike power consumption. Using a smart approach by understanding the process, the manufacturer will be able to significantly cut power requirements.

Variable frequency drives
To create a total energy solution, one of the first places to look is at the variable frequency drive (VFD). The drive’s components have a huge impact on the overall power consumption of a machine. Electrical drive technology with intelligent, productive control algorithms and high efficiency ratings are vital in keeping energy costs to a minimum throughout the lifecycle of a machine.

A VFD can help a manufacturer three ways:
- Energy savings
- Reduction in motor wear
- Increased process improvements

While electric motors represent almost 70 percent of the total industrial power demand, just about 70 percent of the installed motors today do not use optimal motor control.

In terms of energy, there are significant savings if the manufacturer runs the motor at speeds of less than 100 percent. This is what the VFD can offer. In some applications, these drives will pay for themselves in less than a year. In most cases, the pay-back is around two years or less.

One argument against installing energy efficient motor controls is often that these systems are more expensive. The problem with this common argument is most costs associated with large electric motors are in the energy they use over their lives, rather than in their initial costs and installation expenses. The purchase price of a 150 hp motor accounts for less than 1 percent of its overall lifecycle costs, research shows that energy costs account for virtually all of the rest. The same analysis applies to smaller motors where the purchase price and installation costs of a 2-hp motor account for less than 4 percent of its lifecycle cost. Energy costs make up almost all of the rest.

In addition, a VFD can cut down on motor wear, so the motor lifecycle increases. There are process improvements as well. A manufacturer can control the process much more finely with the drive than with just starting it across the line.

When a VFD is connected to a motor, it is possible to adjust the motor’s operational speed. To do this, the VFD takes the incoming power and changes it based upon various inputs. This, in turn, varies the speed of the motor.

Case history
A Detroit, MI, manufacturer of diesel engines wanted to capture the energy generated by its testing and put it back into its own grid to lower utility costs.

The company makes the 600 horsepower workhorse engines that power semi-trailer trucks and must run millions of miles. To ensure they reach that goal, the engines undergo non-stop testing.

To test the durability and performance of these engines, its engineers use test stands in a huge, ventilated facility adjacent to its manufacturing plant. A test stand consists of a diesel engine coupled to a dynamometer that applies a load to the engine the equivalent of pulling a 40-foot, fully loaded trailer weighing 20 tons or more.

The engine maker uses a dynamometer with an eddy-current clutch, which puts an electrical flux around the rotor of a motor providing resistance to the engine. The test beds cool via a water-to-air cooling system that circulates cool water through the hot machinery. The rotational force generated by the engine pumps the heated water up to the cooling towers on the roof where the cool air absorbs the heat. After running through the cooling towers, the water is ready to cool the system again.

The 30 test stands run constantly except for when they connect a new motor for testing. The lab’s testing procedures consumes 2.5 million gallons of fuel each year – the equivalent to what 4,000 cars would burn annually. In terms of electricity, they run through 2.1 megawatts a year.
The engine maker ended up replacing the eddy-current dynamometer of two test stands with an induction motor and a four-quadrant VFD. The motor will be holding back against the manufacturer’s test engine and thus generating energy. The VFD has an “active front end” design that provides regeneration capability to recover the energy previously wasted as heat and return it to the company’s own power grid.

Using a solution from Siemens, the two test stands should save about $150,000 a year in utility costs, a payback of less than four years based upon energy savings alone. The payback is even better once one accounts for the eliminated cost of maintenance for eddy-current clutches and the reduced cost of cooling the water used to dissipate heat generated by the old eddy-current clutches.

Given economies of scale in converting the rest of the test stands, the recovered energy will make the engine manufacturer more energy self-sufficient. And the energy cost-savings would add up to an additional $2.1 million a year. The company would also prevent about 15 metric tons of CO₂ emissions each year.

Reducing motor costs
While VFDs are a vital component in a system’s energy consumption, the efficiency of the motor will determine how efficient the entire system operates. A fan is only as efficient as the motor powering it – and motors are a key part of all fans, compressors, and pumps. The design of the machine itself does provide some savings, but they are in direct relation to the energy efficiency of the motor, which ends up being the main source of savings.

Understanding the motor and being smart about how a manufacturer integrates that into the control scheme ends up being important to energy efficiency. Electric motor systems account for nearly 70 percent of the entire U.S. manufacturing sector’s electricity usage, according to the U.S. Department of Energy (DOE).

In an assessment of industrial motor systems, the DoE found about 40 percent of the companies it surveyed had made no improvements in fan or pump systems and 52 percent had not added any kind of controls to more efficiently power variable loads.

Case history
NYCO Minerals, Inc. annually mines and processes 100,000 tons of wollastonite, a form of calcium silicate. Energy costs at the Willsboro, NY mine doubled over the past few years. Management had to keep its focus on the bottom line as mineral processing plants tend to be energy intensive because they use hundreds of electric motors for milling, classification, purification, treatment and transport.

How they were able to add to the bottom line was simple: Get the most cost effective and energy efficient motor on the market. They ended up replacing motors with Siemens’ new NEMA Premium® Plus models, which have die-cast copper rotors that make them one or two efficiency bands percent more efficient than current NEMA Premium motors.

The initial replacement order was $80,000 and with all the energy savings, mining management expects the motors will pay for themselves in two to three years, some faster.

A NEMA Premium Plus motor fitted with a copper rotor offers solid economics. With a price of about $550 for this motor, the annual savings, compared with an average EPAct motor are $48 per year, leading to a payback of 0.98 years.

Process knowledge a cost benefit
Knowing the process and capabilities of installed machines and components remains vital to improving true energy efficiency.

Properly calculating the size of a motor needed to operate an application will end up saving energy and dropping costs. In one example, if a manufacturer has a conveyor with a 5-hp motor that breaks frequently, the tendency is to replace it with a larger horsepower motor because the 5-hp broke and the larger will be stronger. However, most manufacturers don’t realize the larger motor will use more energy than the conveyer needs, and lower the conveyer’s efficiency.

The manufacturer needs to do an analysis of the conveyor before replacing that motor, and in the end, they may find a smaller motor would work just fine. Motors have an operational sweet spot in their torque curve where they operate most efficiently. This might be as low as 75 percent of full load in some cases. If a user runs the motor at less than this sweet spot or has too much load for the motor, it still takes every bit as much current just to turn the motor, even when it’s unloaded. That results in wasted energy. Sizing the motor properly will result in maximum energy efficiency.

Mechanical efficiency
Motors and drives garner most attention optimizing a system for energy efficiency, but the system’s mechanical components also play an important role in squeezing the most performance out of each kilowatt of energy. Couplings and gearboxes fall into that category.

Knowing the right-sized and most efficient motor will improve system efficiency from the motor-only point of view. However, manufacturers can apply the wrong couplings to an application and unintentionally undo any savings.

When that happens, it not only affects efficiency, it also affects wear and everything else on the other parts of the system. The coupling transmits the power that is present, but if the wrong coupling is in place, it creates problems along the drive system. It can create extra forces that wear out bearings on motors and gearboxes, resulting in downtime and higher maintenance costs. That is why it’s critical manufacturers make the proper coupling selection.
There have even been cases where manufacturers felt they needed a new motor because of an exceptionally noisy operation. However, after changing to the proper coupling, the noise problem was eliminated at a fraction of the cost of a new motor.

A gearbox is also a mechanical system, but it definitely has an efficiency that can either save or cost manufacturers money. Increasing the efficiency of a gearbox, versus changing to a more expensive motor, can be the way to go. A math equation shows if a manufacturer increases the efficiency of a motor by 8 percent but the gearbox is only 60 percent efficient, then the manufacturer really does not gain in energy efficiency.

**Conclusion**

An energy efficient solution relies upon technology working well together to squeeze as much efficiency out of the system as possible, but it also needs people understanding their part in the process and what they need to do to ensure a finely-tuned system keeps running smoothly.

From the mechanical side of a solution to the electrical side, the bad news is energy costs will continue to rise. With demand for manufactured products rising that means energy consumption will also increase. But production costs don’t necessarily have to follow. If a manufacturer taps into its knowledge base and makes sure all technology and people are on the same page, there is great potential to tap into enormous energy savings.

Energy is a major cost of any business, and the issue is those costs keep rising. If it isn’t already, electrical consumption will soon be one of the metrics on the control system right next to how much scrap there is, how much utilization time there is on a machine, and how many safe working days there have been.

Through strict efficiency in energy usage, the gains achieved, along with the productivity gains from late 1990s and early 2000s, will mean manufacturers will be able to improve the bottom line.
Energy savings estimator

While costs continue to rise, energy is a controllable operating expense and users should manage those costs with the same expertise and resources as part of their business.

In addition, robust energy management processes, procedures, and practices are as effective at saving energy as a technology solution.

One way to use technology is to give a snapshot view of how it is possible to become more energy efficient and to potentially save costs, is the use of the Energy Estimator. Siemens offers the free downloadable software tool that allows a user to calculate energy savings potential and to see how quickly it is possible to earn a return on investment.

In terms of motors, as a rule of thumb, if the manufacturer can get a payback in less than two years, then that will be an efficient investment. If the payback is between two and three years, that is acceptable, but not as readily. If it is over three years, the industry will not accept that as a good investment.

Based on a few key parameters, the tool calculates the potential savings for the application. By inputting the facilities’ information into the Energy Savings Estimator, a manufacturer will be able to identify opportunities for savings and evaluate alternative strategies that can help increase efficiency and reduce waste.

There is another way of looking at it also. The industry standard for the lifespan of most motors is 15 years. So, if the manufacturer gets a payback in two years and the motor lasts 15 years, that is 13 years the motor is running and the user is gaining money that goes directly to the bottom line.

For more information and to find out how to improve energy efficiency go to the Energy Savings Estimator web site at http://www.usa.siemens.com/energysavingsestimator.
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