Using Kaizen to Reduce Energy Consumption and Yield Savings

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Lean manufacturers use many process-improvement tools to achieve and sustain efficiency, flexibility, and profitability. Such tools have enabled them to swap warehouses of idle inventory for fast-moving information networks; transform capacity constraints into quick-response production; and standardize processes for consistent quality on a global scale.

As these same companies manage spiraling energy costs, they are continuing to rely on lean process improvement to reduce waste and protect profits. Certainly, widespread societal demand exists for energy conservation to preserve the environment, but manufacturing leaders know that energy-reduction also is crucial to their companies' long-term survival. By not reducing energy consumption, manufacturers risk losing the gains reaped from years of LeanSigma® and other continuous-improvement efforts.

Energy is essential for goods production, but compared with other widely consumed raw materials, energy has become one of the costliest and most volatile. Therefore, stabilizing energy-consuming processes and removing as much waste as possible become the mandate to remain a globally competitive manufacturer.

Share of Energy Consumed by Major Sectors of the U.S. Economy	
Σ Industry and manufacturing	32%
Σ Transportation	28%
Σ Residential	22%
Σ Commercial	18%

Source: U.S. Energy Information Administration, Annual Energy Review 2005, www.eia.doe.gov.

All types of businesses are paying more for energy, and indications are that this trend—driven by increased demand and uncertain supply—will continue. The increases hit manufacturers especially hard because they consume vast amounts of energy in their production processes, use energy to transport their goods to customers, and often use energy sources such as natural gas and petroleum as raw materials.

According to the U.S. Energy Information Administration, the cost of natural gas, which is the most common source of energy in manufacturing, increased by 9.3 percent from 2007 to 2008 and is expected to increase at least an additional 1.9 percent from 2008 to 2009.

Sources of Energy Used for U.S. Industry and Manufacturing	
Σ Natural gas	36%
Σ Other sources	33%
Σ Electricity	17%
Σ Coal	7%
Σ Fuel oil	2%
Σ Coke fuel and wind	4%
Σ Propane	1%

Source: U.S. Energy Information Administration, Annual Energy Review 2005. www.eia.doe.gov.

Fortunately, manufacturers have ample opportunities to reduce energy consumption through the use of common lean tools and techniques.

Benefits of Energy Reduction through Lean Process Improvement

Traditionally, lean activities have not focused on energy usage, but we know that manufacturers that have applied such activities to production practices have gained significant competitive advantage. Typical improvements resulting from continuous-improvement activity include lead times that



are 25 percent to 50 percent of the industry average, annual inventory turns greater than 24, productivity increases of at least 1 percent per month, and growth rates that are three-to-five times the industry average.

By applying lean activities to energy use, an average facility can reduce its energy consumption by up to 20 percent, of which 30 percent can be achieved by making procedural and behavioral changes. Manufacturers such as agribusiness, food and beverage, paper and packaging, and other continuous-process industries can potentially double these reductions because their processes operate 24/7 and tend to be more energy-intensive. One continuous-process manufacturer working to cut energy consumption achieved a minimum 10 percent reduction with each process change.

Manufacturers that reduce energy usage do more than lower their utility bills. Benefits include:

- Improving workplace culture by creating a safer, cleaner internal environment, and instilling a sense of pride in employees for contributing to a safer and cleaner world.
- Contributing to a reputation of social responsibility locally and globally, which makes a company's products more attractive to customers.
- Taking the first step toward ISO 14001 certification.
- Becoming a more attractive partner to new and existing customers that have environmental-sustainability mandates for suppliers.
- Having accurate data about the true energy consumption of processes, which contributes to better decision-making regarding unit costs; production planning; and capital-equipment maintenance, repair, and purchases.
- Complying with current or future government regulations or industry guidelines regarding energy consumption and/or carbon emissions.
- Reducing the impact of energy's price volatility.

Applying lean thinking to energy requires the same understanding of value creation and waste reduction as traditional lean applications. Lean practices aim to make companies more competitive and profitable by increasing value-adding activities and decreasing non-value-adding activities as much as possible.

Most companies have great opportunity to reduce non-value-adding activities (waste) because, typically, 95 percent of any process is wasted time or activity. To the standard list of seven wastes, we can add an eighth waste: wasted energy. Taiichi Ohno, founder of TPS, famously said, "One thing you can't recycle is wasted time." The same is true for energy: Once energy is wasted, not only is the resource gone, but your company still will incur a substantial cost for it.

Additionally, we must understand two truths about lean process improvement before using its tools to reduce energy waste. First, lean process improvement is one part of lean management, which requires comprehensive commitment to culture change from a company's leaders. Lean management is not a set of tools or a means of reducing waste in and of itself. One of the first benefits of committing to lean management frequently is drastic reduction in wastes (such as excess inventory) and a subsequent boost in cash flow. This, however, is just part of lean management's ultimate goal: to build long-term sustainability through rampant and continuous process improvement, which feeds exponential creation of customer value at the lowest possible cost. Dedicated energy-reduction efforts should not be undertaken with a short-term focus or tied solely to short-term goals. They should be folded into a company's existing lean-management strategy and become part of everyone's daily work. Second, lean process improvement is not a complete solution for energy management just as the Internet is not a complete solution for information management. Lean

energy management should be part of a larger energy-management infrastructure that includes effective asset management, supplier development (in this case, energy suppliers), strategic site selection, and other relevant factors.

Capturing Wasted Energy

The key to capturing wasted energy is loss prevention. Plants consume most of their energy (more than 80 percent) while processing raw materials into finished goods. This is a good place to begin identifying energy waste because removing this waste will have a substantial and immediate impact. Here are two ways companies can begin capturing lost energy immediately:

Industrial Energy Usage by Activity	
Process heating	53%
Machine drives	22%
Facility HVAC	9%
Electrochemical process	4%
Process cooling and refrigeration	3%
Facility lighting	3%
Conventional electricity generation	3%
Other processes	1%
Onsite transportation	1%

Source: Prepared by the Leonardo Academy from U.S. Department of Energy data, from Annual Energy View 2003.

- Finding and stopping leaks: Continuous-process manufacturers have reduced energy waste significantly by declaring "death to leaks" of oil, natural gas, compressed air, treated water, steam, and/or electricity. Such leaks might seem too small to be worth detecting and correcting. However, plugging even small leaks can significantly reduce energy consumption. Stopping one leak from a 1/4-inch pipe carrying compressed air at 80 PSI can save a company $12,000 in one year
- Managing equipment and process waste: Common behavior in plants can waste energy: leaving lights, machinery, and computers on unnecessarily; using electronic carts or conveyors when push carts will do; creating excessive material or chemical waste that must be processed further; and making defective parts or finished goods that require energy for rework.

Applying Kaizen to Energy Reduction

Kaizen events can focus on a process or a system. Work teams and team leaders of frontline activities use process kaizen. Senior managers use system kaizen (also called flow kaizen) to address enterprise-wide management issues. An example of process kaizen would be detecting and eliminating leaks on the production line or cell, as discussed previously. An example of system kaizen would be changing the flow of raw materials so that suppliers deliver directly to production lines in order to eliminate the need for warehouse space, conveyers, and/or forklifts. Expanding system boundaries even further, a kaizen workshop could address energy at the product-development stage (e.g., machining requirements, material choice, packaging needs, storage specifications) or at a product's end-of-life stage, such as disposal or reuse at a customer site.

When system kaizen involves suppliers and customers, the goal becomes to equally share the benefits of improvement. For example, savings derived from collaborative improvements in transportation of raw materials from suppliers or delivery of finished goods to customers should be made transparent to all collaborators and equally distributed.

Another target for lean application that is growing in popularity and has the potential to yield significant energy savings is back-office operations. Particularly in the financial functions, reducing transaction waste through simplification and automation yields less reproduction, storage, distribution, and maintenance of paper records—all of which require the daily use of office machinery. One Midwest manufacturer of fabricated steel parts is in the process of switching from paper checks to electronic funds transfers as the result of ongoing process improvements to accounts payable

processes. So far, the company has reduced the number of weekly paper checks it issues by 62 percent, and in doing so, has cut the time it takes to issue payment to vendors from 4.5 hours a week to 1.5 hours a week. The company now pays its suppliers faster and with less material waste and energy consumption.

Spreading and sustaining the improvements of energy kaizens requires the same infrastructure of disciplined procedures as other continuous-improvement efforts. Some of these include:

- **Standard work:** Precise procedures established for each operator's work based on rate of performance, sequence of activities, and maintenance of a standard inventory of assets required to keep the process operating smoothly. For example, following an energy kaizen, a cell team adds daily checks for steam leaks to the standard work of shift start-up. In doing so, the team identifies new leaks immediately and corrects them. (Standard work also can save energy by eliminating variation in activity. After a team determines the most efficient method of production through kaizen, standard work ensures that everyone is following that method.)
- **5S:** Often, 5S is the first step to removing waste in an area or process. Periodic 5S audits ensure that the practices continue there after. For example, an operator performing complex assembly with her hands in a one-piece flow cell can keep work-in-process flowing by maintaining order at her work station using 5S. Another operator not using 5S is disorganized in her work and causes a disruption in flow. To catch up, the plant manager must add an additional two hours to the next shift to meet production goals, which increases per-unit costs in several ways, including energy consumption.
- **Plan-Do-Check-Act (PDCA)**: An improvement cycle introduced by W. Edwards Deming that proposes a change in a process (plan), implements the change (do), measures the results (check), and requires adjustment (act) based on the results. For example, a plant's maintenance crew monitors daily energy consumption and uses the findings to set monthly energy-reduction goals for individual projects. Once a month, team members report on their energy-reduction projects using the PDCA steps. This structure allows the maintenance supervisor to monitor the progress of the projects and offer help if needed while giving individual team members a guide for working independently.
- **Visual management:** Placing all tools, parts, reports, instructions, and performance indicators of a process or system in plain view so that everyone involved can immediately understand the status of the process or system. Energy example: As part of a "death to leaks" kaizen workshop, a production team assigns a unique color to pipes based on what each pipe contains. This makes for quick identification while checking for and correcting leaks. The colors also are used in a new energy-consumption chart that is added to an indicator board that portrays actual performance versus planned performance for each shift. Operators soon learn to monitor energy consumption by source using the colors, as well as using the colors in reports to indicate which pipes have been checked and, if need be, repaired. Over time, they gain knowledge of where leaks are likely to occur and under what circumstances, and become better at predicting when worn parts need to be replaced.

Lean continuous improvement always has emphasized waste reduction. This makes lean tools such as kaizen ideal for rooting out and removing energy waste. Outwardly, benefits of energy waste reduction include a projection of responsibility to employees, customers, communities, regulators, and lawmakers. Internally, manufacturers benefit from immediate and often significant cost savings, more stable processes, and a jump on certification programs such as ISO 14001.

While concerns about climate change and resource protection demand attention from high-energy-consuming businesses such as manufacturers, so does the competitive mandate of increasing customer value while controlling costs. Fortunately, common and proven lean process-improvement tools can help companies address both challenges. ■

This article is an excerpt from a white paper by the same title. For a copy of the full white paper, contact Angela Scenna, ascenna@tbmcg.com.