# THE BENEFITS OF INSTILLING AN ENERGY EFFICIENT CULTURE IN AN ORGANIZATION

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## ABSTRACT

Achieving energy efficiency goals in a dynamic manufacturing environment is both complex and challenging. Industrial facilities and processes, especially within certain sectors, often are highly energy intensive. Operations are seldom optimized due to reluctance to affect production, competing priorities, and the view that energy is an uncontrollable cost. The author will begin with the challenges facing those responsible for **energy management** in industrial facilities.

Adopting an **organizational culture** that values and supports energy efficiency is an important underlying aspect of energy management in a company.. The author uses specific examples of successes from small, medium, and larger companies. This includes the reasons why a company should adopt an energy efficient culture, the elements of Best-In-Class Energy Management, and the components of a successful program.

The paper will also discuss how to link **energy management and lean manufacturing** principles and initiatives that will strengthen the continuous improvement culture. This includes how to integrate energy into the value stream map; identify, quantify and estimate energy use at each point along map; develop waste, recovery and alternate technology opportunities, and create a "future state" energy map. Instructive case studies will be presented involving several manufacturing sectors including: food processing, plastics, paper, aerospace, chemical, and engineered products.

Finally, the author will close by presenting somekeys to success in adopting an energy efficient culture and integrating an Energy Management System (EMS) to yield measurable results in manufacturing.

## CHALLENGES FACING INDUSTRIAL FACILITIES

Industrial facilities and processes, particularly in certain manufacturing sectors, are often highly energy intensive. This environment can present significant opportunities for improved efficiency and resource conservation within manufacturing, chemical, and process system operations. An abundance of technical literature and guidance is available on energy conservation for common energy system categories such as HVAC, lighting, and compressed air. However, process operations are frequently overlooked. The reasons include reluctance to directly interfere with production operations, unfamiliarity with technical aspects of industrial processes and systems, and prevailing culture in many industrial plants that assigns a lower priority to energy efficiency. Other factors that lead to inefficient energy usage in industrial environments include emphasis on first-cost when implementing capital improvements, deferred/reduced maintenance due to decreased operating budgets, and retooling production operations to meet changing business conditions without considering impact to the efficiency of existing facility operations.

Energy-intensive industrial processes include the following:

- Metal processes such as casting, annealing, and hot and cold rolling
- Plastics processing such as extrusion, thermoforming, injection molding, and converting
- Pulp and paper processing
- Chemical and petrochemical processing
- Mining and mineral processing
- Chip fab manufacturing
- Process curing and drying
- Food processing operations, such as pasteurization and refrigeration
- Process heating and cooling

Increased competition has caused many companies , to adopt and instill a continuous improvement culture that focuses on operational excellence and cost reduction. This can include lean manufacturing principles; six sigma, or other similar programs. Those that successfully integrate energy management into these processes and throughout the organization achieve and sustain greater level of improvements on an on-going basis.

## ADOPTING AN ENERGY EFFICIENCY CULTURE

There are many business reasons for a company to improve energy management in addition to reducting costs and improving competitiveness. The increasing global emphasis on sustainability and reduction in greenhouse gas emissions has added another important dimension to the discussion.

A change in organizational attitudes toward energy use can reinforce the image of the company as a good corporate citizen , while minimizing the impact on the environment, supporting load reduction on the grid, helping maintain or increase employment levels, and staying ahead of increasing energy costs. In addition, many companies in the supply chain are now required to measure and report on their sustainability and energy management efforts.

Four elements are prevalent in Best in Class Energy Management manufacturing facilities: Consuming Less, Buying Cheaper, Managing Risk and Educating and Raising Awareness.

Effort to reduce energy demandcan be multi-faceted including conserving resources, maintaining optimal system and operational performance, investing in new technology, and adjusting effectively to business changes. In order to consume less, obtaining real time data that measurest and tracks energy use and production must be an integral component of the energy management system.MS. Performance metrics are essential , to both controlling and improving energy us. One key metric is relating energy consumption to manufacturing output (i.e. kWh and/or MMBtu per unit of production) is the energy intensity needed to make an impact at the process level. By having a system in place and empowered resources to act, operations can be kept under control and necessary corrective actions can be undertaken.

Implementing any improvement system, requires people that are informed and aware. This directly relates to the importance of developing conservation culture throughout an organization. Unless personnel know the impact energy costs have on the operation, they are unlikely to act. All staff needs an understanding of the relationship between their actions and energy consumption. Having energy dashboards, newsletters, and articles that are in concert with other improvement initiatives will maintain a focus and priority to the initiatives being undertaken..

Improvement targets must be set so there is a clear understanding of the criteria for success and a culture that continually challenges the norms Key questions are: Why are machines, systems, and processes operated the way they are? What is being wasted? What are alternatives?

The author has interfaced with all sizes and types of industries and those with successful energy efficiency cultures have many of these elements. The following are examples of some of these industries:

**Large Beverage Manufacturer**

- Objectives set a the Corporate, Plant, and Floor levels with annual improvement targets
- Key Performance Indicators (KPI) for electric, gas, and water per gallon of product produced
- Energy dashboard prominently displayed with red, yellow and green indicators
- Primary utilities sub-metered
- Plant Excellence Program established, projects monitored, and reported on by individual and plant group

**Large Snack Food Manufacturer**

- Objectives set a the Corporate and Plant Management and Staff levels with 2.5% annual improvement targets
- Key Performance Indicators (KPI) for electric, gas, and water per pound of product produced
- Energy dashboard prominently displayed on daily basis
- Resource Conservation Program established, projects monitored, and reported on at plant level
- Resource Conservation “Treasure Hunts or Kaizen Events” conducted nationally with cross plant participation

**Medium Plastics Manufacturer**

- Objectives set at the Corporate and Plant levels with 5% annual improvement targets
- Central procurement of commodities
- Operational Excellence Program established including:
  - Energy intensity for electric per pound of product produced
  - Energy dashboard prominently displayed monthly but tracked daily by Plant Engineering
  - Best practices captured and shared among plants

## LINKING ENERGY TO LEAN MANUFACTURING

Lean manufacturing is about producing just-in-time products using right sized equipment and limited product movement. Without such systems in place energy can be wasted in over producing, un-optimized product flow, over-sized equipment, and excess inventory and space.

For those companies that have adopted lean manufacturing principles, integrating energy to the value stream mapping process will identify opportunities to reduce energy intensity. Energy should be treated like any other process input that both generates products and waste. By gaining a better understanding of what is used vs. what is needed, waste can be determined and opportunities to conserve, recover, or improve or replace technology can be identified. Knowing that energy use is embedded in every part and that every piece of scrap has an energy component will unlock the realization that industrial process efficiency improvements in energy conservation.

The author has worked with many industries in identifying the benefits of energy stream mapping and improving processes. The following are examples of the benefits of linking energy efficiency to lean manufacturing:

### Paper Manufacturer

A specialty paper products manufacturer with 115 employees and 350,000 SF plant that consumed 33 million kWh and 3.6 million gallons of fuel oil to produce 58,000 tons of product was able to improve energy efficiency per net ton of paper produced by 8.6% while increasing capacity. Two projects were identified including improved web control to reduce losses and improved waste heat recovery leading to line speed increase on heavier products.

### Chemical Manufacturer

A chemical products manufacturer with 75 employees and 200,000 SF plant that consumed 1 million kWh and 52,600 MMBtu of natural gas to produce 6 million pounds of product was able to improve energy efficiency per pound of chemicals produced by 50% while increasing capacity 32%. Project involved change from a large batch operation to a continuous flow operation with more energy efficient vacuum technology and heat recovery.

### Food Manufacturer

A food products manufacturer with 230 employees and 550,000 SF plant had one product line that consumed 830,000 kWh and 20,000 MMBtus of natural gas to produce 178 million pounds of product was able to improve energy efficiency per pound of product produced by 12.8% for electricity and 5.4% for natural gas while increasing capacity 15%. Mapping of the production line identified that product cooling was a bottleneck in the operation and by increasing cooling line speed was increased and overall intensity reduced.

## KEYS TO SUCCESS

Based on the experience of the author in identifying, quantifying, and implementing energy efficiency for industrial processes and process support operations' needs, integrating energy management into the continuous improvement culture of an organization is the most effective way to achieve maximum resource conservation in a cost effective manner. The methodology to achieve success should consider the following:

- There are few "canned" conservation strategies for industrial processes. Many processes are industry-unique.
- The analysis of industrial process energy efficiency is often contingent on fundamental engineering principles such as energy and mass balances to identify and quantify waste.
- The best results are based on actual field measurement of critical parameters such as flows, temperatures, pressures and power. Data logging is vital when processes incorporate variability over time.
- When seeking energy conservation opportunities that directly impact process operations, the concerns of the process engineers and process managers must be considered. In most industrial plants, product quality and production efficiency are priority. Energy conservation efforts must not override these metrics, and for energy efficiency projects to be successful, buy-in from the production group is critical.
- Energy efficiency measures should be tied into productivity improvements (i.e. yield, throughput)
- Measure, track, and establish goals
- Establish and empower an active Energy Management Team at all levels of the Corporation
- Continually educate and raise awareness

Key aspects that can be identified and transferred to many industry sectors include the following:

- OEM supplied equipment is typically provided to minimize first time costs, not optimize energy efficiency
- Process utilities are used, added, or expanded to support process needs and are not always the most efficient method
- More efficient methods of control are available today then when processes were first installed

- Utilize funding mechanisms, such as federal, state, & utility based programs to support identification and implementation of energy efficient solutions

Many opportunities exist for achieving energy efficiency in industrial processes which will benefit companies in maintaining their competitiveness in a global environment.

**BIOGRAPHY**

Richard F. Rappa, P.E., C.E.M. is a Sr. Vice President at CHA Consulting, Inc., a full service engineering and construction management firm that provides services to clients throughout North America. He is manager of all manufacturing and energy services provided by the company. He has over 35 years of experience in industrial facilities' operations management, plant engineering, and project/program management.

Mr. Rappa has extensive experience providing energy management solutions, including conducting and managing industrial energy studies, implementing energy solutions, and also performing cogeneration feasibility analyses and Combined Heat & Power (CHP) engineering and design.

Mr. Rappa, who received his B.S. in Mechanical Engineering from Rensselaer Polytechnic Institute, is a registered Professional Engineer in New York State. He is a member of the Society of Plastics Engineers, Association of Facilities Engineers, and Association of Energy Engineers.

Prior to joining CHA, Mr. Rappa was Global Engineering & Environmental Health & Safety Director for ExxonMobil Chemical's Film Division, where he was responsible for capital upgrades and expansions worldwide. He was also Manufacturing Engineering Manager for Bausch & Lomb's Contact Lens Division where he was responsible for development and expansion of contact lens manufacturing processes.