Energy Management for Motor Driven Systems

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Chapter 1. Energy Management for Motor-Driven Systems

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the core elements of an effective energy management program for motor-driven systems.
- **Evaluate** where motor-driven system improvements are most likely to produce cost-effective savings.
- **Apply** survey, billing, and operating data to support energy conservation decisions.
- **Explain** how management commitment, employee participation, implementation, and performance monitoring support long-term energy savings.

Executive Summary: Energy management for motor-driven systems is an organized, ongoing process for reducing energy cost while maintaining production reliability and output. The most successful programs combine management support, technical analysis, employee participation, targeted implementation, and routine performance tracking.

Introduction

This section explains how industrial facility engineers can reduce energy costs by improving the management of motor-driven systems. The overall approach includes identifying and analyzing motor-driven system energy conservation opportunities, troubleshooting and tuning the in-plant electrical distribution system, correcting low power factor, understanding utility billing statements, and establishing preventive and predictive maintenance practices.

Industrial facilities have a straightforward reason to manage energy use carefully: energy costs directly affect profitability. Increasing utility costs reduce profits, compete with capital and maintenance budgets, increase product costs, and reduce the competitiveness of the facility. Energy use is therefore not simply a utility expense. It is an operating variable that affects production economics, reliability, and long-term business performance.

A common misconception is that energy conservation means turning off equipment or reducing production. For industrial facilities, effective energy management has a different objective. The goal is to produce the required products or services with the minimum practical energy consumption, while maintaining reliable production and obtaining economical fuel and power supplies. In engineering terms, energy management is a production efficiency strategy, not a shutdown strategy.

Energy efficiency improvements can provide benefits beyond lower utility bills. Facilities that implement energy-efficient technologies and operating practices may also improve productivity, enhance environmental performance, support compliance with environmental and pollution abatement requirements, and strengthen the facility's public image as an environmentally responsible operation.

Energy management is not a one-time project. It is an ongoing effort marked by gradual improvements in energy efficiency. For motor-driven systems, a successful energy management process generally includes:

- **Maximizing production efficiency**
- **Minimizing energy consumption**
- **Maintaining a high energy load factor**
- **Correcting low power factor**
- **Acquiring and using economical energy supplies**

Effective energy management requires organizational commitment. It becomes successful when the practices associated with efficient energy use become part of normal facility operations and decision-making.

Elements of a Successful Energy Management Program

Energy management is a structured team effort. It creates energy awareness, collects and organizes energy cost and consumption data, identifies and analyzes energy conservation opportunities, implements selected improvements, and monitors the results. The program should be designed so it does not place an unreasonable burden on plant maintenance or engineering staff.

The following ten elements are central to a successful energy management program.

1. Secure Top Management Commitment

Top management must be committed to a motor-driven systems energy conservation program. Management's attitude toward energy conservation strongly influences whether the program succeeds. If leadership treats energy use as a controllable cost and a strategic operating issue, the organization is more likely to assign resources, act on recommendations, and sustain improvements over time.

Management commitment must include both personnel resources and financial resources. Employees are more likely to apply effort to an energy conservation program when management clearly communicates that the program matters. Without visible management support, energy management can become an informal side effort that is easily displaced by day-to-day production demands.

💡 Design Tip: Energy management competes with other capital and maintenance priorities. A technically sound recommendation is more likely to be implemented when management has already accepted energy efficiency as a legitimate business objective.

2. Appoint an Energy Coordinator

A facility should appoint an energy coordinator to guide energy management efforts. The energy coordinator should have an energy background, and energy management should be a primary duty rather than a minor add-on responsibility.

The energy coordinator functions much like a coach. The role requires mobilizing resources, providing technical advice, motivating others, and supporting implementation. In a motor-driven systems program, the coordinator's responsibilities typically include:

- Making energy management part of each department's normal operating practices.
- Providing operators, foremen, and maintenance staff with the tools needed to participate in the energy management team.
- Analyzing trends in energy use and efficiency and identifying areas of concern.
- Informing plant management of barriers to energy reduction and recommending ways to remove them.
- Stimulating interest in energy-saving measures.
- Assisting in the development of energy use standards.
- Reviewing plans for plant expansions, process modifications, and equipment purchases to verify that energy is used efficiently.
- Directing the activities of outside consultants.
- Preparing monthly or bi-monthly facility energy efficiency reports so management remains informed about motor-driven system improvements, energy savings, and cost reductions.

The coordinator's role is both technical and organizational. The coordinator must understand energy data, motor-driven equipment, utility cost structure, and plant operations, but also must be able to work across departments.

3. Obtain Employee Cooperation

Operations and maintenance staff are essential to the success of an energy management effort. In most facilities, the effectiveness of an energy improvement program is proportional to the time and effort the energy coordinator and department representatives are allowed to devote to it.

Facilities should recognize and support internal "idea champions." An idea champion is the person with the vision, desire, and persistence to promote a conservation project or operating improvement and carry it through to completion. These individuals often identify practical opportunities that are not obvious from utility bills or equipment lists alone.

An energy committee should be established with representatives from each department. These representatives should be expected to make recommendations and conduct investigations. Participation creates the “critical mass” needed for a successful program. It also builds ownership, which is important because many savings opportunities depend on operational practices, maintenance habits, and scheduling decisions.

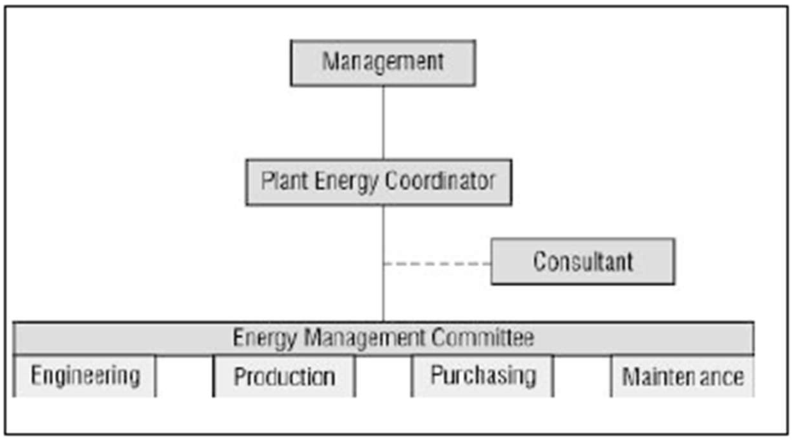

Figure 1-1 Typical Energy Management Team Organization Chart

4. Conduct Energy Surveys

An initial plant energy survey identifies where and how energy is being used and where it may be wasted. The survey should include an inventory of energy-using equipment. For motor-driven systems, the inventory should document basic energy use data, often obtained from equipment nameplates, along with typical running time and operating profiles.

Without basic audit information, the engineer cannot determine whether equipment is operating unnecessarily, operating wastefully, or operating outside the most efficient range. Survey information is also needed to establish standards and measure the performance of individual equipment, production lines, departments, and processes.

The energy survey helps the energy coordinator focus attention on the most energy-intensive equipment. Conservation savings are usually greatest where losses are largest. For motor-driven systems, auditors should give priority to applications with one or more of the following characteristics:

- Motor operating time exceeds **1,000 hours per year**.
- The application uses larger horsepower motors.
- The load is nearly constant and the motor operates at or near full load for much of the time.

- Energy, power, or demand charges are high.
- Utility rebate or demand management incentives are available.

The source material notes that motors above **20 hp** may represent only about **20 percent** of the motor population while consuming about **60 percent** of motor-driven equipment energy. This does not mean smaller motors should be ignored, but it does show why larger, heavily used motors are often the most productive starting point for an energy survey.

The initial physical plant survey should be performed department by department. It should identify wasteful operations and obvious sources of loss that can be corrected quickly. The survey should also identify where energy or process-flow metering should be installed. A useful rule of thumb is that in-plant metering may be economically justified when the annual cost of energy exceeds five times the cost of the meter.

One practical survey approach is to:

1. Determine the energy consumption rates and costs for major equipment in each department.
2. Ask department-level energy committee members to determine how long equipment operates and how long it remains in service without performing useful work.
3. Determine the cost of wasted energy.
4. Ask department-level energy committee members to develop procedures to reduce waste or identify barriers and equipment limitations that prevent waste reduction.

💡 Design Tip: The most useful energy survey does more than list equipment. It connects operating time, load profile, production value, and utility cost. That connection allows engineers to separate high-value improvement opportunities from low-impact observations.

5. Organize Energy Data

To convince plant management of the value of motor systems management, the engineer must show how energy affects operations. High energy costs may not be recognized as a problem until they are compared with other facility-level costs. Energy conservation opportunities compete for the same capital and personnel resources as other projects, so top management must understand the scale of the opportunity.

The logical starting point is the utility bill. The facility should obtain the applicable electric utility rate schedule and determine whether alternative schedules are available. The facility should also collect electrical energy consumption and cost data for at least one year to establish a base period.

The engineer should review this information for patterns. Energy cost may be higher during certain portions of the year, demand may peak during specific operating conditions, and power factor penalties may appear only under certain production scenarios. Graphing energy use and cost with an energy