The Four Steps of Effective Energy Management

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Energy conservation requires serious management. Its purpose is to make profit for the company. It should not be a hobby or a social program or a public relations activity. If you manage your energy efficiency program with professionalism, it will be the best investment that your organization can make. Today, organizations that fail to trim their energy costs are dying and are being replaced by competitors elsewhere.

Sometime during the next 50 years, the Age of Petroleum will end. Our range of energy supply choices will be similar to those that existed in the mid-19th century. It is far from certain that any major new sources will be available. The world's population will be much larger, and it will be dependent on energy as never before. Well before petroleum and natural gas disappear completely, the demand for energy will become frantic and prices will soar.

For your company and our civilization to survive, we will have to make a timely transition to very efficient energy use. In this article, we will review our present situation and provide a procedure for managing energy that guarantees success.

The Present State of Energy Efficiency

The industrial sector has achieved the greatest success in reducing both its energy consumption and its energy costs.

U.S. manufacturing accounts for one-third of total U.S. energy consumption. After the oil crisis of 1973 – the Big Bang that launched the modern era of energy conservation – the manufacturing sector responded more strongly to rising energy prices than did any other sector. The Alliance to Save Energy compiled this summary of industrial conservation since the Big Bang:

- Between 1972 and 1983, energy prices rose an average of 251%, adjusted for inflation.
- It took about two years for industry to start responding. Between 1974 and 1985, industrial energy use fell by 44% relative to physical output (e.g., BTU's per ton of product), and it fell by 40% relative to the dollar value of shipments.
- Then, from 1985 through 1994, which was a period of declining energy prices, energy use in manufacturing continued to fall. This decline was much smaller, 1% relative to physical output and 17% relative to the dollar value of shipments.

Efficiency improvement in the industrial sector resulted from the design of more efficient plants, from extensive retrofits to improve efficiency, and from improved operating practices.

We lack data to know how much efficiency potential still remains in the industrial sector. Also, this sector is highly diverse, so the answer varies from one facility to another. My own experience suggests that much more savings remain to be tapped.

Commercial buildings, which account for 18% of total energy consumption, today waste almost as much energy as they did before the Big Bang. This dismal record stems from neglect of efficiency by architects, mismanagement of efficiency retrofits, and the difficulty of motivating efficient behavior in the commercial environment.

Residential buildings, which account for 21% of total consumption, experienced a one-time improvement in efficiency from the addition of energy efficiency requirements in building codes. The efficiency of residential appliances has improved radically since the Big Bang, but this trend is now topping out. Today, energy consumption in housing is actually rising, and new houses are much less efficient than they could be. Improving residential efficiency is primarily a consumer and legislative issue.

The efficiency and economic potential existing in the industrial and commercial sectors can be tapped by two improvements in management. The first is to apply a professional approach to the selection and accomplishment of energy efficiency improvements. The second is to restore the credibility of energy management as a profit maker in the minds of top managers.

The Deficiencies of Contemporary Energy Management

The years since the Big Bang produced radical improvements in the efficiency of energy-using equipment. In contrast, effective management of energy costs has yet to take hold. Even today, energy management consists primarily of brief episodes of interest, usually centered around a current fad.

We fall into the trap of believing that energy conservation is exempt from the requirement for management discipline because it is a societal good. People have been wanting to achieve energy efficiency by discovering some special magic, like the Philosophers' Stone that turns lead into gold, to make energy conservation work. This accounts for the tendency to use exotic technology, such as energy management computers and cogeneration systems, as energy panaceas.

Often, we see that an energy conservation project is used as an amusing diversion from the daily routine. Such projects are treated as a one-night stand. The motivation is a visceral thrill with little selection involved, and no follow-up afterward. The objective of the infatuation is usually a fad that is expensive, complex, and unfamiliar – and hence likely to fail in a spectacular way. To date, energy conservation has largely been a series of such quickies. In place of this, we want to achieve a lasting marriage between your organization and energy management.

Among managers who are too serious to use energy conservation as entertainment, we encounter the dyspeptic notion that energy conservation is an alien intruder to the operations of the facility, competing with production efficiency. We have to demonstrate that energy efficiency – when done properly – is an integral part of all industrial activities, in both technical or management respects.

The Four Steps of Successful Energy Management

Okay then, what is the right way to do energy management? Effective energy management is a process that consists of four steps, which are the same steps that are needed for success in any complex business activity:

- Step 1. Identify All Your Opportunities
- Step 2. Prioritize Your Activities Rationally
- Step 3. Accomplish Your Activities Successfully
- Step 4. Maintain Your Activities Throughout the Life of the Facility

If you follow these four steps rigorously, you will achieve the maximum profit and you will be guaranteed success.

STEP 1. IDENTIFY ALL YOUR OPPORTUNITIES FOR LOWERING ENERGY COST

Step 1 is to find all your opportunities for saving energy cost. These include improvements to equipment, operations, and energy purchasing.

The key point about Step 1 is that you should accomplish it – in its entirety – before you commence any energy efficiency improvements or cost saving activities (except for fixing obvious defects). A large facility may have hundreds of ways to save energy cost. Keep your checkbook in your pocket until you have identified all of them.

Step 1 is challenging to accomplish because it stands in the way of using energy conservation as a form of entertainment – spending the company's money on fun projects – rather than as a source of profit. But without completing Step 1, you will miss most of your most profitable opportunities, you will invest your company's money less than optimally, and you will waste money on inappropriate activities.

Finding your energy cost saving opportunities is like an Easter egg hunt. You cannot know what your opportunities are until you have found all the eggs.

In Existing Facilities, Step 1 is a Competent Energy Audit

The process of accomplishing Step 1 in an existing facility is usually called an "energy audit." The energy audit is the detailed design for your energy efficiency program, just as drawings and specifications are essential for the construction of a building. Today, energy audits are almost never done correctly. So, it's important to know the right way to do them.

A proper energy audit involves several activities. The first is a complete inventory of every energy user in your facility – every motor, every pump, every lamp, every heating and cooling coil, every dishwasher, wash basin, smelter, grinder, compressor, retort, cooling tower, etc. Most of this inventory already exists in the as-built drawings.

Also, make graphs of the energy bills for each type of energy consumption in the facility for the past several years, to the greatest degree of detail that the records allow. An experienced energy auditor can read these graphs in the same way that a physician

reads a cardiogram. They show how your facility uses energy, where it wastes energy, and how you may be able to improve your energy purchasing.

Then, inspect each item of equipment and each system for possible energy waste under all operating conditions. This job has to be done with human eyeballs. You can't do it with a computer program or in any other way. You need a camera, a voice recorder, a flashlight, a few measurement devices, shoe leather, and a lot of time.

Next, define all the potential cost saving measures that correspond to each identified source of energy waste. To identify the possible remedies, you need appropriate guides and checklists (the *Energy Efficiency Manual*, MotorMaster and similar selection tools, U.S. government industrial Best Practices, industry literature, and other sources).

Typically, each cause of energy waste has a variety of solutions. For example, to improve the efficiency of a large cooling tower with single-speed fans, you could install variable-frequency drives, or multiple-speed motors, or multiple motors driving each fan, or you could retrofit variable-pitch fans, or you could buy new cooling towers. Each of these alternatives has advantages and disadvantages.

The energy audit must be done at the site. Finding energy waste and defining solutions is a progressive activity, involving lots of questions and decisions. The person doing the audit will be running all over the facility until the audit is complete.

The Energy Audit Takes Time and Effort

The amount of time and effort required for the audit is proportional to the number of ways that energy is used (hundreds or thousands), to the number of ways that energy is wasted (hundreds), and to the number of possible solutions for each cause of energy waste (several).

Industrial plants concentrate their energy consumption in a few large energy streams. Commercial buildings disperse their energy consumption in hundreds of different energy streams, most of which are small. Industrial efficiency improvements are less standardized, and hence require more time to specify. Here's a comparison between the audits for two typical facilities, each of which spends $1,000,000 per year for energy:

	INDUSTRIAL PLANT	LUXURY HOTEL
Inventory of Energy Users	**one day**	**several days**
Preparation and Analysis of Energy Consumption Graphs	**one day**	**one day**
Recognition of Sources of Energy Waste	**several days**	**several weeks**
Engineered (Large) Cost Saving Measures	**3**	**5**
Other Cost Saving Measures (aggregated)	**15**	**40**
Define Efficiency Improvements	**three months**	**six months**
TOTAL TIME	**four months**	**seven months**

Limit Step 1 to Proven Conservation Measures

Step 1 must be comprehensive in finding all the improvements that apply to your facility. However, you should limit your consideration to measures of *proven reliability*. The discipline of avoiding unreliable measures is as important as the discipline of including all the reliable ones.

Novelty is the sexiest thing in energy management, and therefore it is the thing most likely to get you in trouble. The way to avoid failure is to rigorously limit your potential energy saving activities to measures that are well proven.

A good guideline is to limit your consideration to equipment and methods that have been proven by at least one complete life cycle of experience. For example, the first generation of high-efficiency fluorescent lamps and variable-frequency motor drives either failed or caused serious problems.

Don't risk your company's money by using your facility as a laboratory for testing new products. As energy managers, you are at the end of a long chain of development. Scientists invent theories, laboratories test those theories, manufacturers make equipment, designers learn how to apply the equipment, mechanics learn how to install it, and people like me compile experience about how things really work.

All this occurs so that at the end of this chain, the facility manager can make intelligent decisions without risk. Your job is to give your top management the absolute certainty that the measures you propose will deliver profit.

Who Should Conduct the Energy Audit?

An energy audit requires an intimate knowledge of your facility's operations. It requires scientific understanding of all the ways that energy is used in your facility. It requires the experience to recognize energy waste where it occurs. It requires engineering understanding of the options that are available for improving efficiency. It requires trade experience in making equipment work reliably. It requires economic understanding of utility issues.

That's a tall order. Virtually no single individual has all these capabilities. To bring them together for the audit, the facility manager needs to educate himself, to hire expert help, and probably both.

If you are a competent plant operator who is comfortable with doing research about unfamiliar equipment and concepts, you can do the energy audit yourself. The fact that you are familiar with the facility on a daily basis is a significant advantage. The main question is whether the daily demands on your time will allow you to do it.

On the other hand, a qualified energy efficiency expert – with emphasis on "qualified" – will get the job done more quickly, and with more experienced judgement about which methods to consider and which to avoid. However, the outside expert will not know your plant as well as you do.

The best audit will result from an effective collaboration between yourself, your facility's top management, your staff, and a well chosen energy efficiency consultant. Your most important contribution to the audit is to manage that collaboration.

A Caution about "Walk-Through" Energy Audits

The "walk-through" energy audit is a fraudulent concept. Completeness is the main theme of your energy audit. By definition, a walk-through audit is superficial. Any energy audit that is less than complete is a defective energy audit, for the reasons that we discussed previously.

You would not want an airline pilot to do a superficial pre-flight check, and you would not want your physician to do a superficial diagnosis of a serious health problem.

Commonly, a "walk-through" audit is a disguised sales pitch. This includes free audits performed by utility companies. Free audits offered by government agencies are make-work projects. Audits by universities are educational activities for the students (which are valuable for them, but not for you).

Another Caution: Vendors are Not Consultants

A regular fraction of my work consists of responding to calls from clients about proposals that they get from vendors. I can't recall an instance where a proposal by a vendor proved to be desirable for the facility.

Facility operators are sophisticated people, so it continues to amaze me that they are so susceptible to vendor pitches, even for things that are completely bogus. Would you believe a seller of homeopathic remedies about which treatment to use for a serious illness? Would you trust a Ford salesman or a Chevrolet salesman to advise you which brand of truck to buy?

Vendors are important for help in selecting within their own catalogs, and for installing their products reliably. Vendors, contractors, engineers, utility representatives, and efficiency consultants all have essential roles to play in your energy management program. It is your job as the facility operator to make sure that each of these parties contributes in the proper way.

If someone calls himself an energy consultant, be sure that your interests are the ones being served. A consultant who is trying to sell products or deals is actually a vendor. For example, most of the "energy consultants" listed in the Yellow Pages are actually vendors.

When Designing New Facilities, Step 1 is an Integral Part of the Design

By far the best time to minimize the energy cost of a facility is during the design. At that point, efficiency improvements cost little or nothing. However, once the concrete is poured, many improvements are foreclosed and the rest become much more expensive.

When designing new facilities, Step 1 consists of an efficiency review that is an ongoing and integral part of the design process. It is analogous to the energy audit of an existing facility. Every item of energy consuming equipment and every system is considered for opportunities to maximize efficiency. The same guides to efficiency are used as for an energy audit. This activity requires the same careful selection of consultants.

Do Your Energy Audit or Design Review Now

Step 1 is the start of your energy management program. But today, 31 years after the Big Bang, nobody is just starting out in energy conservation. By now, your organization has probably gone through several episodes of trying to lower energy costs.

Even so, most organizations have never done a proper energy audit or a proper design review. Most energy conservation activities were stimulated by vendor pitches or fads. Most so-called "energy audits" today are trivial activities that occur in isolation from actual decision making about energy costs.

You have to change that. To achieve all the profit that is possible from energy management, go back to Square One and start over with a properly conducted energy audit.

Don't worry that conducting an energy audit at this late date will be construed as an admission of failure. Upgrading your procedures is an essential part of good management.

STEP 2. PRIORITIZE YOUR ACTIVITIES RATIONALLY

Step 2 is to plan the sequence for the activities that you identified in Step 1. The first point about Step 2 is that the sequence really does matter.

One reason is economic. Basic economic theory says that you will derive the greatest overall saving by accomplishing a series of activities in the order of their rate of return. But, this is only a starting point.

More important, you should sequence your activities so that the facility staff can accomplish them most efficiently. In particular, sequence your activities so that the earlier ones will not create a log jam that blocks the remainder of your program.

Consider All the Criteria That Matter

To determine the optimum sequence of your cost saving measures, rank them according to all the criteria that are relevant.

If you ask most managers how they rank investments, they will rattle off the usual financial criteria of initial cost, cost savings, and rate of return. But especially for energy efficiency improvements, economic criteria are not sufficient. Indeed, they are not the most important.

Your prime emphasis in selecting potential measures should be certainty that the measure will succeed. This criterion is paramount because the rate of return of a failed measure is zero. And, a failed project will cripple the future of your efficiency program.

For any method of reducing energy cost that you are considering, essential criteria are: (1) the *demonstrated performance* of the measure, and (2) the *ability of your staff to accomplish and sustain* the measure (which relates to Steps 3 and 4).

Also consider non-energy benefits and liabilities. For example, boiler controls that optimize combustion efficiency greatly reduce the need for boiler maintenance and they reduce air pollution. On the other hand, window films that reduce solar heat gain become unsightly within a few years and they increase the risk of window breakage.

Initial cost is the least important criterion. If you can accomplish a measure so that its success is certain, and if that measure offers a rate of return that is higher than commercial interest rates, initial cost hardly matters. If a measure is expensive, you can achieve positive cash flow from the outset by borrowing money to pay for it.

Calculate with Realistic Numbers

As an experienced facility manager, you know how to "run the numbers" for your projects. However, I often see savings estimates for energy projections that are absurdly unrealistic. The history of energy conservation is full of phony numbers, generated by people who were trying to rationalize the spending of company money for fun projects. Be brutally skeptical about your estimates.

In your estimates, calculate a range that reflects the uncertainty of initial cost and future conditions, especially future energy prices and changes in facility operations.

STEP 3. ACCOMPLISH YOUR ACTIVITIES SUCCESSFULLY

Step 3 is accomplishing each cost saving measure successfully. Each measure is an independent project that requires its own knowledge, skills, equipment, and people. So, Step 3 is repeated each time you initiate the next cost saving measure on your list.

Why do we need to discuss this as a separate Step? Because the largest cost of energy conservation over the past 30 years has been the failures. A large fraction of all the energy conservation projects accomplished since the Big Bang of 1973 have failed. If your project doesn't work, it won't pay off.

Failure is completely avoidable if you plan each measure properly.

Do Your Homework for Each Measure

You have undertaken unfamiliar activities and made them successful. You did it by doing your homework, finding the right people, finding the right equipment, and closely monitoring performance. Energy management is simply a continuing series of such activities.

For each measure, know all the issues that you need to address. Find examples of success and copy them. Equally important, find out about failures and why they occurred. Success is largely a matter of identifying all potential failure modes, and systematically avoiding each of them.

A simple example is replacing a large electric motor. First, refer to the *Energy Efficiency Manual* to determine the appropriate type of motor and the selection characteristics. Then, make a careful calculation of the most efficient size. Finally, use the MotorMaster software tool to identify the specific model that provides the best efficiency, the appropriate enclosure type, the correct mounting, and other features.

For efficiency improvements in specialized industrial processes, get the U.S. Department of Best Practices that apply to that particular industry. Study the catalogs of competing equipment manufacturers.

In all cases, talk to others who have accomplished the activity that you are planning to accomplish. But, take all testimony with a grain of salt.

STEP 4. MAINTAIN YOUR ACTIVITIES THROUGHOUT THE LIFE OF THE FACILITY

Step 4 is to ensure the survival of each cost saving measure for the life of the facility. Do you want your activity to make a profit for a few months? For a year? For several years? No, you want every cost saving to continue for the life of the facility.

Why do we need to spell this out as a separate Step? Because each cost saving measure, whether it involves equipment or procedures, will fail unless steps are taken to keep it profitable. Unfortunately, there is a tendency to believe that energy conservation is exempt from maintenance. "Do it and forget it." Nothing could be more wrong.

For example, many measures to optimize boiler efficiency are cheap, easy, and exceptionally profitable. However, these measures may decay in time periods that range from several years to as little as several days. As a result, most boiler plants are operating substantially below par.

If you have done the first three steps properly, Step 4 falls right into place. In Step 3, you accomplish the measure with an emphasis on survival. The value that you add in Step 4 to is to create a maintenance program for the measure.

The trick in Step 4 is to avoid creating a separate maintenance burden. If you make that mistake, your energy saving measures will be the first to be neglected, because they will be perceived as separate from the "critical" maintenance needed to maintain production. Instead, integrate the maintenance of each measure seamlessly into your overall maintenance operations.

HOW TO SELL ENERGY CONSERVATION TO TOP MANAGEMENT

Energy managers commonly complain that they encounter resistance to energy conservation by the top management of their organizations. For example, top managers nowadays demand a much higher rate of return for energy conservation projects than they would require from any other investment.

Resistance to energy conservation is not an illusion. Top managers no longer trust energy conservation. They have been given promises for the last thirty years that failed to adequately repay the investments that were made.

To overcome the bad reputation of the past, you must build trust that you know what you are talking about and that you can deliver the profit that you promise. You have to be able to show that you can succeed where others have failed. If you educate your top management about the Four Steps, you will convey credibility that you are interested in creating profit, not playing at company expense.

Stress that the industrial sector has demonstrated the economic value of energy management. It works under real conditions.

And, stress that we have finally created the information and tools that we need to make conservation reliable. After a long period of difficult adolescence, energy management is now ready to enter maturity.