
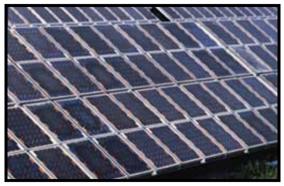



GUIDE TO ENERGY EFFICIENCY

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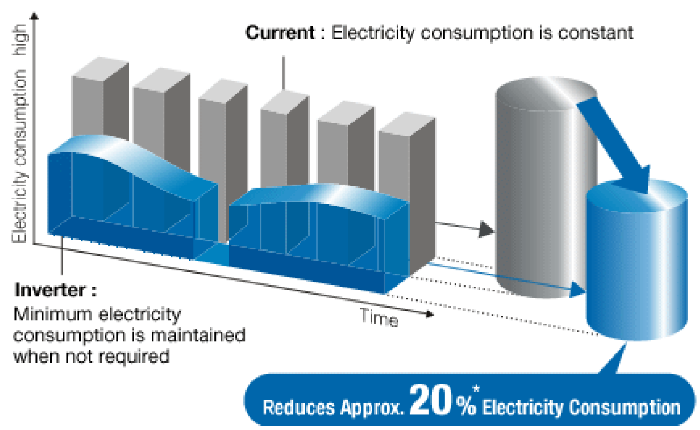

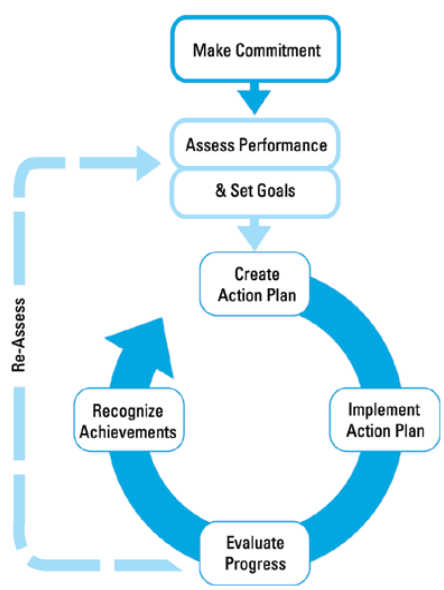

GUIDE TO ENERGY EFFICIENCY
ENERGY MANAGEMENT: SELF ASSESSMENT GUIDE

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Conversion Factors

Energy Unit	Energy Equivalent
1 kWh	3,412 BTU
1 Therm	100,000 BTU
1 Cu. Ft. of Natural Gas	1,000 BTU
1 Gallon Propane *	83,000 - 91,600 BTU
1 Gallon Oil *	140,000 - 152,000 BTU
1 Ton Coal *	28,000,000 BTU
1 Boiler Horsepower	9.81 kW
1 Horsepower	746 kW
1 Ton Refrigeration	12,000 BTU/hr

* Varies slightly with supplier

ENERGY MANAGEMENT: SELF ASSESSMENT GUIDE

1. Introduction

Many industries wish to monitor and improve their energy performance for both economic and ecological reasons. Businesses can benefit significantly by moving towards energy management practices. There are more motives besides reducing costs to implement an effective energy management system; the improved performance can have a positive effect on production, operations, maintenance and environmental issues.

A first step towards and energy management system is a global analysis of the energy flows to better understand the potential for improvement. Getting information about energy consumption is an effective starting point for industries that want to lower their energy bill. Three types of energy use are found in manufacturing facilities: direct production of goods, space conditioning and general facility support such as lighting.

Most energy reduction opportunities in industrial facilities are identified after observation and analysis of the facility. However, much can be done before a site visit to identify possible energy-reduction opportunities.

Basic techniques can:

- Quantify production, space conditioning and non-production related energy use
- Uncover some energy savings opportunities
- Help develop reasonably accurate budgets and costing models
- Tack savings due to better energy usage

• Gather data & determine your energy fluxes • Set up your energy balance	• Identify energy saving projects Calculate savings & Pay Back • Set up an Energy Efficiency Plan with performance goals	• Project implementation studies based on measurements • Accurate calculation of savings & Pay Back based on factual data • Implement the action plan	• Monitor the actual savings after implementation • Provide training on Rational Use of Energy • Review the action plan if needed

3 to 6 months

Figure 1: A roadmap towards energy savings

2. Barriers to Energy Efficiency

2.1 Identified Barriers and Solutions

KEY BARRIERS	SOLUTIONS	STAKEHOLDERS
MANAGEMENT **Lack of awareness at company top management level of energy efficiency. This is the root cause of many other barriers, especially:** • Management finds production more important • Management is concerned about investment costs of energy efficiency measures • Lack of policies, systems, energy/environment and energy managers within companies • Lack of integration of energy into core business management and reporting	**Awareness raising / marketing strategy aimed at company top management** • Awareness raising seminars for top management • Training / capacity building of energy manager and external facilitators on how to convince and assist management • Information dissemination • Demonstration projects • Comparative study (benchmarking) • Clearing house • Awards & recognition • Networks • Success stories / best practice examples • Energy labeling of technologies • Media campaign • Inclusion in school curriculum	**Everyone influencing company management:** • international organizations, government • Financial institutions, • NGOs, Academia • Suppliers, customers, Industry associations • Media • Employees, environmental manager • Business management schools & consultants (not just technical) • Schools (start young!!)
KNOWLEDGE AND INFORMATION • Limited access to and availability of technical information • Limited technical knowledge at company level and facilitating organizations	**Strategy that aligns demand and supply of information / technology aimed at company staff and external facilitators** • Training/ demonstration on EE technologies, EMS, and CP audits, technology requirements & feasibility studies • Establish systems to maintain knowledge within companies • Customize information and technologies • Research & development • Visits to different companies by external facilitators • Comparative studies • Technical training /capacity building of energy managers and external auditors and facilitators	• International organizations • Government agencies • Research institutions / universities / CP Centers • Industry / trade associations • Suppliers
FINANCING • Difficulty in obtaining external financing for energy efficiency projects, in particular by SMEs	**Financing strategy aimed especially at financial institutions** • Assist companies to make proposals bankable • Different criteria for evaluating / investing in EE projects • Special funds & CDM • Awareness raising of financial institutions • Inform companies about existing financing packages / institutions	• Financial institutions • Central Bank • Government • International organizations • Company finance managers (CFO, accountants) • Financial consultants / accountants

KEY BARRIERS	SOLUTIONS	STAKEHOLDERS
POLICY • Weak legislation and/or enforcement • Limited financial incentives by government for energy efficiency • Irrational (subsidized) energy pricing policies	**Policy & legislative reform strategy aimed at government** • Resource pricing • Transparency of energy prices, policy, and investments, contracts • Fiscal / economic policies aimed at aligning energy, environment and economic policies and removal of energy subsidies • Pragmatic legislation (something than can actually be implemented & enforced) • Enforcement strategies • Monitoring of compliance • Capacity building of government officials • Change of political will / leadership	• Government • Policy makers • Lobbyists • International community • Service providers (e.g. QMS) • Public / community • Consultants • Industry associations • Financial institutions • NGOs • Employee

2.2 Lack of Management Awareness

The lack of awareness of energy efficiency by top management of companies is an important barrier because without management commitment it is an uphill battle to improve energy efficiency. This appears to be the root cause of other barriers, such as the priority for production, lack of investment capital, and limited policies, systems and reporting processes to manage energy consumption, and hierarchical management structures. These are described below.

Perhaps the most important barrier is that **management is focused more on maximizing the production output and turnover** rather than on producing safely, more efficiently and reducing production costs. As a result, it can be difficult to convince management to authorize an energy assessment or the implementation of energy efficiency options. Not because it is unimportant, but simply because production output is considered more important.

Related to this is the fact that **many companies see "the environment" as a legal compliance issue and cost burden** instead of an opportunity to reduce costs. One consultant commented: "Water and energy issues are treated as secondary (at best) and as a nuisance (at all times)." Energy efficiency was a much better term to use than environment, cleaner production or greenhouse gas emissions because management associate energy efficiency more with cost savings. The good news is that meetings with management at the end of the project revealed that awareness of the cost savings opportunity through environmental measures had increased significantly in some businesses.

What appears to be the situation in many businesses is that company management often considers **new technologies as the only way to significantly improve resource efficiency**. But this is also a "prestige" issue. Truth is that significant savings can be achieved by improving existing production processes without investing in expensive new technologies.

Lack of awareness about resource and energy efficiency of top management is also caused by the **immature systems to manage energy**, such as policies, environmental management systems, and an energy or environment manager. This way management is not sufficiently informed about energy and consequently cannot be pro-active towards energy management. In addition, without systems, staff is less able to take initiatives to reduce energy consumption.

Studies show that companies that have management systems in place are also the ones most likely to continue with improving resource and energy efficiency after the project's completion. This confirms the importance of management systems in addition to concrete actions. Finally, **hierarchical management structures** in companies can be an inhibitor for staff to raise suggestions even if there is a formal procedure for this because staff could be afraid of repercussions.

2.3 Limited Knowledge and Information

A second barrier is about knowledge and information. It covers limited information and (technical) knowledge at company level and facilitating organizations, but also a limited access to and availability of knowledge and information. Company information on energy and resources is crucial because only then the improvements after implementation of options can be measured, and management is more likely to continue with resource and energy efficiency if quantitative data on savings are available.

Poor information systems were the main cause of lack of electricity and resource consumption data. The reason for poor monitoring is often that energy is considered as a fixed cost and therefore not actively monitored or managed. This is despite the fact that energy costs can be as high as 50 percent in some businesses. Common observations are:

- Usually only the very large companies have monitoring equipment. During a energy assessments, businesses often use the design parameters of equipment (which can be quite different from actual operating parameters!) because they do not have monitoring equipment.
- Different departments often hold different information but no one has the overview to manage resource and energy consumption effectively.
- Information is not always communicated to those who can influence resource consumption.
- Suppliers of electricity and water often install only one meter for the entire business and their invoices will therefore only state the total costs and electricity or water consumed. There are not many businesses with adequate sub-metering, which would make the identification of energy losses and monitoring of results of implemented options a lot easier. Furthermore, suppliers generally do not benefit if the companies reduce resource and energy consumption, which creates a disincentive for them to highlight savings opportunities or participate.

Limited internal knowledge and expertise was also a common problem. A minimum technical knowledge of energy, production processes and equipment is required to be able to identify, investigate and implement options to improve resource and energy efficiency.

In most businesses, management and staff never participated in a technical training course on cleaner production and energy efficiency. Even at one of the large multinationals training was limited to senior staff but production staff received very little training. In one paper company boilers were modern but operating very inefficiently because the company had not trained the boiler operators. This appears to be a common problem, especially in government-owned plants where making profits is given less emphasis. It is interesting to note that many companies joined the GERIAP project especially to give their staff the opportunity to get trained on energy efficiency.

Many companies have **difficulties in accessing external information and expertise**. Information companies really want include benchmark figures, consultants, funding resources, information on the federal regulations, suppliers who can provide new technologies and monitoring equipment, etc.

But research into barriers to energy efficiency also highlighted that the external information on resource efficiency is scattered because so many organizations hold a piece of the puzzle, including ministries, international organizations, consultancies etc. This makes it difficult for a company to get a clear overview of available information or even to know where to start looking.

2.4 Lack of Financing

Almost all companies mention the financial limitations of implementing energy efficiency options. For some companies the issue is that **money was available, but not readily available**. For example, one company that is a subsidiary of a large multinational needs permission first to make investments over US$ 10,000, which takes time. Others have to wait for the next budget round to gain access to capital or until a major production expansion or plant movement was completed.

Government-owned operations have to go through a bureaucratic process to get funds for energy efficiency options. Some businesses solve this by financing several improvements from the already allocated maintenance budget. But the big lesson to learn is to find out before an energy assessment is started what the decision-making process is with regard to approval for options and obtaining the required investment capital.

The most common barrier mentioned was the **lack of money to invest in options**. Options with a payback period of more than two or three years are rarely implemented. Some options provide huge savings and a short payback period of often less than one year, but the option requires a high investment and the business simply does not have the money at hand. One option is to take out a loan, but interest rates can be high, and banks often do not have confidence in the creditworthiness of companies to give them a loan, especially small and medium sized companies (SMEs). Other companies feel uncomfortable with taking a loan, and these are often family-run companies that are used to saving money first before investing it.

On the other hand, lack of financing can also be a perceived barrier that stops companies from taking action. Often there is a gap between what management would like to do and how much they are willing to spend. At the start of a project management of some companies indicated an interest in technically sophisticated options. But when push came to shove, management would not approve the options citing high investment costs and long payback periods. It is therefore important to also focus on options that require little investment but have good return on investment, even if these are not the most glamorous options.

Fortunately, finance options are increasing and even federal and state government is starting to offer incentives for energy efficiency improvements. Outside the USA, notably in otherwise underdeveloped countries in Asia, the establishment of Energy Service Companies (ESCOs), which provide (part of) the investment capital for energy efficiency projects in return for a share of the financial savings over a certain number of years, are a very interesting funding source that could find use in the USA as well. In general, communication about what is already there is therefore equally important as looking into developing new financing mechanisms!

2.5 Lack of Policies and Legislation and Enforcement

While companies hold the key to reducing their energy consumption, government policy certainly has a big influence. Limited policies, poor enforcement and conflicting economic and environmental policies were identified as the fourth group of barriers.

Lack of effective policies is a key issue, but the situation is different between countries. Most countries have environmental legislation focused on limiting pollution levels (such as emissions and wastewater) but not on using resources efficiently. In addition, policies are mostly command-and-control through legislation, and examples of economic policies (e.g. taxes, subsidies) and voluntary policies (e.g. covenants or agreements between government and industry) are scarce.

A second problem is **weak enforcement of environmental policies and legislation**. A reason for limited enforcement is that governments allocate insufficient funds for policy implementation and enforcement. Plus local authorities are often hesitant to fine companies, afraid that they might move to other parts of the country, and thereby causing a loss of local jobs.

But most damaging to American industry's energy potential are **government policies that are only aimed at short-term economic gain and growth** but ignore the environmental impacts and therefore are a threat to long-term economic and social development. An important cause is that so many government agencies have an interest in energy, but from a different angle. For example, there are ministries / departments for environment, industry, energy, and science and technology which all develop energy-related policies, which are not necessarily consistent. And when economic and environmental interests clash, unfortunately the economy almost always wins.

3. Organizational Issues

The following table provides a way to gain insight into a company's current approach to energy matters. Each column deals with one of the six important energy management issues. For evaluation, consider each column individually. (The table is based on BRESCU 1993 Energy Management Matrix)

Energy management policy	Organising	Staff motivation	Monitoring and reporting systems	Staff awareness and training	Investment
Energy management policy, action plan and regular review have commitment of top management as part of a corporate strategy. Energy management fully integrated into management structure.	Clear delegation of responsibility for energy consumption.	Formal and informal channels of communication regularly exploited by energy manager and energy staff at all levels.	Comprehensive system sets targets, monitors consumption, identifies faults, quantifies savings and provides budget tracking.	Marketing the value of energy efficiency and the performance of energy management both within the organisation and outside it.	Positive discrimination in favour of energy saving schemes with detailed investment appraisal of all new buildings, equipment and refurbishing opportunities.
Formal energy management policy, but no active commitment from top management.	Energy manager accountable to energy committee representing all users, chaired by a member of the managing board.	Energy committee used as main channel together with direct contact with major users.	Monitoring and targeting reports for individual premises based on submetering, but savings not reported effectively to users.	Program of staff training, awareness and regular publicity campaigns. Some payback criteria employed as for all other investment.	Cursory appraisal of new building, equipment and refurbishment opportunities.
Unadopted energy management policy set by energy manager or senior departmental manager.	Energy manager in post, reporting committee, but line management and authority unclear.	Contact with major users through ad-hoc committee chaired by senior departmental manager.	Monitoring and targeting reports based on supply meter data.	Energy unit has ad-hoc involvement in budget setting. Some ad-hoc staff awareness and training.	Investment using short-term payback criteria only.
An unwritten set of guidelines. Energy management is the part-time responsibility of someone with only limited authority and influence	Informal contacts between energy manager and a few users.	Cost reporting based on invoice data.	Energy manager compiles report for internal use within technical department.	Informal contact used to promote energy efficiency	Only low-cost measures taken.
No explicit policy. No energy manager or any formal delegation of responsibility for energy consumption.	No contact with users.	No information system	No accounting for energy consumption.	No promotion of energy efficiency.	No investment in increasing energy efficiency in premises/sites

Table 1: Energy Management Matrix

The table presented above allows for quickly assessing an organization's current energy management and where it should aim for. It provides therefore an overall roadmap on how to improve an organization's energy management and the different aspects of energy management.

There are 5 important domains in energy management:

- Organizational issues: including commitment to energy management, appointed energy manager and responsibilities
- Staff motivation: e.g. channels of communication, accessibility of data

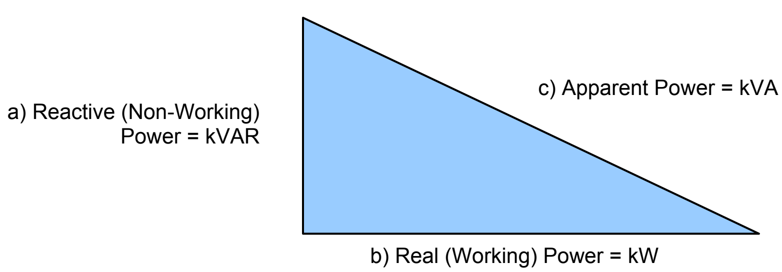
- Monitoring and reporting systems: gathering and analyzing the data
- Staff awareness and training: influence of energy efficiency in decision making
- Investment: Commitment towards energy efficiency concerning new investments

4. Energy Inventory

4.1 Understand Your Power / Electricity Bill

Not all items may apply to your bill, depending on the size of your operation and the classification that has been assigned to your business by your power company.

- **Read Type:** The three most common types of reads are those done by the company, those which are estimated, and those which have been adjusted through a manual process before being mailed.
- **Average KWH Per Day:** Calculated by dividing the usage by the number of days of service.
- **Cost per Day:** Shown for the current, immediate past, and prior years monthly billing cycles.
- **Customer Charge (residential, small/large general):** A fixed monthly charge that recovers customer related costs such as meter reading, bill preparation, postage, account maintenance and customer service. It also recovers the depreciation and interest cost for meters and service lines. These costs are the same for each member in a rate class. Thus, the charge is a flat monthly amount that does not vary based on usage.
- **Energy Charge (kWh):** This charge is assessed for each kilowatt-hour used. It primarily recovers fuel and other costs that vary with the amount of usage. For residential and large general service, it also recovers the fixed or capacity related costs, such as plant and equipment, needed to provide energy on demand.
- **Demand Charge (large general service customers only):** This charge is assessed per kilowatt of peak monthly demand. It recovers the costs of having the ability to meet a consumer's power needs "on demand." They include the cost of having generation, transmission and distribution facilities available and ready to generate and deliver power when needed. Monthly spikes in demand can heavily increase your cost of electricity. This charge is based on the highest rate of consumption during the billing period. It is usually obtained by the electric company by measurement of energy consumed in sequential fifteen minute periods throughout the month. The fifteen minute period with the maximum consumption is then converted to an average rate of consumption in units of kilowatts or kW. This maximum kW value is then multiplied by a demand factor which can vary considerably depending on whether on is talking about demand during on-peak (daytime hours) or off-peak (night time hours). This demand charge is then added on to your consumption costs to yield the monthly electric costs. Demand costs can often make up 50% or more of the total electric bill.
- **Power Factor (PF):** The third component of the bill, power factor (reactive charge), is significant only if five percent of the bill is a penalty charge for having a low power factor. It most often is significant when the great majority of the electric consumption is taking place in electric motors.



$a^2 + b^2 = c^2$

PF = kW / kVA
PF = b / c

The power factor can be corrected by installing banks of capacitors within the building or providing a matched capacitor to each motor to offset their reactive effect.

Apparent Power *is the amount of power provided to your facility by the electric utility.*
Reactive Power *is non-working power, and is measured in kVARs. Inductive loads (e.g. transformers, electric motors, and high intensity discharge lighting) are a major portion of the power consumed in industrial facilities, and they require current to create a magnetic field. The current used to create the magnetic field is required to operate the device, but does not produce work.*
Real Power *is the work done by the device, and is measured in kW. If your facility draws 100 kW Real Power and 100 kVAR Reactive (magnetizing) Power, then your utility must provide your facility with Apparent Power of 142 kVA. The power factor is 70%, which means that only 70% of the current provided by the electrical utility is being used to produce useful work.*

- **Fuel Adjustment Charge:** The fuel adjustment, assessed on a kilowatt-hour basis, can be either an additional charge or a credit to a consumer's bill. It allows increases or decreases in the cost of fuel and purchased power to be passed on to consumers. Thus, if the actual cost per kWh is less than the amount allowed for fuel and purchased power in the base utility rate, the difference per kilowatt-hour will be credited to the consumer's account based on usage.
- **Regulatory Cost Charge (RCC):** The regulatory cost charge is established by the State of Kentucky each year to fund the operations of the Regulatory Commission of Kentucky. All utilities pay a portion of the Commissions' cost. For electric utilities, it is assessed per kilowatt-hour.
- **Late Charges:** Notice if the utility bills contain late charges. Paying bills on time will reduce excess fees from late charges and reduce the cost of energy to your facility from a few hundred dollars a year to a few thousand. This is one of the easiest manners to reduce your energy bills.

4.2 Standard Billing Analysis
A first step towards a more efficient energy use is a closer look at the energy bills. The purpose is to identify the major cost drivers of energy consumption and obvious anomalous energy usage.

A standard billing analysis includes the following tasks:

- Graph trends
  In general, our eyes are much better at identifying patterns and trends from graphical information than from tables of numbers. It facilitates thus the tracking of anomalies in the demand data. For example, in Figure 2, it is immediately clear that the electricity consumption in April is anomalously high.
- Summarize rate schedules
  Most electrical rate schedules can be simplified into charges for service, total energy use, peak electrical demand and low power factor. This is to learn more about the real energy cost driver(s).
- Verify billing amounts
- Identify major savings opportunities
  Disaggregated energy costs enable a good view of energy consumption and its related costs; thus for determining significant saving opportunities

4.3 Steps for an Energy Breakdown
Energy breakdowns help target and screen energy saving opportunities. In doing so, a business automatically gets a better understanding where and how energy is used. An energy flow scheme will be the outcome.

Electrical demand can, as a first estimate, be segregated into production and air conditioning by drawing a line through winter demand. Electrical demand below the line is for production and electrical demand above the line is for air conditioning. Thermal energy use can also be divided into production and space heating components by drawing a line through summer gas use. Roughly speaking, gas use below the line is for production and gas use above the line is for space heating.

Finally, energy use by equipment can be estimated based on rated power, fraction loaded and hours of operation. Initial estimates of electricity and gas use by equipment should be calibrated to match the breakdowns of electricity and gas use into production and space conditioning components. This process insures that estimated energy use by equipment does not exceed the actual quantities purchased and conforms to the patterns of use is evident in the billing data. Improve estimates by using historical data.

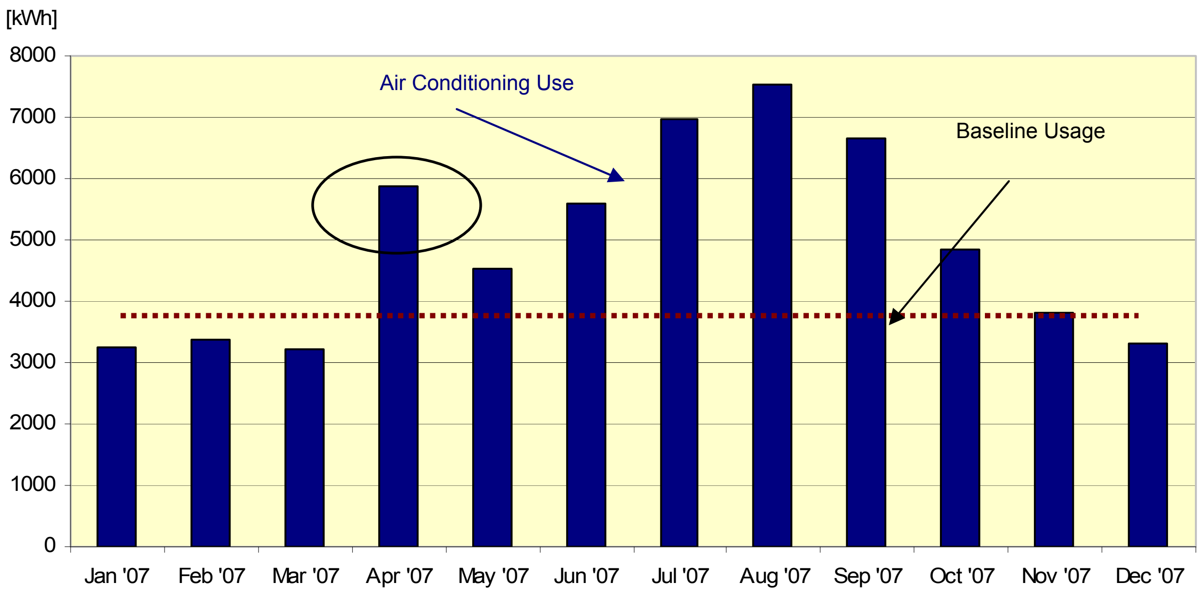


Figure 2: Monthly Electrical Demand

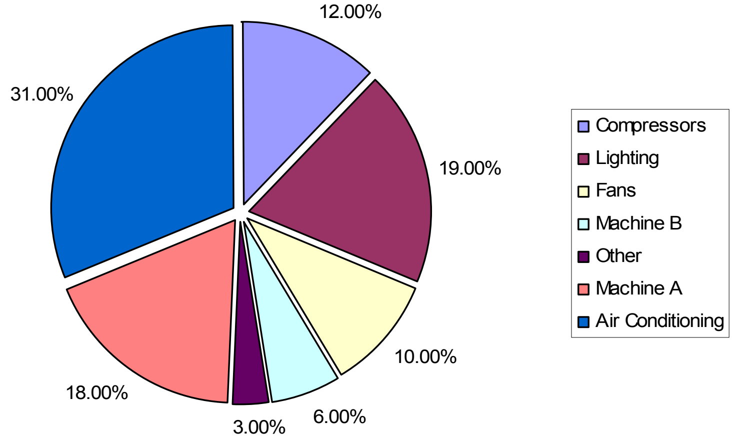


Figure 3: Example of Electricity use breakdown by equipment

Rules of thumb for effective monitoring:

- Record only the most relevant variables
- Record historical data form the past 24 months at least
- Ensure measurements are accurate enough to be useful
- Ensure measurements are regular and frequent enough to pick up any relevant highs and lows, and are compatible with the rate at which control actions occur.
- Plot the ratio of peak and off -peak electricity
- Plot actual versus charged demand (electricity & gas)
- Record relevant associated data simultaneously (e.g. production rate)
- Monitor large plant items individually

Where do you use the most energy? The following information can help you determine where your most rewarding energy efficiency opportunities are. Energy is a significant portion of your controllable and variable overhead expense and should be considered a critical financial performance factor!

Energy Usage Categories (%)						
Type of Operation	**HVAC**	**Lighting**	**Hot Water**	**Food Preparation**	**Misc. Use**	**Process / Equipment**
Office Building	40	29	9	2	5	15
Manufacturing	35	28	2	0	3	32
School / Education	50	20	22	3	3	2
Hotel / Motel	25	18	40	7	6	4
Apartment Building	70	15	5	0	10	0
Retail Store	51	31	7	3	4	4
Restaurant	23	15	11	45	5	1
Health Care	30	16	26	7	14	7
Religious Institution	41	46	9	2	1	1

Table 2: Energy Usage Categories

5. Energy Checkups

5.1 Energy Analysis

Based on the acquired data on electricity and gas use, correlations can be calculated with influential variables. These influential variables usually consist of production parameters (such as quantity of units produced) and the outdoor air temperature.

These correlations result in one or two parameter models for the different consumption components (being facility, space conditioning and production).
The models enable users to:

- Quickly and accurately determine baseline energy use
- Predict future energy use
- Understand factors that influence energy use
- Calculate retrofit changes
- Identify operational and maintenance problems

5.2 Installation Inspection

Based on the gathered information, important (i.e. large) consumers and possible irregularities in consumption are identified. Focusing on these installations, a general installation inspection will lead to energy saving projects and the feasibility of the different proposed energy saving projects can be determined based on cost-effectiveness. Rough estimates of installation cost and energy savings returns allow for the calculation of pay back and internal rate of return of the investment. Checklists exist for basic analysis of the performance of installations.

The following fields ought to be covered during this energy check-up:

- Compressed air
- Cooling systems
- Boiler and steam systems
- Load management

- Lighting
- HVAC
- Engines and drives

One should be aware of the two fundamental processes of energy consumption:
- Energy efficient transformation of energy into utilities
- Rational use of utilities in industrial processes

5.3 Set Performance Goals
Performance goals drive energy management activities and promote continuous improvement. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies and improving the energy efficiency. Communicating and posting goals can motivate staff to support energy management efforts throughout the organization. It helps to identify progress and setbacks at a facility level.
Production metrics, benchmarks or indices serve as standards for controlling energy use and assessing performance. When benchmark levels for current performance have been defined and accepted in practice, targets can be set for improvements in the efficient use of energy.

However, targets should be set in consultation with those managing and working in particular areas rather than being imposed from above. Improvements may involve changes in operating practices, modifications to existing plant or buildings, or capital investment in more energy efficient plant or buildings.

6. Energy System Improvement Projects

6.1 Project Implementation Studies
Once the review of potential energy savings activities has been undertaken, the company is in a position to make decisions regarding priorities. A plan for future action is then developed. This need not be a stand-alone process. For many companies it is far more effective to integrate energy planning into the general strategic planning of the business and its operations.

The action plan needs to be manageable in size and clearly structured so that it provides clear information, and can be easily used as a key document in the development of the energy management system.

In preparing the action plan, an energy manager needs to identify energy concerns and problem areas and, if possible, prioritize these and other potential impacts and describe the weaknesses of existing energy management practices.

Possible favorable energy saving projects can be investigated more detailed based on measurements (if possible). This enables the accurate calculation of savings & payback time, based on factual data. Make sure priorities are assigned to the various energy management activities and a structured timeline is built and used.

A final comprehensive report should cover the following topics:
- Summary of historical data (e.g. using an initial energy review of the whole facility which can be used to establish the baseline for the development of the energy management system)
- The purpose and scope of the plan
- An executive summary outlining the key information on projects (e.g. potential energy savings and paybacks, greenhouse gas emissions, quality improvement, monitoring of process, savings in maintenance)
- Priorities for action (e.g. issues requiring urgent action, issues where no immediate action is required but there is a need for longer-term improvement, and strategically important areas for future development)
- The process or means of achieving the objects and target(s)
- The timeframe and resources required

- Allocation of responsibilities
- Evaluation processes to assess the effectiveness of the program, including an annual review.

6.2 Implement an Action Plan

Gaining the support and cooperation of key people at different levels within the organization is an important factor for successful action plan implementation. Reaching the set goals frequently depends on the awareness, commitment, and capability of the people who will implement the projects. Implementation of the action plan will take time.

To implement an action plan, consider taking the following steps:

- Develop targeted information for key audiences about the energy management program
- Build support at all levels of the organization for energy management initiatives and goals
- Through training, access to information, and transfer of successful practices, procedures and technologies, you can expand the capacity of the people involved.

7. Evaluate Progress

Evaluate progress includes formal review of both energy use data and the activities carried out as part of the action plan as compared to the performance goals.

Measure results:

- Review energy use and cost data (capital and operating expenses)
- Analyze energy efficiency achievements based on your established performance metrics
- Compare energy performance to baselines and/or expected energy use based on developed simulation models

Review action plan:

- Get feedback
- Gauge employee and organizational awareness
- Quantify side benefits such as reduced operation and maintenance expenses or productivity improvement
- Reward achievings

8. Auditing

Consultants also often execute the whole process of evaluating the energy use and improving the current situation. An energy audit can be defined as a systematic study or survey to identify how energy is being used in a building or plant, and identifies energy savings opportunities. An energy audit provides the energy manager with essential information on how much, where and how energy is used within the organization. The approach is comparable as mentioned in previous paragraphs:

- Step 1: Send energy checklist
- Step 2: Visit installations and collect more data
- Step 3: Make a list of potential saving projects
- Step 4: Perform calculations
- Step 5: Make report and discuss draft
- Step 6: Present the final report

Audits can be categorized into two types, being the preliminary and detailed audit. A walk-through or preliminary audit comprises one day or half-day visit to a plant and the output is a simple report based on observation and historical data provided during the visit.

The findings will be a general comment based on rule-of-thumbs, energy best practices or the manufacturer's data. A detailed audit will provide technical solution options and economic analysis for the factory management to decide project implementation or priority. A feasibility study will be required to determine the viability of each option.

9. Energy Savings Checklist

The following checklist can be used to identify some first energy saving opportunities. It is important to consult those that work with the below listed equipment to evaluate advantages and disadvantages of the proposed measures on a case-by-case basis.

All question/notes highlighted in the color of this paragraph represent initiatives that can generate 50% or more of your energy savings at minimum costs.

A. Administration & Communications

- Has the critical need to be more efficient in the use of energy at your location been incorporated into a strategic energy plan and broadly communicated?
- Is there a staff position that includes responsibility for utilities management?
- Have "Conservation Action Teams (CAT)" been organized to provide leadership and enhance the success of reducing energy costs?
- Is there a program to recognize individuals who provide leadership and increase success of the energy plan?
- Are energy conservation posters conspicuously displayed throughout your facility?
- If energy systems have not been recently upgraded, have you considered using an energy expert to conduct an efficiency assessment or audit?
- Does your capital investment policy include criteria for financing energy upgrade projects?

B. Utility Accounting

- Is energy usage and cost data tracked monthly and distributed to all major users?
- Is data monitored to question and pursue remedies for unusual variations from the norm?
- Is benchmarking used to determine performance goals?
- Are facilities with high costs surveyed to discover opportunities for cost reduction?
- Are energy costs and program performance included in monthly business reviews?
- Are measures taken to discover billing errors and recover incorrect charges?
- Do you understand your electrical rate structure (average charge, peak charge, etc.)?
- Do you know you electricity costs associated with both use (kWh) and demand (kW)?
- On an annual basis, do you review rates with your supplier to ensure you are on the most favorable rate structure?
- When you change the use of your facility, do you also review the impact on your rates?

C. Office Equipment

Using Energy Star Office Equipment saves about $50 per employee per year.

- Are computers, monitors, printers, copiers, and other office equipment turned off and/or set for "sleep" mode when not in use?
- Is Energy Star equipment specified for new purchases?

D. New Construction

- If you are expanding or constructing a new building, are you giving full consideration to a LEED certified or a "High Performance" designed and constructed facility, which addresses building orientation, design, layout, lighting, equipment and control selections that will result in maximum energy efficiency?

E. Building Envelope

- Is weather stripping on windows and doors well-maintained?
- Are blinds and shades adjusted to take advantage of daylight and to utilize or avoid the impact of solar heating?
- Have thermal windows been installed to minimize heat and cooling losses?
- Are operable windows opened for ventilation during mild weather conditions?
- Are window air conditioners covered during the heating season?
- Can the insulation of a building be improved, particularly in the roof area?
- Are light-colored, reflective roofing materials specified?
- Have you considered flexible windbreaks and interior doors for loading areas?

F. Vehicle Use & Selection

- Are employees given incentives for car pooling or using mass transit / public transportation?
- When you organization purchases vehicles, are fuel mileage and emission levels considered?
- Have you investigated using alternative fuel vehicles (AFV) or considered cooperating with community AFV efforts?

G. Lighting Systems

Each 5,000 Watts of office lighting turned off for 10 hours per week will save $260 per year and the elimination of 25 75-watt bulbs will save $244 per year.

- Evaluate possibility of replacing existing ballasts with modern low-loss ballasts
- Ensure lighting levels comply with requirements
- Consider the different lighting options and its characteristics (average life span, efficiency, light color and color rendering)
- Consider de-lamping, voltage reduction, motion detectors, light sensors, time switches, better reflectors and better sky lighting
- Discourage use of extra low voltage lights due to total cost, frequent replacement and effect on air conditioning costs
- Are lighting systems wired so that lights throughout a large are do not have to be on when activity is taking place in only a small section of the area?
- Are lights turned off when rooms or areas are not occupied?
- Is task lighting used to allow background lighting to be reduced?
- Have energy conservation stickers been placed on light switches?
- Are occupancy sensor controls considered which can automatically turn off unused lights in meeting rooms, offices, etc.?
- Have incandescent lamps been replaced with compact fluorescent lamps?
- Have T-12 34-Watt fluorescent lamps and old ballasts been replaced with T-8 lamps and electronic ballasts?
- Are low wattage tubes used in existing fluorescent lighting fixtures?
- Have measures been taken to remove unnecessary lights or de-lamp fixtures in over lit areas.
- Are old ballasts upgraded when lamps are replaced?
- Are light emitting diode (LED) lighting fixtures used in “Exit” signs?
- Has unnecessary lighting in snack and beverage machines been removed?
- Has housekeeping and security staff been advised to keep lights turned off in unoccupied spaces?
- Is it possible to schedule some or all housekeeping duties during daylight or operating hours?
- Are exterior light photo cells / controls working properly?
- Has the use of decorative or unneeded exterior lighting been discontinued?
- Are lights controlled by an Energy Management System (EMS)?

H. Plant Drives / Electric Motors

When purchasing a new motor, the additional cost of“premium” efficiency motors will be paid back in less than 2 years.

- Determine the overall efficiency of the current motor and evaluate the effects by replacing it with a high efficiency motor

- Examine the possibilities of a motor-controlling unit of some kind (e.g. on/off , soft-start unit), certainly for those motors running in partial load
- Examine the possibilities of variable speed (or at least multi-speed) drives for those motors running in partial load
- Compare the nominal characteristics of the engine with the load characteristics. Consider replacing oversized motors
- Ensure the appropriate drive is used (i.e. direct drive, V-belt, notched belt, flat belt, etc.)
- Do you have a motor management policy that mandates “premium” efficiency motors?
- Do you require repair shops to maintain the efficiency of motors when they are rewound?
- Are motor air vent ports clean and areas adjacent to motors uncluttered and well ventilated?
- Are heavy-duty replacement bearings used when conducting maintenance?
- Are cogged belts used in belt-driven applications or when replacing worn V-belts?
- Are electric motors selected to avoid power inefficiency and over-capacity?

I. Boilers and Steam Systems

A steam leak of 1/16” diameter at 100 PSIG represents $400 per year of wasted energy!

- Minimize hot water requirements and allow for local boosting
- Is the most cost-effective fuel used?
- Install or upgrade insulation on hot water/steam lines
- Consider decentralization of heat production for remote users
- Reconsider installed gas burner versus the merits of a new and more efficient gas burner with controlling unit for power adjusting and burner management (via CO and/or oxygen measurements in flue gas)
- Check and optimize boiler excess air level to practical minimum
- Check for steam leaks from boiler over pressure valves and in the distribution system
- Check insulation of the boiler
- Examine the feasibility of reducing the steam pressure in the distribution net to reduce the steam temperature (and thus its correlated heat losses)
- Check the condensate return lines insulation, pressure (higher pressure > higher temperature) and return levels
- Check potential of a blow-down waste heat recovery system
- Check potential of waste heat recovery from incineration
- Check potential for utilization of fl ash steam
- Check cogeneration potential

J. Compressed Air Systems

A 1/16” diameter compressed air leak at 100 PSIG wastes $608 per year and a 60-HP air compressor operated at 95 PSI instead of 110 PSI can save $316 per year.

- Check compressed air distribution net for leaks
- Check system’s air pressures are the lowest practical for the different applications; consider decentralization and/or pressure regulators where appropriate.
- Examine possibilities to lower the air inlet temperature (e.g. relocation of air inlet)
- Use only compressed air tools where necessary, consider alternatives
- Examine the compressor capacity and regulation versus the actual demand profile: consider the use of a VSD compressor
- Use vacuum pumps in stead of a venturi system
- Are systems turned off whenever possible?

K. HVAC in Buildings

Typical energy savings generated by a regular tune-up of HVAC systems is 10%.

- Check adequacy of ceiling insulation and install or upgrade as necessary
- Select the most appropriate heating system (radiation versus convection)
- Check if filters are maintained and replaced in time to avoid excessive pressure drops
- Check the potential of heat recuperation and air recycling

- Set heating thermostats to appropriate temperatures
- Check zoning of HVAC systems
- Discourage the use of personal radiators and fans
- Use time clocks to control system operation
- Examine the use of VSD on fans
- Do you have a service contract agreement to provide for regular safety and efficiency maintenance to the systems?
- When replacing an inoperative system or component, do you use the opportunity to upgrade efficiency as opposed to installing an exact replacement?
- Are energy efficient heating and air conditioning thermostat set points maintained throughout your facility (70° F heating, 76° F cooling)?
- Are thermostats regularly calibrated?
- Are thermostats tamper-proof?
- Are thermostats properly located to provide balanced space conditioning?
- Are safety rules enforced to prohibit or limit the use of personal heating and cooling devices?
- Are air conditioning or heating controls setback when weather conditions permit?
- Are air conditionings or heating controls set back when facility is not occupied?
- Are off-hour meetings scheduled in locations that do not require HVAC in the entire facility?
- Is housekeeping scheduled to minimize the use of space conditioning?
- Are air filters inspected on a regular basis and cleaned or replaced when necessary?
- Are surfaces on cooling coils, heat exchangers and condensing units regularly cleaned?
- Are exhaust fans turned off along with the HVAC system when a space is unoccupied?
- Has supply air from air-handling units been adjusted to match the volume of space conditioning requirements?
- Has direct conditioning of unoccupied areas (corridors, stairwells, storage rooms, etc.) been minimized by turning off fan coil units and unit heaters, and by closing supply air diffusers?
- Are outside air dampers controlled to close when conditioned space is unoccupied?
- If economizers are present in you HVAC systems, are they modulated to take advantage of free cooling when outside temperature is below 65°F?
- If you use cooling towers, have water meters been installed to record makeup water usage (losses due to blow-down, evaporation and drift) that should result in sewer charge credits?

Check Your Energy Costs

	64°F	66°F	68°F	70°F	72°F	74°F	76°F	78°F	80°F	82°F
Heating	Saving		⇩			Spending				
	-20%	-10%	0%	+10%	+20%	+30%	+40%	+50%		
Cooling				+40%	+30%	+20%	+10%	0%	-10%	-20%
					Spending			⇧	Saving	

L. Refrigeration Equipment

- Examine insulation on the distribution system and end use storerooms
- Examine the compressor capacity adjustment technique (e.g. VSD versus compressor bypassing)
- Evaluate the possibilities of a floating condenser temperature
- Evaluate the set cooling temperature
- Evaluate the advantages and disadvantages of centralized and decentralized cooling equipment
- Increase utilization of cold room space by closing off unused sections
- Are refrigeration units in drinking fountains turned off or set to no lower than 60°F?
- Have non-essential refrigerated vending machines and refrigeration/ice machines been taken out of use?
- Have electrically-heated defrost cycles on refrigerated walk-in boxes been minimized and scheduled for off-peak energy consumption hours (night)?

M. Energy Management Systems (EMS)

EMS automatically monitor and control HVAC, lighting, and equipment to conserve energy, maintain function, and provide occupant comfort. EMS can accomplish the following and more: Control lighting systems by the hour and dim for decreased demand during daylight hours; optimize HVAC operations based on environmental condition and changing uses; turn off or set back HVAC during non-working hours; deactivate water heaters when possible; activate and monitor security systems; control peak loads to reduce demand charges.

- Have you considered using or upgrading an energy management system (EMS)?
- Is your EMS used to limit peak electrical demand on key equipment in order to avoid high demand charges and penalties?

Simple Ways to save 50% or more of your energy costs:

1. Turn off lights when not needed
2. Remove unneeded light bulbs.
3. When replacing light bulbs, use lower wattage or more efficient ones.
4. Lower your heating settings.
5. Raise your air conditioning settings.
6. Reduce heating and air conditioning during unoccupied hours.
7. Turn off heating and air conditioning somewhat before the end of your operating hours.
8. Have your heating, ventilation, and air conditioning systems serviced and adjusted.
9. Turn off machines and equipment when not needed.
10. Make sure all automatic controls are in good working condition and are set properly.

9. Estimating Savings Potential

NO COST: Numerous improvements in efficiency can be achieved through more effective management of resources and informed employee behavior.

INCREMENTAL IMPLEMENTATION: Other efficiency initiatives can be supported with operating and maintenance budgets to be accomplished over an extended period of time. One example is the incremental upgrading of T-12 to T-8 fluorescent lamps and electronics ballasts during spot lamp replacement. Upgrade costs can be spread out over a two-year period and deliver a payback of less than 3.0 years.

CAPITAL APPROPRIATIONS: Some efficiency projects must be addressed with capital appropriations that require a formal payback analysis. Although almost every project is unique to a particular application, the initiatives in the following table are most likely to be worthy investments with attractive paybacks. When capital funding is not available, managers can also consider performance contractors for financing.

PAYBACKS: Payback may vary according to the scheduled use of a facility, types and configurations of energy consuming systems, climate and regulatory codes. However, projects involving systems or facilities that are exposed to the most hours of daily use are likely to benefit from accelerated and shorter paybacks. More favorable paybacks can also be experienced if similar projects at several different sites can be combined to benefit from more competitive contract bidding.

	Payback (years)	Energy Reduction (%)
Lighting		
Using energy saving fluorescent lamps	1.8 – 2.4	15%
Upgrading old T-12 fluorescent lighting and ballast with T-8 and electronic ballasts	2.7 – 5.0	30%– 35%
Replacing incandescent lamps with compact fluorescent light bulbs (CFLs)	0.5 – 3.2	66%– 75%

	Payback (years)	Energy Reduction (%)
Lighting (continued)		
Upgrading 400-Watt metal halide suspended fixtures	0.6 – 1.25	10%– 28%
Replacing incandescent “Exit” signs with LED	< 2.0	87%
Replacing mercury vapor lights with high pressure sodium lights	3.0	16%
Using occupancy Sensors in: - Office - Restroom - Meeting Room	 2.3 – 4.6 1.0 – 2.6 0.5 – 1.3	 25%– 50% 30% 75% 22%– 65%
HVAC		
Cooling upgrade opportunities: - Central Chiller - Unitary A/C	 Variable Variable	 15% - 35% 20% - 35%
Heating upgrade opportunities: - Boiler - Furnace	 Variable Variable	 10% - 30% 5% - 25%
Periodic heating system maintenance	< 0.25	5% - 10%
Nighttime temperature setback	< 0.50	10% - 33%
Reducing heating temperature 3° Fahrenheit	Instant	12% - 13%
Fan optimization, variable speed drive	2.1	50% - 85%
Building Envelope		
Reduce air infiltration in large office building heating and cooling	Variable	1% - 5%
Insulation in all exterior walls	Variable	15% - 35%
Motors		
Specifying “premium” efficiency motor vs. standard efficiency	2.0 for typical 20-hp	3.3% - 6.9%
Using cog-belts instead of V-belts	< 2.0	2% - 8.4%
Air Compressor Systems		
Energy Savings	Variable	20% - 50%
Redirect compressor air intake to use outside air	< 1.0	5% - 7%
Lowering system-wide pressure by 10 psi	Instant	3% - 6%
Repairing compressed air leaks	0.1	5% - 25%
Office Equipment		
Savings using Energy Star Equipment: - Dishwashers - Refrigerators - Copiers - Computers - Monitors (LCD) - TV & VCRs	 6 5 – 7 Instant Instant Instant Instant	 25% 10% 40% 30% - 70% 70% - 90% 25%
Energy Management Systems (EMS)		
Typical energy use savings using an EMS	Variable	10% - 20%

Payback estimates are based on one-shift operations using an average commercial electric rate of 6.39 cents per kWh. Internal labor usage is assumed. Most paybacks noted are typical for office settings. Payback periods can vary widely based on individual applications and will improve even further the high electricity costs are.

10. Starter List

To Do	Completed	Notes
Today		
Turn down the temperature of your water heater to the warm setting (120°F). You'll not only save energy, you'll avoid scalding your hands.		
Check if your water heater has an insulating blanket. An insulating blanket will pay for itself in one year or less!		
Start using energy-saving settings on refrigerators, dishwashers, washing machines, and clothes dryers.		
Survey your incandescent lights for opportunities to replace them with compact fluorescents (CFLs). ENERGY STAR lights can save three-quarters of the electricity used by incandescents. The best targets are 60-100W bulbs used several hours a day. New CFLs come in many sizes and styles to fit in most standard fixtures.		
Check the age and condition of your major appliances, machines, and motors. You may want to replace it with a new ENERGY STAR model before it dies.		
Clean or replace furnace, air-conditioner, and heat-pump filters.		
This Week		
Visit the hardware store. Buy a water-heater blanket, low-flow showerheads, faucet aerators, and compact fluorescents, as needed.		
Rope caulk very leaky windows.		
Assess your heating and cooling systems. Determine if replacements are justified, or whether you should retrofit them to make them work more efficiently to provide the same comfort (or better) for less energy.		
This Month		
Collect your utility bills. Separate electricity and fuel bills. Target the biggest bill for energy conservation remedies.		
Crawl into your attic or crawlspace and inspect for insulation. Is there any? How much?		
Insulate hot water pipes and ducts wherever they run through unheated areas.		

Notes

Notes