MENG 547

Energy Management & Utilization

Chapter 3

Energy Audit

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What is an Energy Audit?

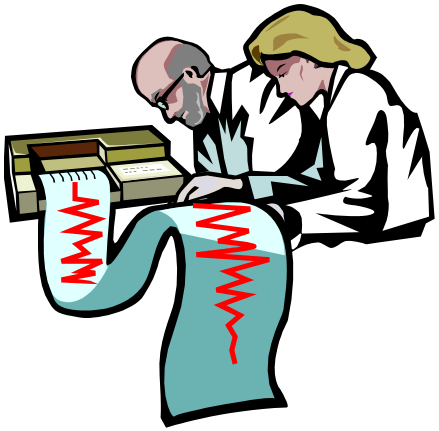
- The energy audit is one of the first tasks to be performed in accomplishing an effective energy management program designed to improve the energy efficiency and reduce the energy operating costs of a facility.

- An energy audit consists of a detailed examination of how a facility uses energy, what the facility pays for that energy, and finally, a recommended program for changes in operating practices or energy consuming equipment that will cost effectively save dollars on energy bills.

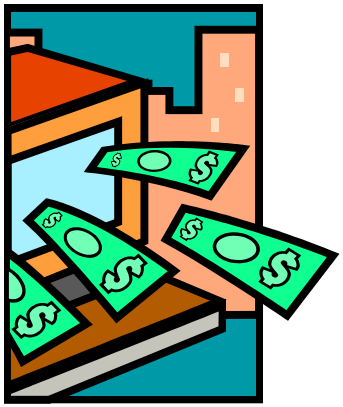
What is an Energy Audit?

- The **energy audit** is sometimes called an **energy survey** or an **energy analysis**, so that it is not confused with a financial audit.
- The energy audit is a positive experience with significant benefits to the facility.
- The term "audit" should be avoided if it clearly produces a negative image in the mind of a particular business, organization, or individual.

Basic Components of an Energy Audit

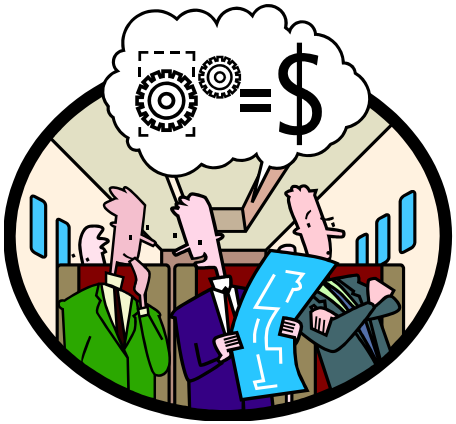


- The audit process starts by collecting information about a facility's operation and about its past record of utility bills.
- This data is then analyzed to get a picture of how the facility uses – and possibly wastes – energy, as well as to help the auditor learn what areas to examine to reduce energy costs.



Basic Components of an Energy Audit

- Specific changes – called Energy Conservation Measures (ECM's) – are identified and evaluated to determine their benefits and their cost effectiveness.



- These ECM's are assessed in terms of their costs and benefits, and an economic comparison is made to rank the various ECM's.
- Finally, an Energy Action Plan is created where certain ECM's are selected for **implementation**, and **the actual process of saving energy and money** begins.

Goals of the Energy Audit

- Clearly identify types and costs of energy use
- Understand how energy is being used – and possibly wasted
- Identify and analyze more cost-effective ways of using energy
  - improved operational techniques
  - new equipment, new processes or new technology
- Perform an economic analysis on those alternatives and determine which ones are cost-effective for your business or industry.

Types of Energy Audits

- **Type I** - also called **walk-thru** or **checklist**
- **Type II** - also called **Mini-audit**
- **Type III** - also called **Maxi-audit**
- **Investment grade** audit
- **Master** Audit

Type I Audit

- This audit consists of a walk-through inspection of a facility to identify maintenance, operational, or deficient equipment issues and to also identify areas which need further evaluation.

Type II Audit

- This audit includes performing economic calculations and may include performing monitoring/metering/testing to identify actual energy consumption and losses.

Type III Audit

- This audit includes the performance of computer modeling to determine the actual year round energy consumption.

Investment Grade Audit

- This audit includes weighing risk into the economic calculations of a type II or III energy audit. This audit can be utilized to obtain funding for the projects identified.

Master Audit

- This energy audit also contains information such as code compliance, maintenance schedule development, equipment inventories, etc.

How Do You Know Which Type of Audit to Select?

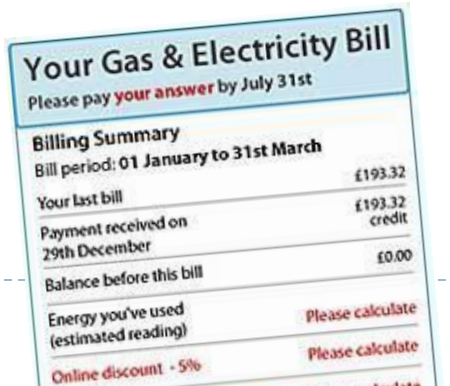
- Depends on the funding available for the audit, the cost and potential of the Energy Management Opportunity, and the required accuracy for the audit information.
- Depends on the type of facility, function of the facility, and processes within a facility.

Analysis of Bills

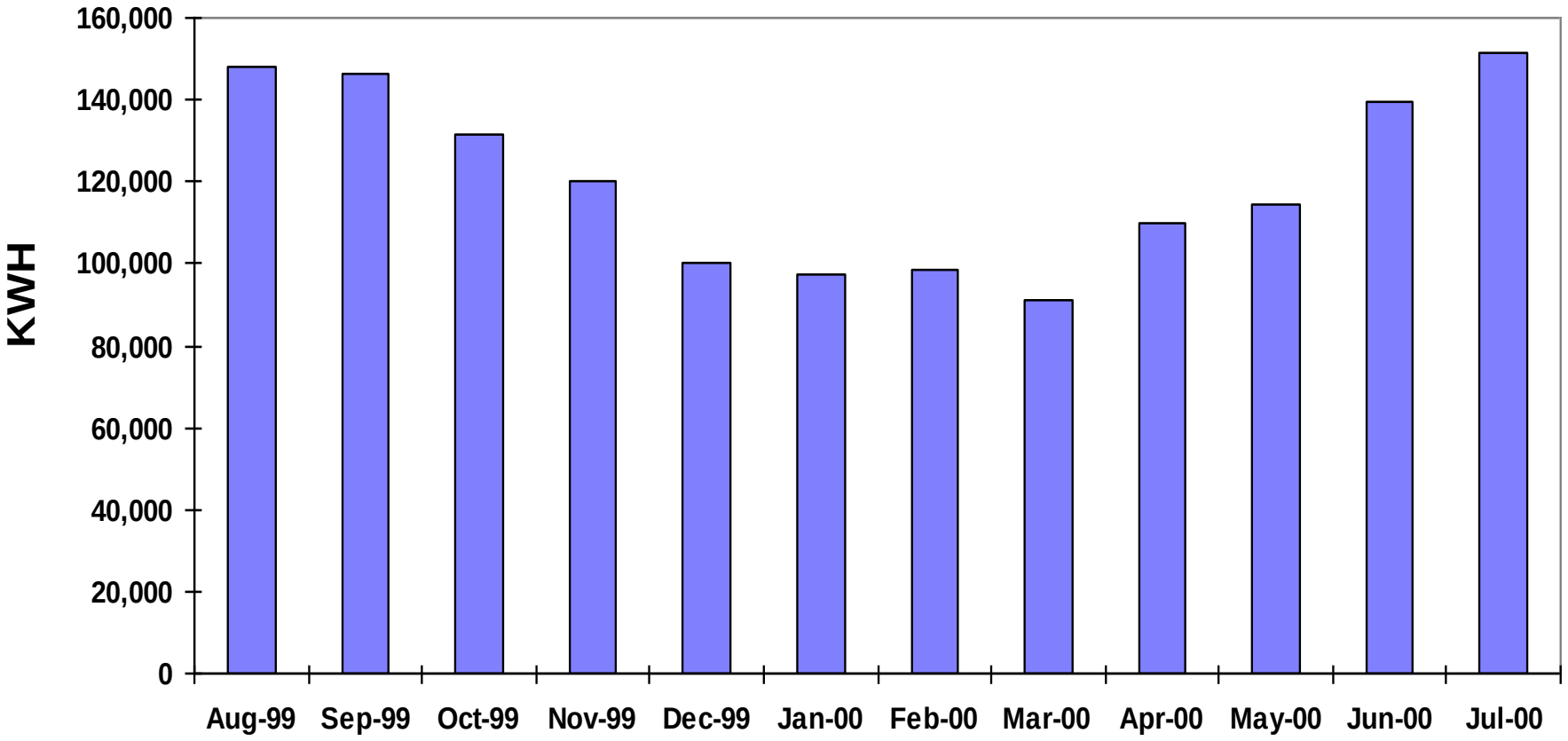
- The audit must begin with a detailed analysis of the energy bills for the previous twelve months.
- This is important because:

  The bills show the proportionate use of each different energy source when compared to the total energy bill.

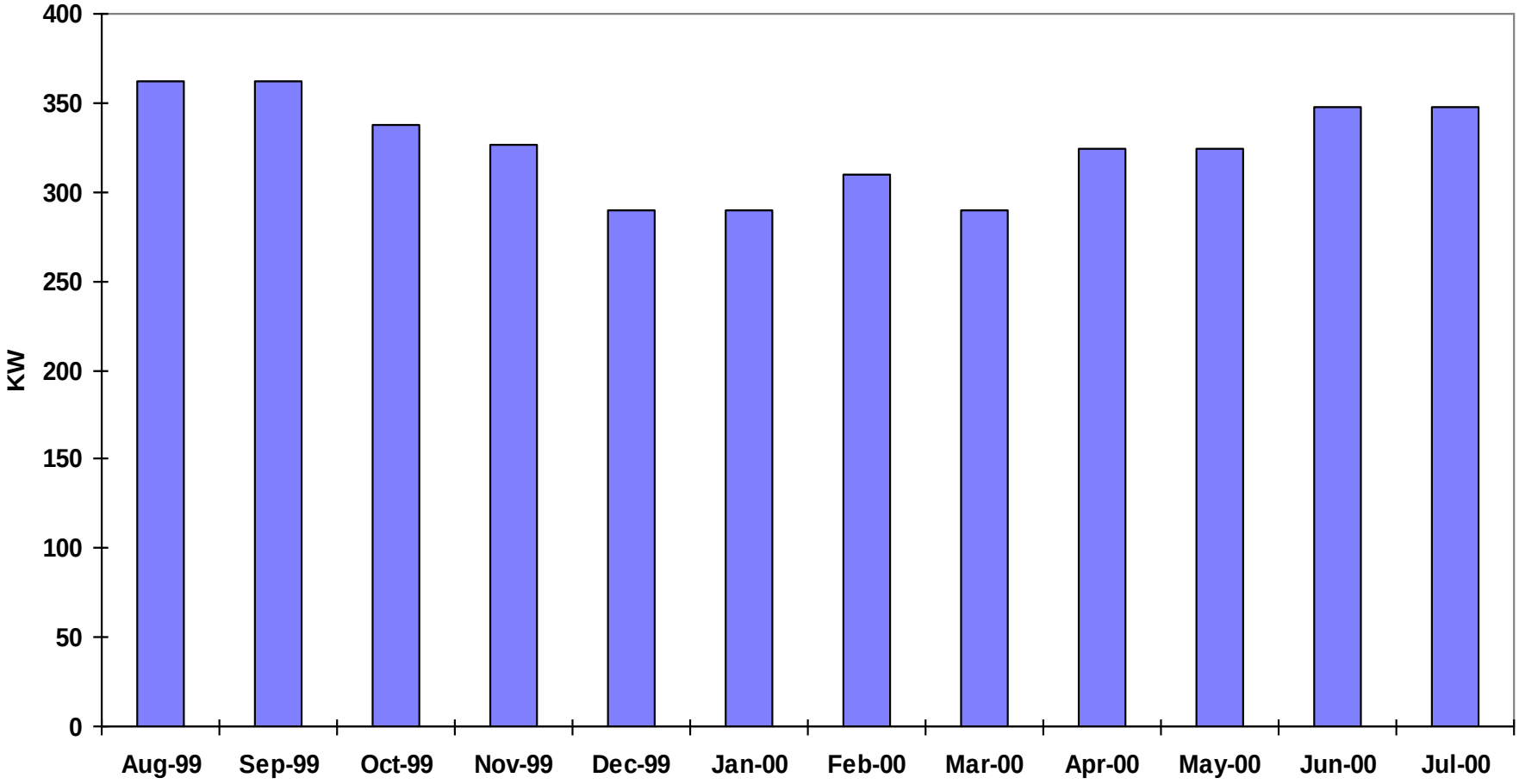
- An examination of where energy is used can point out previously unknown energy wastes.
- The total amount spent on energy puts an upper limit on the amount of money that can be saved.



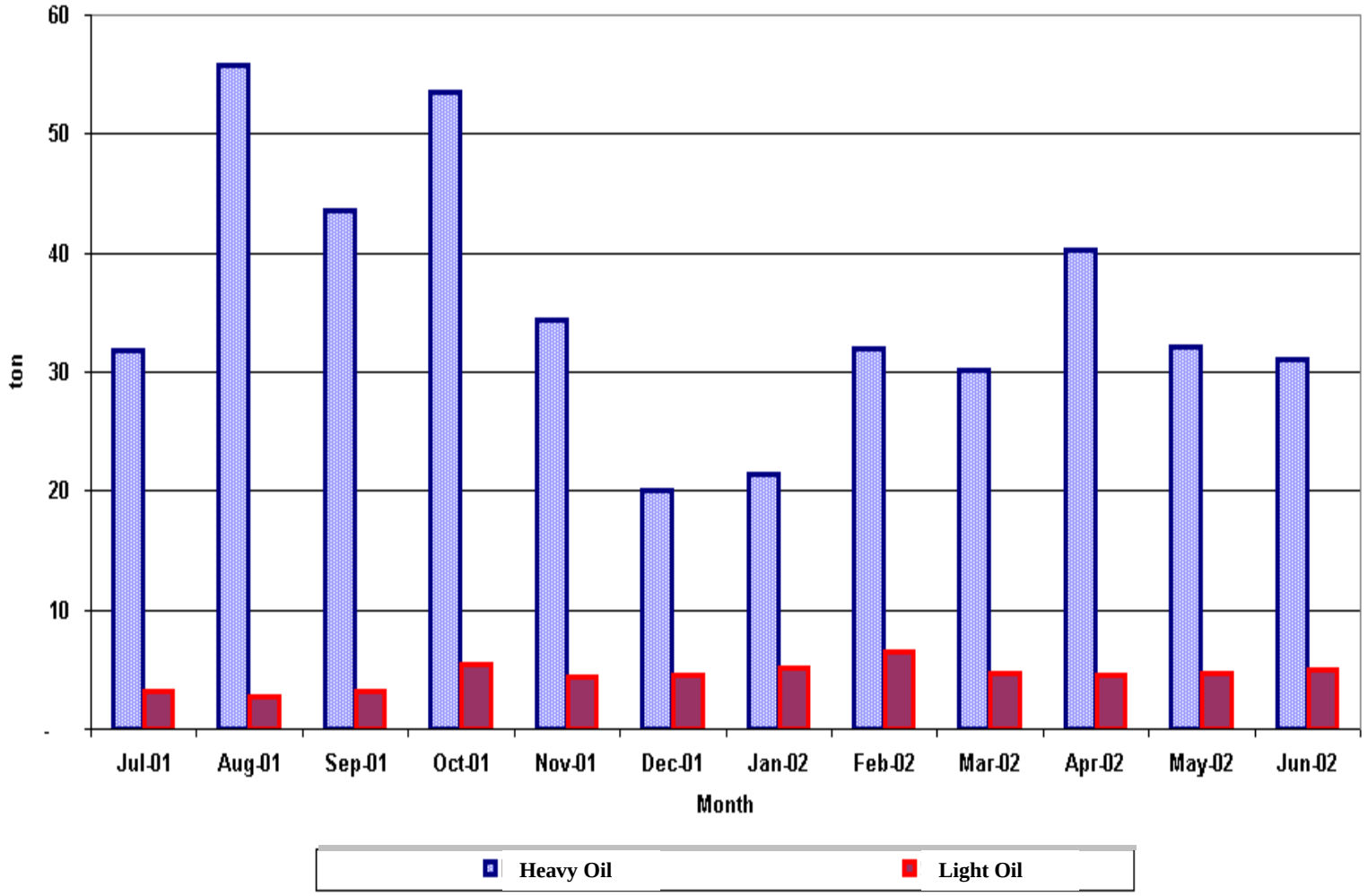
Example of Monthly Electric Consumption in kWh



Monthly Electric Peak Demand in kW



Monthly Fuel Consumption



Analysis of Energy Bills

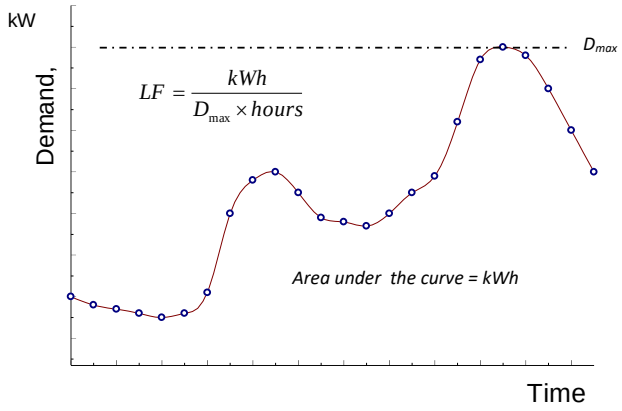
- A complete analysis of a facility's energy bills requires a detailed knowledge of the rate structures in effect for the facility.
- To determine accurate costs of operating individual pieces of equipment, separate energy bills into their components.

  (e.g. demand charge and energy charges for the electric bill.)
- This breakdown also allows more accurate savings calculations for Energy Conservation Measures (ECMs) such as high-efficiency equipment, rescheduling of some on-peak electrical uses, etc.

Load Factor

- The ratio of average demand and peak demand

$$Load\ \ Factor = \frac{monthly\ kWh}{kW \times monthly\ hours}$$



- Load factor is a general indicator for potential of demand savings
- Load factor > 90% have very little potential for demand savings

Facility Electric Load Factor Example

- Monthly data for a facility
  - Peak demand 1250 kW
  - Energy use 500,000 kWh
  - Time of operations 720 hours
- Compute LF

$$LF = \frac{500{,}000 \text{ kWh}}{1250 \text{ kW} \times 720 \text{ H}}$$

$$= 55.6\%$$

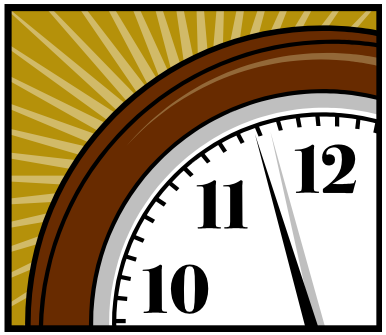
Steps in the On-site Energy Audit

1. Obtain the facility layout or plan; review it to determine:
   - Facility size
   - Floor plan
   - Construction features
     - wall and roof material
     - insulation levels
     - door and window sizes and construction

If no facility plan is available, make a plan or sketch of the building(s) which shows building sizes, window areas, and wall and roof composition and insulation.

Steps in the On-site Energy Audit

2. Obtain operating hours for facility
   - How many shifts does the facility run?
   - Is there only a single shift?
   - Two? Three?



Knowing the operating hours in advance gives some indication as to whether any loads could be shifted to off-peak times.

3. Determine the pattern of building use to show annual needs for heating, cooling and lighting

Steps in the On-site Energy Audit

4. Compile an equipment inventory.

   Get equipment list for facility and review it before conducting audit.

5. Conduct a room-by-room lighting inventory

   - Light fixtures
   - Lamp types, size and numbers
   - Levels of illumination
   - Uses of task lighting

Equipment List

1. Get equipment list for facility and review it before conducting audit.
2. Identify all large pieces of energy-consuming equipment such as: heaters, A/C units, water heaters, and specific process-related equipment.
3. List all major energy consuming equipment, with annual hours of use and energy ratings or efficiencies.
4. The equipment list and data on operational uses of equipment provide an understanding of major energy-consuming tasks or equipment at facility.

Nine major systems to consider

1. Building Envelope
2. HVAC System – people comfort
3. Electrical Supply System
4. Lighting
5. Boiler and Steam System
6. Hot Water System - domestic
7. Compressed Air System
8. Motors – that I can see
9. Special Purpose Process Equipment

As you examine each system, you should ask:

1. What function(s) does this system serve
2. How does this system serve its function(s)?
3. What is the energy consumption of this system?
4. What are the indications that this system is probably working ?

5. If this system is not working, how can it be restored to good working condition?

6. How can the energy cost of this system be reduced?

7. How should this system be maintained?

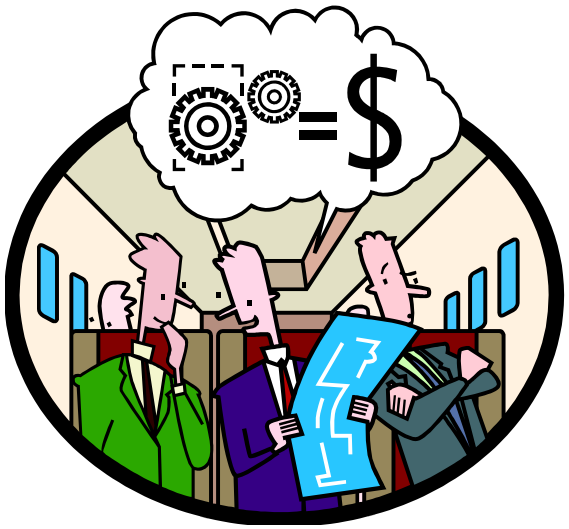
8. Who has direct responsibility for maintaining and improving the operation and energy efficiency of this system?

Preliminary Identification of Energy Conservation Measures (ECMs)

- During the on-site audit, take notes on potential ECMs that are evident.
- In general, devote the greatest effort to analyzing and implementing the ECMs which show the greatest savings, and the least effort to those with the smallest savings potential.
- Identifying ECMs requires a good knowledge of energy efficiency technologies available to do the same job with less energy and cost.

Develop an Energy Action Plan

- The final step in an energy audit is to develop an Energy Action Plan for selecting and implementing the Energy Conservation Measures that were identified.



- This Energy Action Plan should contain a recommendation to establish an energy accounting system to maintain a data base of energy costs for the facility.

- Recording energy use and cost data on a graph provides an easy visual reference and will help you spot trends and potential problems.

- It is also critical for the energy manager to set up an energy monitoring and reporting system to verify the original savings, and to make sure the savings continues over time.