Introduction

In today's scenario, we are facing a major power crunch. Day by day, the gap between demand and supply of electric energy is widening. Bridging this gap from the supply side is a very difficult and expensive proposition. Also, limited energy resources, scarcity of capital and high interest costs for the addition of new generation capacity is leading to increased cost of electrical energy. Renewable sources such as Solar Power, Wind Power and Geothermal Power are capital intensive. With the available technology, contribution of renewable sources is not significant yet. It is estimated that Industrial energy use in developing countries constitutes about 45-50 % of the total commercial energy consumption. The expansion of industrial base does require additional energy input which is becoming increasingly difficult. Energy makes up for a substantial share of overall cost. The only viable way to handle this situation, apart from capacity addition, is the efficient use of available energy by close monitoring and control.

The Energy Conservation Act 2001

The Energy Conservation Act, 2001 provides for efficient use of energy and its conservation and for matters connected therewith or incidental thereto. The Act implemented by the Bureau of Energy Efficiency (BEE), a statutory body under Government of India, envisages creation of cadre of professionally qualified energy managers and auditors with expertise in energy management, project management, financing and implementation of energy efficiency projects, as well as policy analysis. It is a Law to force firms to make more profit and not an Act to control and monitor energy consumption of industry.

Energy Management

Scope

Energy management is the judicious and effective use of energy to maximize profits (minimise costs) and enhance competitive positions. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilisation, throughout the organization.

This broad definition covers many operations from product and equipment design through product shipment. Presently, many businesses and industries are adopting a Total Quality Management (TQM) strategy for improving their operations. Any TQM approach should include an energy management component to reduce energy costs.

Some desirable sub-objectives of energy management progrmmes include:

- Improving energy efficiency and reducing energy use, thereby reducing costs.
- Cultivating good communications on energy matters.
- Developing and maintaining effective monitoring, reporting and management strategies for wise energy usage.

- Finding new and better ways to increase returns from energy investments through research and development.
- Developing interest in and dedication to the energy management programme from all employees.
- Reducing the impact of curtailments, brownouts or any interruption in energy supplies.

Energy conservation, though an important part of energy management, is not the only consideration. To concentrate solely on conservation would preclude some of the most important activities - often those with the largest saving opportunity.

Principles

The principles of Energy Management involve the following:

- Procure all the energy needed at the lowest possible price (Example: buy from original sources, review the purchase terms)
- Manage energy use at the highest energy efficiency (Example: improving energy use efficiency at every stage of energy transport, distribution and use)
- Reusing and recycling energy by cascading (Example: waste heat recovery)
- Use the most appropriate technology (select low investment technology to meet the present requirement and environment condition)
- Reduce avoidable losses. (Make use of wastes generated within the plant as sources of energy and reducing the component of purchased fuels and bills)

Strategy

Energy management should be seen as a continuous process. The starting point in energy management is to identify a strategic corporate approach to energy management. Clear accountability for energy management needs to be established, appropriate financial and staffing resources must be allocated, and reporting procedures initiated. An energy management program requires commitment from the whole organisation in order to be successful. Strategies should be reviewed annually and revised as necessary.

Policy Statement

A written energy management policy will guide efforts to improve energy efficiency, and represents a commitment to saving energy. It will also help to ensure that the success of the program is not dependent on particular individuals in the organization. An energy management policy statement includes a declaration of commitment from senior management, as well as general aims and specific targets relating to:

- Energy consumption reduction (electricity, fuel oil, gas, petrol etc.)
- Energy cost reduction (by lowering consumption and negotiating lower unit rates)
- Timetables
- Budgetary limits
- Energy cost centers
- Organisation of management resources.

Energy Management Co-Ordinator / Energy Manager

To develop and maintain vitality for the energy management programme, a company must designate a single person who has the responsibility for coordinating the programme. If no one person has energy management as a specific part of his or her job assignment, management is likely to find that the energy management efforts are given a lower priority than other job responsibilities. Consequently little or nothing may get done.

Management should support the Energy Management Coordinator with resources including staff. The Energy Management Coordinator should report as high as possible in the organization without losing line orientation. A multi plant or multi divisional corporation may need several such coordinators - one for each plant and one for each level of organization.

Not all the talent necessary for a successful person resides in one person or discipline. For example, several engineering disciplines may be necessary to accomplish a full scale study of the plant stream production, distribution, usage and condensate return system. For this reason most successful energy management programmes have an energy management committee. Two sub committees that are desirable are the technical and steering sub committees.

The technical committee is usually composed of several persons with strong technical background in their discipline. Chemical, industrial, electrical, civil and mechanical engineers as well as others may all be represented in this committee. Their responsibility is to provide technical assistance for the coordinator and plant level people.

The steering committee helps guide the activities of the energy management programme and aids in

communications through all organizational levels. The steering committee members are usually chosen so that all major areas of the company are represented.

Reporting and Monitoring

It is critical for the energy management co-ordinator and the Steering Committee to have their fingers on the "pulse of energy consumption " in the plant. This is best achieved through an effective and efficient system of energy reporting.

The objective of an energy reporting system is to measure energy consumption and compare it either to company goals or some standard of energy consumption. Ideally this should be done for each operation or production cost centre in the plant, but most facilities simply do not have the required metering devices. Many plants only meter energy consumption at one place - where the various sources enter the plant. Systems that should be metered include steam, compressed air, and chilled and hot water. The reporting scheme needs to be reviewed periodically to ensure that only necessary material is being generated, that all needed data is available and that the system is efficient and effective.

Funding cost effective proposals

All companies have capital budgeting problems in varying degrees of severity, and unfortunately energy projects do not receive the same priority as front-line items such as equipment acquisition. Turning down proposals of the energy management team while accepting others with less economic attractiveness is a sure way to kill enthusiasm. Energy management projects need to compete with others fairly. If an energy management project is cost effective, it should be funded. If money is not available for capital expenditures, then management should make this clear at the outset of the programme and ask the team to develop a programme which does not require capital expenditures.

Early project selection

The energy management programme is in difficult terrain in the beginning. Most employees are afraid their heat is going to be set back, their air-conditioning turned off and their lighting reduced. If any of these actions do occur, employee support will wane. It would be smarter to have less controversial actions as early projects.

An early failure can also be harmful, if not disastrous, to the programme. Consequently the energy management coordinator should 'stack the deck' in his or her first set of projects. These projects should have a rapid payback, a high probability of success and few negative consequences. These ideal projects are not as difficult to find as one might expect. Every plant has a few good opportunities and the energy management coordinator should be looking for them.

One good example involved a rather dimly lit refrigerator warehouse area. Mercury vapor lamps were used in this area. The local energy management coordinator did a relamping project. He switched from mercury vapor lamps to high pressure sodium lamps (a significantly more efficient source) and carefully designed the system to improve the lighting levels. Savings were quite large; less energy was needed for lighting; less 'heat of light' had to be refrigerated; and, most important the employees liked it. There environment was improved since light levels were higher than before.

Staff Awareness and Training Programme

A key ingredient to the success of an energy management programme is maintaining a high level of awareness among staff. This can be achieved in a number of ways, including formal training, newsletters, posters and publications and by incorporating energy management into existing training programs. It is important to communicate program plans and case studies that demonstrate savings. Staff may need training from specialists on energy saving practices and equipment.

Annual Review

An energy management programme will be more effective if its results are reviewed annually. Review of energy management policy and strategies will form the basis for developing an implementation plan for the next 12 months.

Energy Accounting

Cost allocation

One of the most difficult problems for the energy manager is to reduce energy costs for a facility when the energy costs are accounted for as part of the general overhead. In that case, the individual managers and supervisors do not consider themselves responsible for controlling the energy costs. The best

solution to this problem is for top management to allocate energy costs down to 'cost centres 'in the company or facility. Once energy costs are charged to production centres in the same way that materials and labor are charged, then the managers have direct incentive to control those energy costs because this will improve the overall cost-effectiveness of the production centre.

Accounting

Energy accounting is a system used to keep track of energy consumption and costs. Successful corporate level energy managers usually rank energy accounting systems right behind commitment from top corporate officials when they list the fundamentals of an ongoing energy management programme.

A basic energy accounting system has three parts: energy use monitoring, an energy use record, and a performance measure. The performance measure may range from a simple kwh / unit of production to a complex standard cost system complete with variance reports. In all cases energy accounting requires metering. Monitoring the energy flow through a cost centre, no matter how large or small, requires the ability to measure incoming and outgoing energy.

Levels of Energy Accounting

As in financial accounting, the level of sophistication or detail of energy accounting systems varies considerably from company to company. A very close correlation can be developed between the levels of sophistication of financial accounting systems and those of energy accounting systems as in the following table.

Financial		Energy	
1.	General Accounting	1.	Effective metering, development of reports, calculation of energy efficiency indices.
2.	Cost accounting	2.	Calculation of energy flows and efficiency of utilization for various cost centres; requires substantial metering
3.	Standard cost accounting historical standards	3.	Effective cost centre metering of energy and comparison to historical data; complete with variance reports and calculation of reasons for variation
4.	Std cost accounting engineered standards	4.	Same as 3 except that standards for energy consumption are determined through accurate engineering models.

Energy Audit

Energy audit involves a systematic study undertaken on major energy consuming sections and equipments including construction of heat and mass balance with a view to identify the flow of energy, efficient use of energy in each of the steps and pin-point wastage of energy. A well-conducted energy audit would reveal the areas of wastage of energy and it would lead to suggestions for possible energy savings in all sectors. The Energy Conservation Act requires the energy audit report to contain recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption [Clause 14(i)]. The conduct of energy audit and implementation of its recommendations on cost-benefit basis through accredited energy auditors is expected to help the designated energy consumers to achieve significant reduction in their energy consumption levels.

The Energy Audit Process

Once a commercial or industrial facility has designated its energy manager and given that person the support and authority necessary to develop an adequate energy management programme, the first step the energy manager should take is to conduct an energy audit. Also called an energy survey, an energy analysis or energy evaluation, the energy audit examines the way energy is currently used in that facility and identifies some alternatives for reducing energy costs.

The goals of the audit are:

- To clearly identify the types and costs of energy use.
- To Understand how that energy is being used - and possibly wasted
- To identify and analyse alternatives such as improved operational techniques and /or new equipment that could substantially reduce energy costs, and
- To perform an economic analysis on those alternatives and determine which ones are cost-effective for the business or industry involved.

Audit levels, in order of increasing complexity are:

Level 1 - The walk-through audit: The walk-through audit is a tour of the facility to visually inspect each system. The walk-through includes an evaluation of energy consumption data to analyze energy use quantities and patterns, as well as to provide comparisons with industry averages, or benchmarks, for similar facilities.

Level 2 - Standard audit: The standard audit quantifies energy use and losses through a more detailed review and analysis of equipment, systems, operational characteristics, and on-site measurements and testing. Standard energy engineering calculations are used to analyze efficiencies and calculate energy and cost savings based on improvements and changes to each system. The standard audit will also include an economic analysis of recommended energy conservation measures.

Level 3 - Computer simulation. The level 3 audit is the most expensive level of energy audit and is most often warranted for complex facilities or systems. The audit includes more detailed energy use by function and a more comprehensive evaluation of energy use patterns. The goal is to build a base for comparison that is consistent with the actual energy use of the facility. The auditor will then make changes to improve the efficiency of various systems and measure the effects compared to the baseline. This method also accounts for interactions between systems to help prevent overestimation of savings.

There are 3 phases of audit - preparing for the audit visit; performing the facility survey and implementing the audit recommendations.

In the first phase data from the energy bills is analysed in detail to determine what energy is being used and how the use varies with time. Preliminary information on the facility is compiled, the necessary auditing tools are gathered and an audit team is assembled.

Phase two starts after a safety briefing when the team performs a walk through inspection, looking carefully at each of the systems within the facility and recording the information for later use. After the plant survey, the audit team must develop an energy balance to account for the energy use in the facility. Once all energy uses have been identified and quantified, the team can begin analyzing alternatives. The final step of Phase two is the audit report which recommends changes in equipment, processes or operations to produce energy cost savings.

Phase three - the implementation phase - begins when the energy manager and the facility management agree on specific energy savings goals and initiate some or all of the actions recommended to achieve those goals. Setting up a monitoring system will allow management to assess the degree to which the chosen goals have been accomplished and to show which measures have been successful and which have failed.

ISO management system standard for energy

ISO has identified energy management as a priority area meriting the development and promotion of International Standards. Effective energy management is a priority focus because of the significant potential to save energy and reduce greenhouse gas (GHG) emissions worldwide.

Existing ISO standards for quality management practices (ISO 9000 series) and environmental management systems (ISO 14000 series) have successfully stimulated substantial, continuous efficiency improvements within organizations around the globe. An energy management standard is expected to similarly achieve major, long-term increases in energy efficiency.

The work will be carried out in a new ISO committee PC 242 Energy Management. ISO 50001 will establish an international framework for industrial plants or entire companies to manage all aspects of energy, including procurement and use. The standard will provide organizations and companies with technical and management strategies to increase energy efficiency, reduce costs, and improve environmental performance.

Conclusion

Managing energy has taken centre stage for reasons of finite availability, environment and costs. It is being discussed at the highest political level across the globe and is being factored in the future plans of large corporations. The International Standards Oranisation (ISO), considering its importance, is working on an exclusive standard for effective energy management.

Energy management has proven time and again that it is cost effective. An energy cost saving of 5-15 percent is usually obtained quickly with little to no capital expenditure when an aggressive energy management programme is launched. An eventual saving of 30 percent is common, and savings of upwards of 50 percent are also reported. These savings all result from retrofit activities. For most manufacturing and other commercial organizations energy management is one of the most promising profit improvement - cost reduction programmes available today.

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