Principles of Energy Management

**Prepared By:**

**Shivani Kanyan,**

**Lecturer (I & C Engg.)**

**IMPORTANT TERMS AND DEFINITIONS**

* Energy Policy defines the overall guidelines for the efforts to achieve greater

energy efficiency. It is dealt with top management of the organization.

* Energy Planning follows the National/ Organisational Strategy. The data

pertaining demand, production, shortfall, imports etc. is collected with time

and analysed.

* Energy Planning involves several activities such as forecast, budget,

infrastructure, materials, equipment, technology, financial resource, human

resource and R& D planning.

* Energy Management deals with energy monitoring and implementating energy

conservation measures with maximize profit and enhance the productivity with

reduction in cost.

* Energy Conservation involves avoiding he wastage of energy and adopting

methods to save (conserve) energy without effecting productivity and comforts.

Energy conservation does not imply avoiding essential use of energy for

productivity and comforts. It is an act of saving energy by reducing a service.

**IMPORTANT TERMS AND DEFINITIONS**

* Energy Efficiency is defined as saving energy, but keeping the same level of

service. Energy conservation is as “cutting back” whereas Energy efficiency is

as “using energy more effectively.”

* Energy Audit is an inspection, survey and analysis of energy flows for energy

conservation in a building, process or a system to reduce the amount of energy

input into the system.

* The primary objective of Energy Audit is to determine the ways to reduce

energy consumption per unit of product output or to lower the operating cost.

* Energy Intensity is a measure of energy efficiency of an Nation’s economy. It is

calculated as the amount of energy consumed for generating per unit of Gross

Domestic product.

* Energy elasticity is the percentage change in energy consumption to achieve one

percent change in National GDP in a country over time.

**ENERGY CONSERVATION**

* Energy conservation means reduction of energy consumption but without making

any sacrifice of quantity and quality of production.

* In other words, for same energy consumption, higher production.
* It does not prevent you, use of energy by fixing some limit of energy

quantitatively within the agreement, but insist for use efficiently.

* Thus decreasing the cost of production by some extent by way of reduction in

the energy bill.

* It is therefore, imperative that energy which is in shortage, be utilized efficiently

and the areas of where the energy is wastefully used are to be identified and

corrective measures are searched for adoption.

* Like capital, labour and material, energy is one of the production factors used

to produce the final goods and services.

* So, Energy conservation can be defined as the substitution of energy with

capital, labour, material and time. This definition also covers the substitution of

scare type of energy with abundant energy.

**PRINCIPLES OF ENERGY** CONSERVATION

* Two principles governing energy conservation policies are maximum

thermodynamic efficiency and maximum cost-effectiveness in energy use.

* The first and second law of thermodynamics measure the efficiency of energy use, allocation of available production factors determines the cost effectiveness of conservation.
* Maximum thermodynamic efficiency in energy use is defined as maximum work done production by using a given amount of primary energy input as defined follows

Maximum work = (Energy input) – (energy loss in transfer) –

(energy discharge)

**ENERGY CONSERVATION APPROACH/ TECHNOLOGIES**

* Conservation of energy is using energy more

efficiently by substituting time,

convenience, labour and capital, for effective optimization of costs.

* The governing principles for energy conservation focuses on maximum

conservation efficiency and maximum cost effectiveness in energy use.

* The energy efficiency includes obtaining maximum energy for a given input and achieve energy quality of output over availability of energy input.
* So, Steps towards energy conservation requires 3 Levels of efforts:-
1. Formulation of administrative and information programme relatively easy and inexpensive to implement in process/ system/ plant etc. effective in

reducing the current energy consumption to the extent of 3 to 7%.

1. Re-equipping:- Retrofitting and Re-cycling through small incremental

investments for gaining 5 to 10% savings.

ENERGY SAVING DEVICES FOR ENERGY

CONSERVATION

(a) Special Boilers and furnaces

1. Fluidized bed boilers
2. Flameless furnaces
3. Fluidized bed type heat treatment furnaces
4. High efficiency thermal boilers for coal fired/ oil fired boilers

v. Waste heat boilers design for gas turbine for combined cycle station.

(b) Instrumentation and monitoring systems for monitoring energy flows:-

1. Automotive electrical load monitoring systems
2. Heat loss meters
3. Microprocessor based control systems
4. SCADA based Information Management Systems
5. Load Flow Programs for all electrical systems

ENERGY SAVING DEVICES FOR ENERGY

CONSERVATION

(c) Waste heat recovery equipments and generation systems:

1. Economizers and feed water heaters
2. Air preheaters and Recuperates
3. Back pressure turbines for co-generation
4. Heat pumps
5. Vapour absorption refrigeration systems

(d) Power Factor correcting devices.

1. Static condensers
2. Shunt capacitors
3. Synchronous condenser system

RENEWABLE SAVING DEVICES FOR ENERGY CONSERVATION

1. Flate plate solar collectors
2. Concentration and pipe-type solar collectors
3. Solar Cookers
4. Solar water heating systems
5. Solar crop driers and systems
6. Solar refrigeration, cold storage and air conditioners
7. Solar desalination systems
8. Solar power generating systems
9. Solar pumps based on solar thermal and solar photovoltaic

conversion

1. Solar photovoltaic modules and panes for water pumping and other

applications

k) Wind mills and specially designed devices run on wind mills

RENEWABLE SAVING DEVICES FOR ENERGY CONSERVATION

1. Special devices including electric generators and pumps running on wind energy
2. Air /gas/ fluid heating systems
3. Biogas plants and biogas engines
4. Electrically operated vehicles
5. Agricultural and Industrial waste conversion devices producing energy
6. Equipment for utilizing the ocean energy and thermal energy
7. Machinery and equipment for the design and manufacturing of these devices.

**ENERGY MANAGEMENT**

* As it is known fact that the reserves of all conventional forms of energy are fast

depleting.

* Everyday the human population across the world uses energy for its work in a

civilized life such as schools, adequate food, shelter, sanitation, medication,

water, clothing, transportation, industrial applications etc.

* As the Per Capita Energy consumption is considered as an important factor of

development, so, the consumption of energy is also increased.

* To overcome the problem of energy deficiency and growing demand of energy,

there are two possible options:-

1. expand and optimize the energy production and
2. conserve and optimize the available energy and utilize the resources to the

fullest extent.

* 1st is known as supply side management (SSM) and later is known as demand

side management (DSM).

ENERGY MANAGEMENT

* Energy Management is defined as, “The art and science of optimum use of

energy to maximize profits (minimize costs) and thereby improve the economic

competitiveness.”

* The energy should be used efficiently, economically and optimally.
* Management is the practical science, technique and dynamic process of setting

objectives, planning, organizing, arranging material/ financial/ human and other

required resources, executing, supervising, monitoring, removing unwants to

achieve the objectives & set new objectives.

* As already discussed, energy is important resource for all the sectors of

economy. Thus Energy Audit, Energy Conservation Measures, Water Recycling

are essential functions of energy management.

ENERGY MANAGEMENT

* Energy management involves strategy, policy, organizational changes, energy

audit , energy conservation measures, administrative actions, training and

awareness programs, association of working level personnel, evaluation of

present energy consumption, implementation of Energy Conservation

Measures (ECMs), Monitoring of energy conservation efforts etc.

* Energy management aims at regulating the pollution levels caused by energy

conversion processes.

ENERGY STRATEGY, ENERGY POLICY

AND ENERGY PLANNING

* The Strategy, Policy and Planning are the essential steps taken by Energy

Management to achieve the objectives.

* The term Strategy refers to course of action to be selected and tactics to be used

from available options. e.g. If Nation does not have coal or petroleum, then

strategy can be to develop the Nuclear Technology or Bio Energy Resources.

* The term Policy refers to the official principle plans guideline for course of

action to be taken. e.g. Nation may have a policy to give Tax relief to Renewable

Energy plants.

* Planning refers to detailed formulation of various actions in given time to

achieve the objectives. Strategy and policy are the guidelines for planning.

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ENERGY STRATEGY, ENERGY POLICY AND

ENERGY PLANNING

* Energy Strategy is adopted at National Level to ensure adequate and

uninterrupted supply of sable energy to various customers on short term, mid

term and long terms basis.

* Energy Strategy involves the planning and directing large scale energy supply

over long term, mid term and short term basis with reference to demand and

the trends for usable forms of energy.

* Energy Management deals with energy monitoring and implementating energy

conservation measures.

* Energy Planning follows the National/ Organisational Strategy. The data

pertaining demand, production, shortfall, imports etc. is collected with time

and analysed.

* Energy Conservation involves avoiding the wastage of energy and adopting

methods to save (conserve) energy without effecting productivity and comforts.

Energy conservation does not imply avoiding essential use of energy for

productivity and comforts.

ENERGY STRATEGY, ENERGY POLICY

AND ENERGY PLANNING

* Energy Conservation Opportunities (ECOs) are the avenues open to implement

energy conservation activities. e.g. reducing electrical energy consumption by

switching off when not required, use of holding furnaces in steel plants/ refining

plants, automatic controlled power supply to improve efficiency.

* Energy Audit is an official scientific study/ survey of energy consumption of a

region/ organization/ process/plant/ industry/ equipment aimed at reduction of

energy consumption and energy costs without affecting productivity and

comforts and suggesting the methods for energy conservation & reduction in

energy cost.

* Waste Recycling involves separating useful materials (metals, plastic, paper)

etc. from waste and recycle it for further use.

STEPS FOR ENERGY MANAGEMENT

The Energy management involves the following basic steps

1. Energy management as Policy and Commitment
2. Management’s Commitment
3. Select Energy Manager:- Define the Energy Manager and its

responsibilities.

* Energy planning.
* Monitoring energy consumption
* Planning energy conservation
* Implement ECMs
* Organising Human Resource development Programs
* Achieve ECOs.
1. Formulate Energy Strategy and Energy Conservation Plans
2. Bring Awareness and Involvement at various levels by means of

Training programs, workshops, communications, books and

ournals.

STEPS FOR ENERGY MANAGEMENT

1. Introduce Suggestion, Scheme and Award Scheme- Obtain suggestions on

ECMs and Encourage implementation of the suggestions at various levels.

1. Appoint/ Select Energy Audit team/ consultants
2. Obtain report on ECMs.
3. Obtain a Technical Assistance (TA) report.
* ECM
* Dos and DON’Ts
* Operation and Maintenance instructions regarding ECMs
* Recommendation about new technologies
1. Implement recommendation of TA report and ECMs
2. Implement energy-optimising O & M practices
3. Establish practices of Monitoring Energy Consumption and effectiveness of

ECMs

1. Implement Administrative measures
2. Recycling of Scrap, Waste material etc.
3. Review and optimize design of plant and equipment. Allocate the funds also.

OBJECTIVES OF ENERGY MANAGEMENT

* Objectives of Supply Side Energy Management
* To formulate energy strategies, plan energy supply on short/mid term and long

term basis and to ensure adequate supply of various forms of usable energy to

various customers with minimum cost and minimum environment pollution.

* Objectives of End User Side Energy Management
* To select optimum energy forms for consumption and to optimize energy

consumption of each form of energy for reducing energy costs and for

improving productivity, standard of living and environment.

SEVEN PRINCIPLES OF ENERGY

MANAGEMENT

 Principle 1: Usable energy can be obtained from various primary

resources by conversion processes. Primary resources are available

in plenty but the usable energy is limited. When usable energy is

converted into work, some energy

is lost into environment.

Possibility of their conversion is useful form requires technology and

finance. Both may be uncertain.

 Principle 2: Usable energy must be

managed by the Supply Side

Management and User side management. The energy must be

monitored vis-a-vis the production.

 Principle 3: Usable secondary energy is a vital economic commodity.

With every consumption of usable energy, there is a reduction in the

available energy and Usable energy must be energy gained.

 Energy saved is a financial gain. Energy wasted is a financial loss and

must be avoided by attention and corrective actions.

SEVEN PRINCIPLES OF ENERGY

MANAGEMENT

* Principle 4: There are several possible methods to reduce per unit

energy consumption. By implementing various methods, the per unit

energy costs can be reduced.

* Principle 5: There are options of energy route for every process.

Choice can be made after evaluating the relative merits.

* Principle 6: Automation in energy consumption processes gives

energy saving and recovery of investment in automation.

* Principle 7: Every one used energy. Every person in the organization

has creative ability towards energy objectives.

ENERGY AUDIT

x Energy Audit is an official survey/ study of the energy consumption/

processing/ supply aspects related with an organization/

process/plant, system, equipments.

x Energy Audit is an inspection, survey and analysis of energy flows for

energy conservation in a building, process or a system to reduce the

amount of energy input into the system.

x The primary objective of Energy Audit is to determine the ways to

reduce energy consumption per unit of product output or to lower the

operating cost.

x The objective of Energy Audit are to recommend steps to be taken by the

Management for improving the energy efficiencies, reducing the energy

costs and improving the productivity without sacrificing quality,

comforts (standards of living) and environmental balance.

x The Energy Audit is officially recommended by the Management

x The Energy Audit is carried out by the Energy Audit Group headed by

the Energy Auditor.

ENERGY AUDIT

x Energy Audit is usually carried put in following 3 stages within

certain time frame:-

x Walk through Energy Audit

x Intermediate Energy Audit &

x Comprehensive Energy Audit

x Audit report is submitted to the Management with recommendation

of

x Energy Conservation Opportunities (ECOs)

x Execution of various Energy Conservation Measures (ECMs),

x Improvements in energy efficiencies,

x reducing energy wastage,

x reducing pollution levels,

x recycling/ reuse of waste,

x improving quality and productivity

of energy conversion processes.

ENERGY AUDIT

x Energy saving opportunities and scope for energy conservation exists

in every energy consumption process/organization/equipment/

system/plant.

x Energy Auditing is the official method for identifying energy

conservation opportunities and recommending actions to be taken by

the management for energy conservation measures.

xTypes of Energy Audit

x The energy conservation opportunities may be easily identified or

may be identified only after intermediate or detailed study. Thus

energy audit are classified into three categories:-

x Simple Walk through Energy Audit

x Intermediate Energy Audit &

x Comprehensive (Detailed/ Exhaustive) Energy Audit

WALK THROUGH ENERGY AUDIT

x The Walk-through Energy Audit is the first, simple, rapid survey of

the plant/ process/ system.

x The Audit team takes a round through

a plant area with attention

focused on the energy inputs, spots of wastage and available ECOs.

x Items for waste recycling opportunities are identified.

x The data regarding energy inputs/ outputs is collected for use during

Intermediate energy audit.

x The Audit Team includes the Energy Management Consultant (and

their staff), Manager (operation and Maintenance), Plant Engineer,

Energy Supervisor etc.

x Additional team-members may be selected depending upon the

nature of Audit.

The team walks through the plant and observes the process, write

down the observation in the Check List format.

WALK THROUGH ENERGY AUDIT

x Usually two-types of Walk-through audits are conducted:-

x During off-period

x During working shift.

x During off-period walk-through audit, the following data is

collected:-

Layout, building- Nameplate details – Input energy sources – Output

loads – Energy routes form inlet, intermediate storage to final

consumption, - Auxiliaries for cooling, ventilating, lubricating etc. -

High temperature regions and thermal insulations. – Control rooms and

monitoring/ measuring instruments.

x Off period walk through goes without disturbing the operating

personnel and without disturbances from the working shift.

x During working shift walk through audit, the actual process is

closely observed with focus on various electrical, thermal,

mechanical, chemical, physical energy inputs and outputs. The

obvious energy wastage locations, waste energy objects are spotted.

OBSERVATIONS FROM WALK

THROUGH ENERGY AUDIT -1

Various observations are made during walk through EA and in the

report. These are as under:-

 Various types of energy and material inputs and various types of

energy outputs. For example: Inputs: Electricity, Petrol, Diesel,

Furnace oil, Lubricating oil, Chemical, metals, Coal/ Fire/ Wood/

other fuels, Biomass, Consumables etc. Outputs: Finished products,

By-products, Waste, Scrap, Heating/ Air conditioning/ ventilations,

Lighting.

 Spots for reducing influx, exflux in thermal systems, flow of heat

from high temperature to low temperature, loss of energy

continuously by inlet of cold media or outlet of hot media.

 Opportunities for waste reduction and waste recycling.

OBSERVATIONS FROM WALK

THROUGH ENERGY AUDIT-2

x Power Factor and its improvement, MVA-Maximum demand and its

reduction.

x Optimizing Operating cycle to reduce energy consumption.

x Substituting the prevailing energy form by more economical means

like use of diesel in place of petrol, heating by use of non-conventional

energy resources in place of conventional methods

x On the basis of such observations, various recommendations are

submitted under various categories such as Category A, Category B,

Category C to find ECOs

INTERMEDIATE ENERGY AUDIT

x Intermediate Energy Audit covers detailed survey, measurements and

systems analysis than the walk through EA.

x The energy consumption and energy

loss are measured and

quantified. The Intermediate EA aims at the following information:-

x Identification & Quantification of Energy usage.

x Economic evaluation of energy usage

x Economic analysis of energy usage and proposed energy

conservation measures.

x Evaluation of Operating Cycle and maintenance procedure.

x Identification of Capital Intensive ECOs.

COMPREHENSIVE ENERGY AUDIT

x It is a Thorough and Extensive Energy Audit that analysis and

quantifies the amount of energy consumption in each sub-system of

the plant, e.g. Lighting, Heating, Ventilation, Air conditioning, Boiler

plant etc.

x This amount of energy consumption is then compared with the Target

Energy Consumption in Comprehensive EA.

x The Target Per Unit Energy Consumption is the Optimum Energy

Consumption per unit product, e.g kWhr per ton of finished steel.

x Prevailing per unit Energy consumption is the actual energy

consumption in the current status (on going) (kWhr/kG).

x The Comprehensive Energy Audit Report includes the comparison

between the

x Required Investments for implementing the Energy Conservation

Measures and

x the projected Savings through ECMs

STEPS FOR COMPREHENSIVE ENERGY AUDIT

1. Overall System Audit (Envelope Audit) which accounts for energy

leakage/ loss through the total system to atmosphere. The energy

conservation measures to eliminate such losses are recommended

1. Functional Audit identifies the energy conservation measures in O

& M of each plant and its subsystems. Also suggests ECOs in O &

M.

1. Utility Audit identifies yearly/ monthly/ daily energy consumption

of commercial secondary energy and suggest ECOs.

1. Modernization Audit recommends major changes in the process

requiring retrofitting.