Energy Efficiency Optimization (For Process and Power Plants)

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About Energy Efficiency Optimization

- Energy efficiency optimization refers to the application of mathematical / statistical / operations research techniques to minimize energy consumption, energy cost and loss reduction without loss of production quantity / quality.
- A basic mathematical background is desirable to know the theoretical concepts.
- It is possible to carry out energy efficiency optimization, by using simple tools – e.g. optimization and modeling software.

WHY ENERGY EFFICIENCY OPTIMIZATION ?

Energy efficiency optimization is the best route to meet the energy demand at minimum cost without loss of production / output of the system.

In conventional Energy demand management, users are guided by their own intuitive decisions, which may not be optimum.

For meeting the energy demand effectively at minimum cost and meeting all the imposed constraints, EEO is the apt solution.

Energy efficiency optimization – Auditing approach.

- To carry out Energy Efficiency Optimization users must know, which are the subsystems / equipments responsible for overall energy efficiency and what parameters need to be monitored and controlled to achieve the objective.
- In real life situations this may include Energy Consumption / Utilization of all forms of energy such as Fuel , Steam , Electricity , Thermal Energy etc related to the process under study

ENERGY AUDITING

- Energy auditing of the system / subsystem helps to bring down the total energy consumption by loss control and efficiency improvement of the right items.
- For achieving this, a systematic Energy Auditing of the total system is essential.

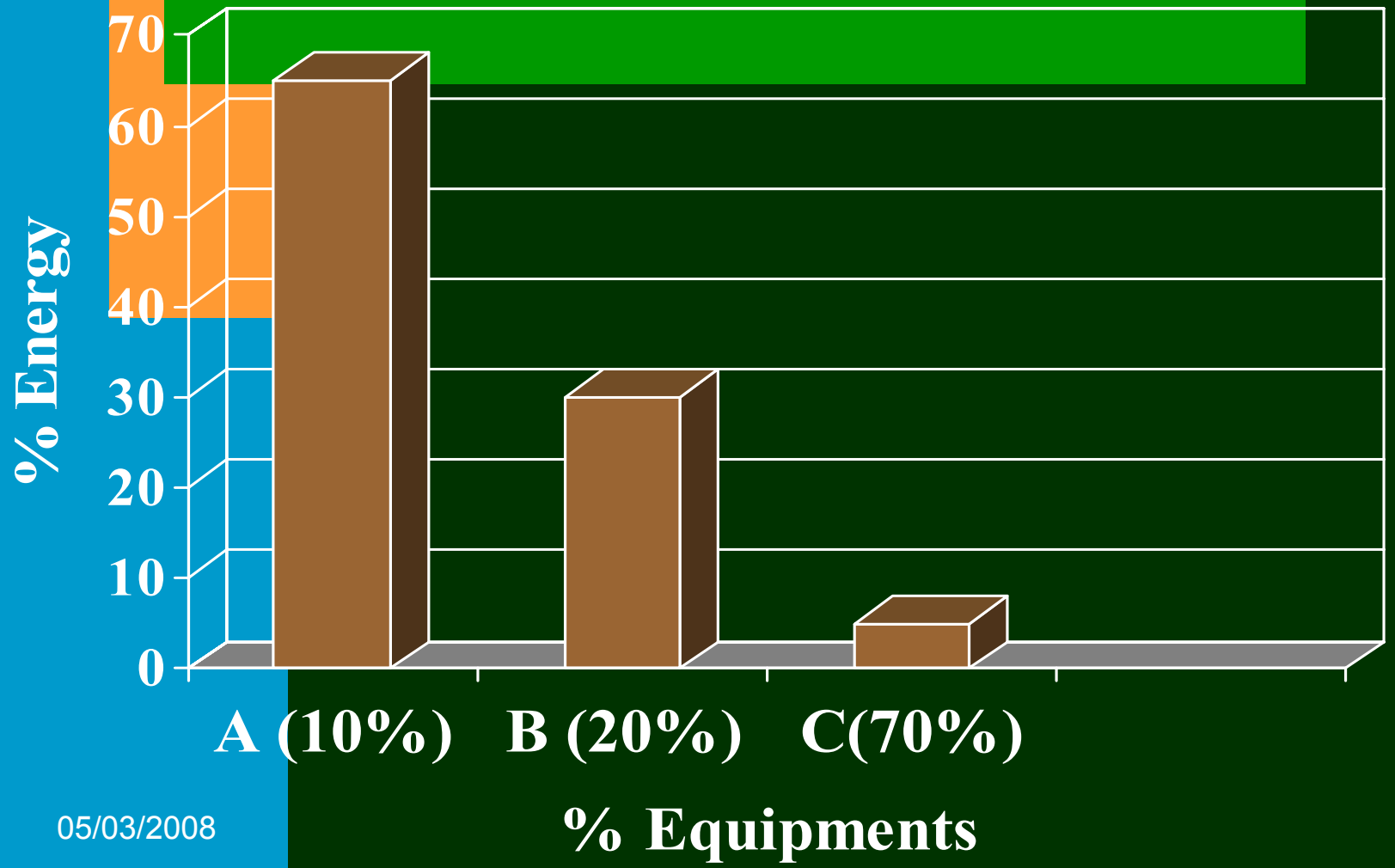
Prioritization of Energy cost centres

- Prioritization of Energy cost centres is done using Pareto's theory.
- In this process , the total system is divided into a number of subsystems and elements and energy input / output data collected for analysis.(design and observed energy quantities.)
- Energy consumption data analysis reveals intensive energy consumers requiring tight control and sets monitoring priorities.
- At unit level, this may cover energy consuming devices.(e.g.boilers/heaters/turbines etc)
- At macro level, analysis of total industrial sector is required.

Pareto's Theory related to Energy Efficiency .

- About 7 to 10% of the total equipment consume 70 to 75% of Total Energy Input to the system.(Class A)
- About 30% of the equipment consume 10% of Total Energy Input (class B)
- The balance 60 to 70 % of equipment consume 6 to 7% of Total Energy Input (class C)
- Same concept may be applicable for Maco system as well.

Typical Pareto's Model



Energy System Analysis

- Energy System Analysis is the first activity to identify class A, Class B and class C sub-systems / equipment of the total system for Performance Monitoring and Optimization
- This concept may be applied to very large macro systems such as national thermal power plants, refineries, petrochemical units etc.
- Using the data collected during the auditing process, it is possible to develop Performance Models for the sub systems (individual plants in case of macro systems) for corrective action.

Advantages of Energy Auditing

- offers fast track solutions to Energy Efficiency Management.
- Monitors performance effectively
- Identifies specific problem area in a very short time.
- Offers tangible solutions.
- Reduces operating cost and
- Increases profit margin drastically.

Organizing Technical Audit

- Technical Audit for Process & Power plants , covers the following conventional energy centers.
  - Utility system (water/steam/air)
  - Boilers
  - Pumps
  - Compressors
  - Turbines (Gas turbines & Steam turbines)
  - Turbo Generators
  - Heat Exchangers / Condensers
  - Miscellaneous applications
  - Systems analysis and MIS

Types of Energy Audit

- Walk through energy audit
- Total system analysis (intensive)
- Heater / Boiler Audit
- Steam system Audit
- Electrical system Audit
- Loss control (auditing process / handling losses)
- Auditing rotating equipments
- Heat exchanger system audit

Energy Audit findings

Offer : Energy resource break-up (steam / power / fuel)

List of class A , class B and Class C equipments

Current energy efficiency of equipments

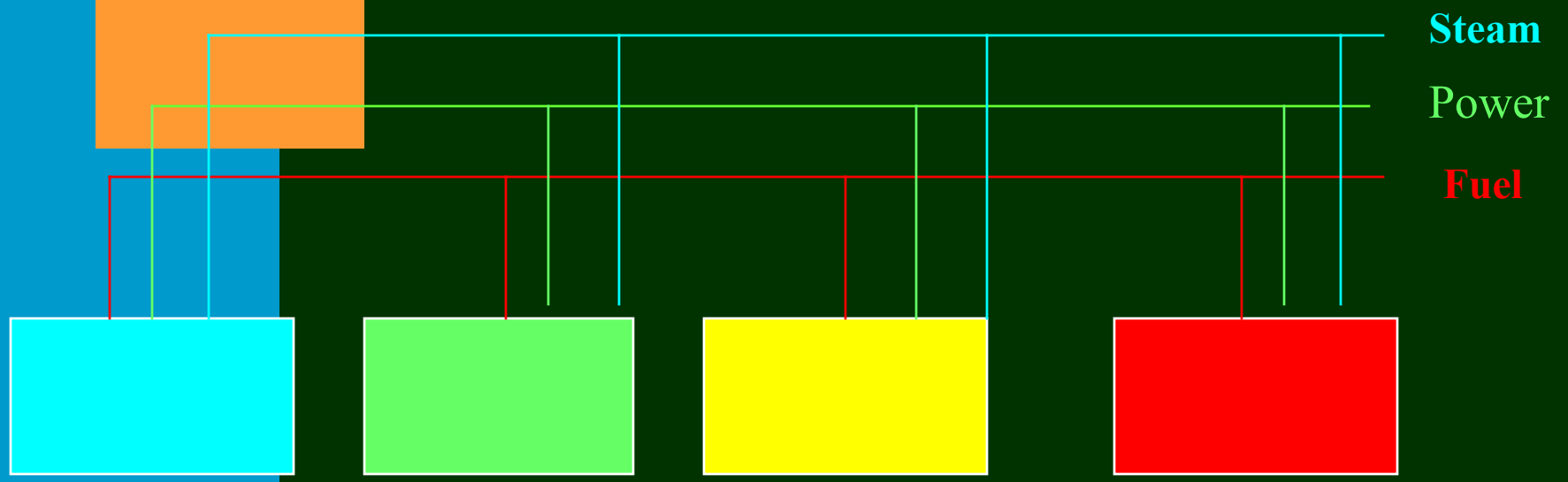
List of equipments with lower energy efficiency

Energy resource utilization and loss areas

Developing Energy Efficiency Models

- Energy efficiency models may be designed to evaluate the energy efficiency of all energy intensive equipment for continuous performance evaluation and monitoring .
- This must cover all type of Energy input resources like Fuel , Steam , Power and Thermal Energy.
- Energy efficiency Models are **the key to Performance Evaluation of the equipment , system and sub systems** for taking corrective actions in the right direction.

Example

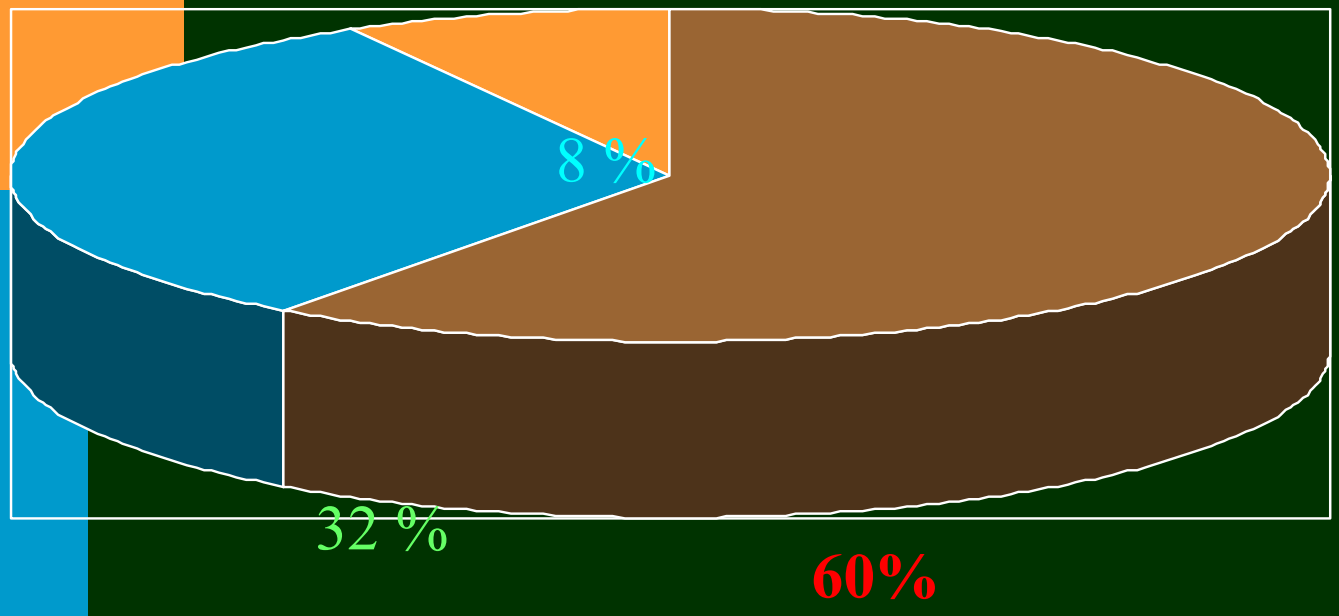


Energy wise System Analysis

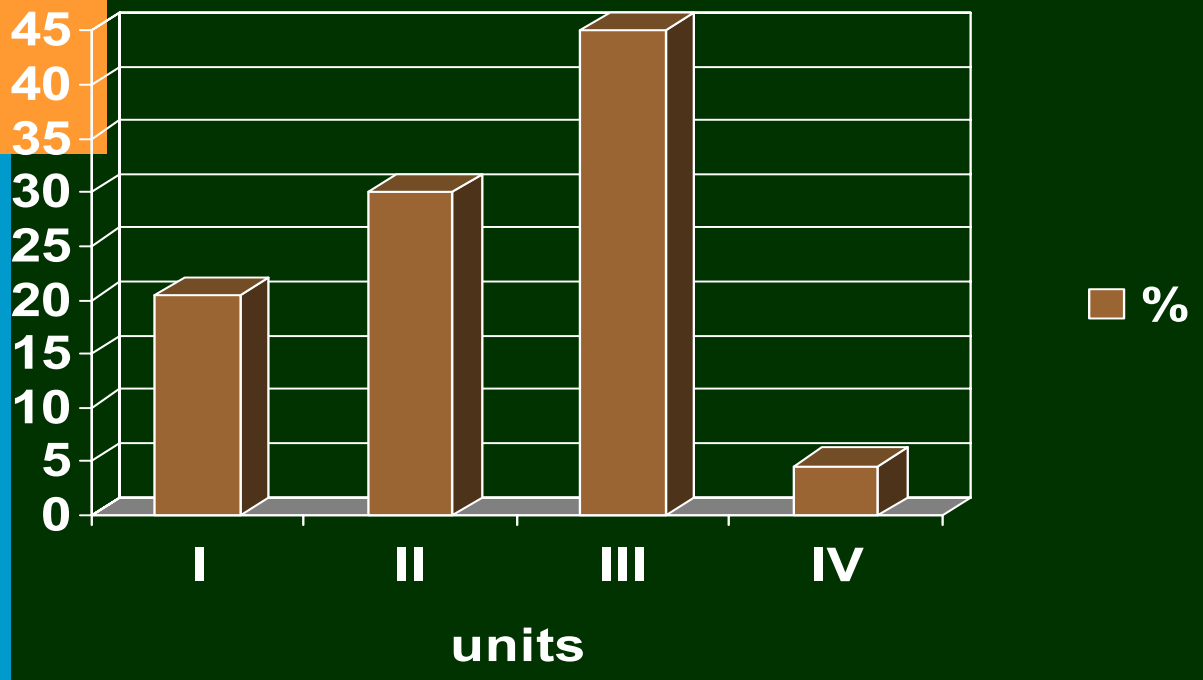
- Using the Energy Data, Techno Therm analyses the entire system Energy wise and offers information such as

- unit wise Steam consumption.
- unit wise power consumption
- unit wise fuel consumption
- total energy input analysis.
- Energy cost , losses etc

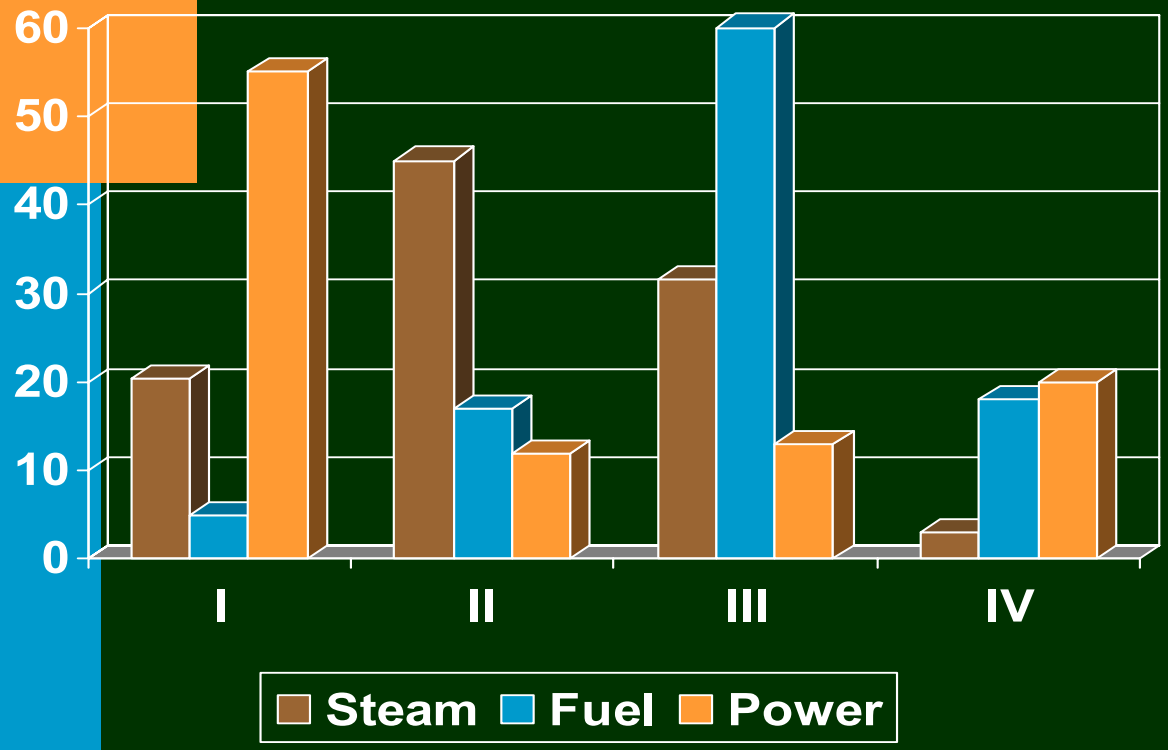
Energy type – Break-up



Unit wise Energy Consumption



Total Analysis



Advantages of Energy Efficiency optimization

Continuous use of Energy Efficiency Optimization helps to

- Identify the type of parameters to be monitored for corrective action .
- Identify the sub system performance
- Identify the equipment / element responsible for poor performance.
- identify the process parameter or others responsible for poor performance

An effective tool for Energy Management Decisions.

This approach is very useful tool for taking fast Energy Management Decisions such as

- Is the system performance okay ? What is the problem ?
- Which parameters are responsible ?
- What is the best alternative to improve performance

Could also be used to identify efficiency deterioration using various models.

Users of Energy Audit

- Operating staff – process and power plants
- Process Engineers / Managers
- Chief Executives / Directors
- Energy Management Consultants
- R & D organizations

  Energy Equipment manufacturers.
- Thermal Power stations / power industry.

Cost - Benefit Analysis

- Use of Energy Efficiency Optimization on continuous basis pays off in a few days to weeks.
- Identifies equipment deterioration.
- Longer run lengths / higher production / power generation of units could be achieved.
- Energy costs could be minimized
- Net profit could be increased.

Useful for MIS users

- In tailored form, this could be used to generate MIS for top executives who can use the information for equipment maintenance / replacement decisions at the right time.
- Substantial savings could be achieved by this.

POWER PLANT APPLICATIONS

- This concept may be used very effectively in Power plants for evaluating and monitoring the efficiency of
- **Power boilers**

  Steam turbines
- **Gas Turbines**
- **Power losses**
- **Performance evaluation etc.**

TYPICAL EXAMPLE

- In the case of Thermal Power plants, the overall efficiency of power generation is determined by
- Boiler efficiency
- Turbine efficiency and
- Generator efficiency
- Built-in modules have the capability to evaluate each parameter separately for corrective action.

MIS FOR Power Plant Performance Monitoring and Control

- This is a very powerful tool for Corporate / Unit level Energy Management for taking corporate and operational decisions at the right time and cost.

A typical MIS gives

- Energy efficiency of individual plant vs target
- Break-up of energy losses
- Cost of power generation and control centres
- Transmission losses unitwise vs norms
- Specific power consumption etc

for corrective action at the Right time and Right Cost.

Capacity Utilization vs Efficiency

- Capacity utilization plays an important role on system efficiency.
- In normal case, higher the capacity utilization, higher is the efficiency. This is known as system characteristics.
- Operational capacity must be optimized to achieve highest possible efficiency of the total system to reduce operating cost.
- Energy efficiency models are used to quantify this information and arrive at optimal solutions.

Flexi target setting

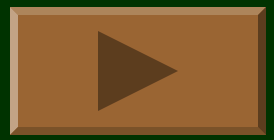
* Energy Management of a large system calls for identifying the parameters responsible for affecting the overall performance of the system.

* This requires thorough analysis and development of performance models which set flexi-targets for the energy performance under various operating parameters.

* This is achieved by customization.

* This also explains the reasons for performance deviation scientifically.

On
Energy Efficiency Optimization



05/03/2008

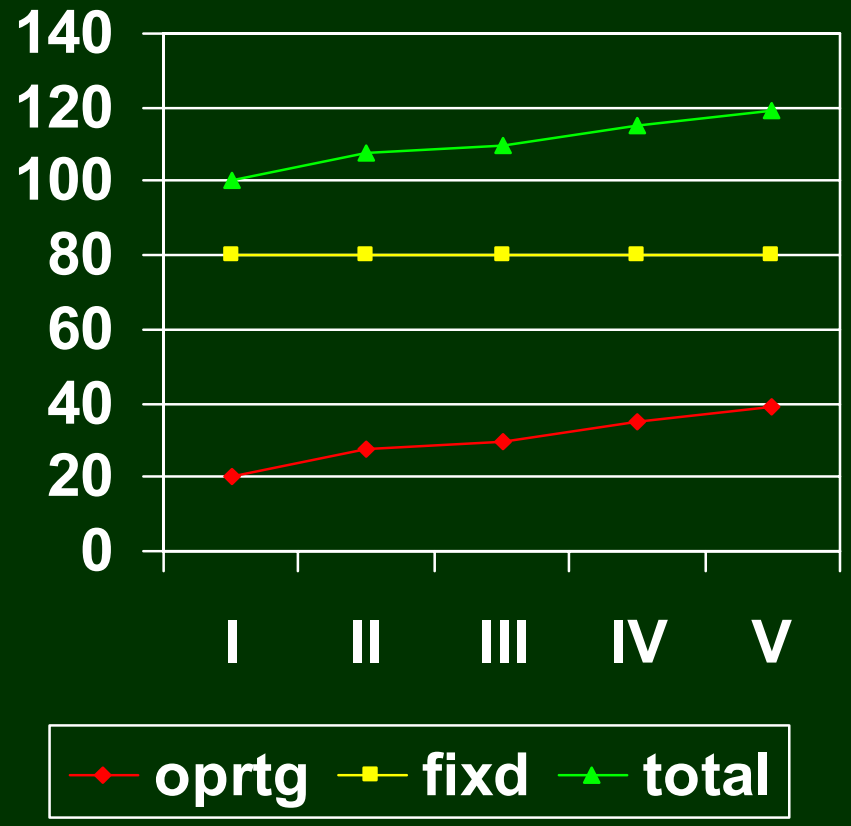
Questions on using Energy Efficiency Models

How effectively can these models be used in the absence of proper flow measurements for fuel and it's properties ?

Indirect method is used for determining the efficiency of heaters / boilers etc which does not require flow data . Parameters used in the program are flue gas analysis , stack temperature , ambient temperature, Relative humidity and setting losses. This tallies very much with direct method of efficiency determination.

Example - Equipment Maintenance / Replacement Decisions.

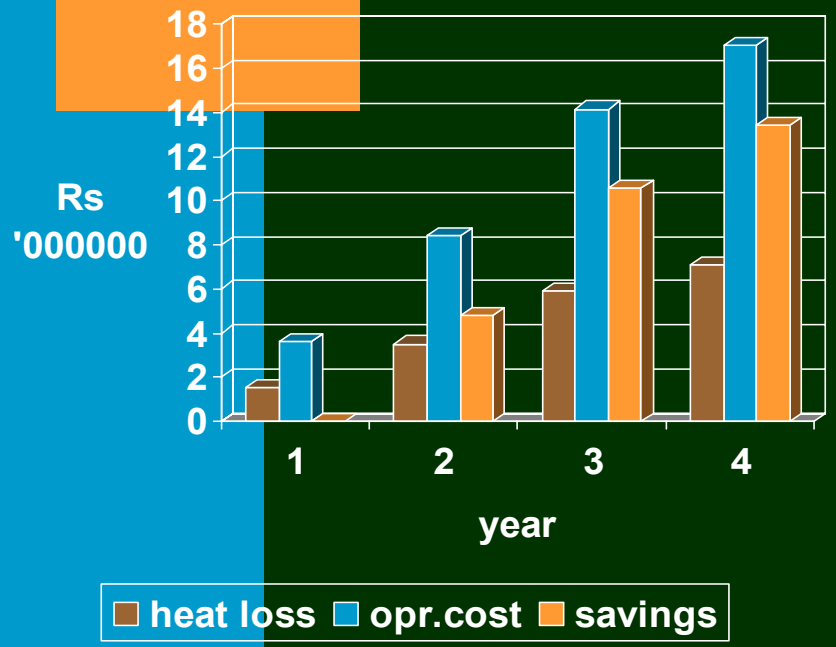
- These models may be used for taking Equipment Maintenance / Replacement Decisions to minimise the Total Cost of Operation which determines the profitability and productivity of the industry.



Failure Prediction of Equipment / components

- These models in combination with Maintenance and Corrosion software may be used effectively to predict equipment / component failure due to corrosion, scaling, pitting, vibration etc using powerful models.

Economics of Insulation



- This approach evaluates Heat loss from various sections of the equipment, which could be used to identify the source of loss for taking insulation retrofit decisions.

INNOVATIVE IDEAS

Cogeneration

Combined heat power cycle optimization

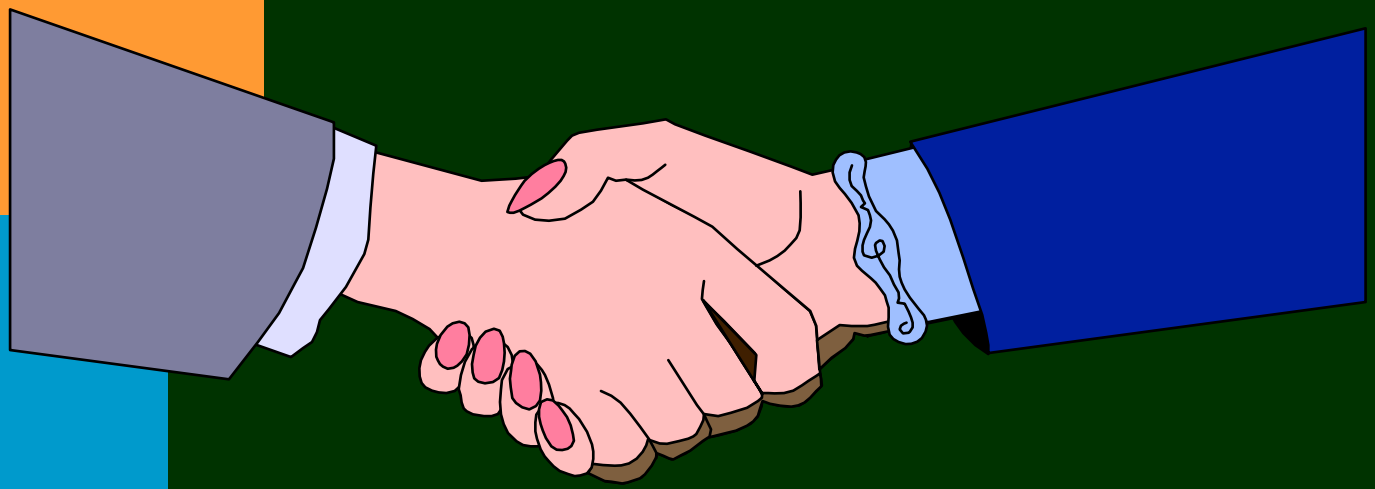
Trigeneration

Organic rankine cycle

Waste heat recovery

Using Energy efficient equipments etc

Thank You



Any Questions ?