

### Optimising the Input Energy Requirements

Consequent upon fine-tuning the energy use practices, attention is accorded to considerations for minimizing energy input requirements. The range of measures could include:

- Shuffling of compressors to match needs.
- Periodic review of insulation thickness
- Identify potential for heat exchanger networking and process integration.
- Optimisation of transformer operation with respect to load.

### 3.8 Fuel and Energy Substitution

**Fuel substitution:** Substituting existing fossil fuel with more efficient and less cost/less polluting fuel such as natural gas, biogas and locally available agro-residues.

Energy is an important input in the production. There are two ways to reduce energy dependency: energy conservation and substitution.

Fuel substitution has taken place in all the major sectors of the Indian economy. Kerosene and Liquefied Petroleum Gas (LPG) have substituted soft coke in residential use. Few examples of fuel substitution

- Natural gas is increasingly the fuel of choice as fuel and feedstock in the fertilizer, petrochemicals, power and sponge iron industries.
- Replacement of coal by coconut shells, rice husk etc.
- Replacement of LDO by LSHS

Few examples of energy substitution

- ✓ Replacement of electric heaters by steam heaters
- ✓ Replacement of steam based hotwater by solar systems

#### Case Study : Example on Fuel Substitution

A textile process industry replaced old fuel oil fired thermic fluid heater with agro fuel fired heater. The economics of the project are given below:

<b>A: Title of Recommendation</b>	<b>: Use of Agro Fuel (coconut chips) in place of Furnace oil in a Boiler</b>
<b>B: Description of Existing System and its operation</b>	: A thermic fluid heater with furnace oil currently. In the same plant a coconut chip fired boiler is operating continuously with good performance.
<b>C: Description of Proposed system and its operation</b>	: It was suggested to replace the oil fired thermic fluid heater with coconut chip fired boiler as the company has the facilities for handling coconut chip fired system.

**D: Energy Saving Calculations****Old System**

<b>Type of fuel Firing</b>	<b>: Furnace Oil fired heater</b>
GCV	: 10,200 kCal/kg
Avg. Thermal Efficiency	: 82%
Heat Duty	: 15 lakh kCal / hour
Operating Hours	: 25 days x 12 month x 24 hours = 7,200 hrs.
Annual Fuel Cost	: Rs.130 lakh (7200 x 1800 Rs./hr.)

**Modified System**

<b>Type of fuel saving</b>	<b>= Coconut chips fired Heater</b>
GCV	= 4200 kCal/kg
Average Thermal Efficiency	= 72 %
Heat Duty	= 15 lakh kCal / hour
Annual Operating Cost	= 7200 x 700 Rs./hr = 50 lakh
Annual Savings	= 130 - 50 = Rs.80 lakh .
Additional Auxiliary Power + Manpower Cost	= Rs. 10 lakh
Net Annual Saving	= Rs. 70 lakh
Investment for New Coconut Fired heater	= Rs. 35 lakh
<b>Simple pay back period</b>	<b>= 6 months</b>

**3.9 Energy Audit Instruments**

The requirement for an energy audit such as identification and quantification of energy necessities measurements; these measurements require the use of instruments. These instruments must be portable, durable, easy to operate and relatively inexpensive. The parameters generally monitored during energy audit may include the following:

Basic Electrical Parameters in AC & DC systems - Voltage (V), Current (I), Power factor, Active power (kW), apparent power (demand) (kVA), Reactive power (kVAR), Energy consumption (kWh), Frequency (Hz), Harmonics, etc.

Parameters of importance other than electrical such as temperature & heat flow, radiation, air and gas flow, liquid flow, revolutions per minute (RPM), air velocity, noise and vibration, dust concentration, Total Dissolved Solids (TDS), pH, moisture content, relative humidity, flue gas analysis - CO<sub>2</sub>, O<sub>2</sub>, CO, SO<sub>x</sub>, NO<sub>x</sub>, combustion efficiency etc.

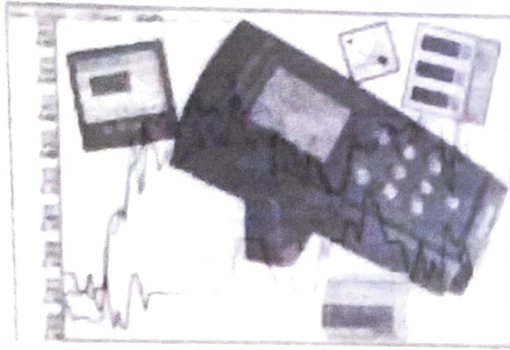
**Key instruments for energy audit are listed below.**

The operating instructions for all instruments must be understood and staff should familiarize themselves with the instruments and their operation prior to actual audit use.



### Electrical Measuring Instruments:

These are instruments for measuring major electrical parameters such as kVA, kW, PF, Hertz, kVAr, Amps and Volts. In addition some of these instruments also measure harmonics.



These instruments are applied on-line i.e. on running motors without any need to stop the motor. Instant measurements can be taken with hand-held meters, while more advanced ones facilitates cumulative readings with print outs at specified intervals.



### Combustion analyzer:

This instrument has in-built chemical cells which measure various gases such as  $O_2$ ,  $CO$ ,  $NO_x$  and  $SO_x$ .



### Fuel Efficiency Monitor:





This measures oxygen and temperature of the flue gas. Calorific values of common fuels are fed into the microprocessor which calculates the combustion efficiency.



### Fyrite:

A hand bellow pump draws the flue gas sample into the solution inside the fyrite. A chemical reaction changes the liquid volume revealing the amount of gas. A separate fyrite can be used for  $O_2$  and  $CO_2$  measurement.



	<p><b>Contact thermometer:</b></p> <p>These are thermocouples which measures for example flue gas, hot air, hot water temperatures by insertion of probe into the stream.</p> <p>For surface temperature, a leaf type probe is used with the same instrument.</p>
	<p><b>Infrared Thermometer:</b></p> <p>This is a non-contact type measurement which when directed at a heat source directly gives the temperature read out. This instrument is useful for measuring hot spots in furnaces, surface temperatures etc.</p>
	<p><b>Pitot Tube and manometer:</b></p> <p>Air velocity in ducts can be measured using a pitot tube and inclined manometer for further calculation of flows.</p>
	<p><b>Water flow meter:</b></p> <p>This non-contact flow measuring device using Doppler effect / Ultra sonic principle. There is a transmitter and receiver which are positioned on opposite sides of the pipe. The meter directly gives the flow. Water and other fluid flows can be easily measured with this meter.</p>

		<p><b>Speed Measurements:</b></p> <p>In any audit exercise speed measurements are critical as they may change with frequency, belt slip and loading.</p> <p>A simple tachometer is a contact type instrument which can be used where direct access is possible.</p> <p>More sophisticated and safer ones are non contact instruments such as stroboscopes.</p>
	<p><b>Leak Detectors:</b></p> <p>Ultrasonic instruments are available which can be used to detect leaks of compressed air and other gases which are normally not possible to detect with human abilities.</p>	
	<p><b>Lux meters:</b></p> <p>Illumination levels are measured with a lux meter. It consists of a photo cell which senses the light output, converts to electrical impulses which are calibrated as lux.</p>	