Electrical Energy Conservation opportunities in Industries- Energy Efficient Motors, Controller Drives & Devices

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Energy sources

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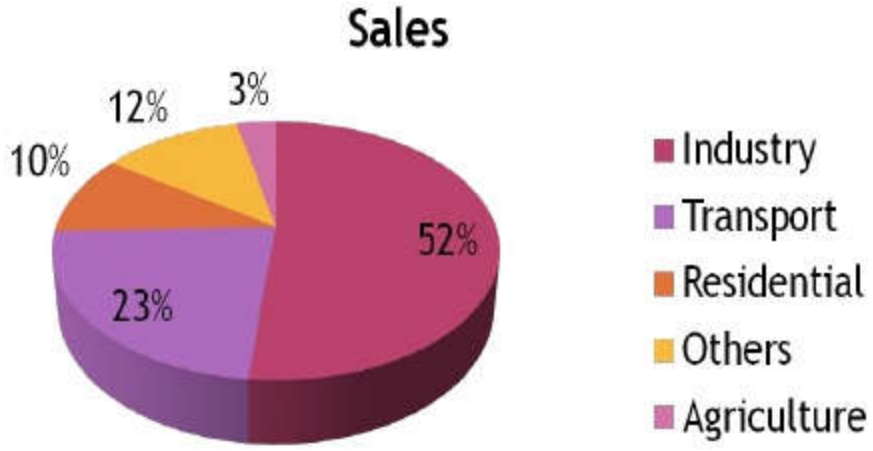
- The industrial sector is consuming 50% of total commercial energy in country.

Commercial sources of energy

▪ Coal and lignite contribute	56%
▪ Oil and natural	40%
▪ Hydroelectric power	3%
▪ Nuclear power	1%

Energy demand

- Agriculture:3.5%
- Industry:50.7%
- Transport:23.2%
- Residential:10.3%
- Others:12.3%



Comparison of Specific Energy Use in Select Industries (Figures in million kcal/ Tonne)

COUNTRY	STEEL	CEMENT	PULP&PAPER	FERTILIZER
INDIA	9.5	2.00	11.13	12.23
USA	6.07	1.30	7.62	11.25
UK	6.06	0.95	9.70	11.32
JAPAN	4.18	1.20	-	-

Barriers To Energy Efficiency

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- Lack of awareness
- Lack of widespread education & training
- Economic and market distortions
- Lack of standardization & labeling on equipment/devices
- Lack of financing
- Lack of effective coordination

Energy Conservation Act 2001

- BEE operationalized from 1stMarch 2002
- Standards & Labelling Program

•Evolve minimum energy consumption and performance standards for notified equipment and appliances

• Prohibit manufacture and sale of equipment & appliances not conforming to standards

•Introduce mandatory labeling to enable consumers to make informed choices

•Work started on Agricultural Pump sets, Distribution transformer, Motors, Lighting products and Refrigerators

Energy Conservation Act 2001

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➢ List of Designated consumer

Designated consumers have to:

- Get energy audit done by accredited energy audit firms
- Implement cost effective recommendations
- Appoint or designate energy manager
- Comply with energy consumption norms and standards

By regulations BEE to prescribe

- Qualification and certification procedure for energy manager and energy auditors
- Accreditation procedure for Energy audit firms

Energy Conservation Act 2001

➢ Energy Conservation Building codes

- To prepare guidelines on codes
- To be modified by states to suit local climatic conditions
- To be applicable to new buildings having connected load of 500 kW and above

➢ To set up Energy Conservation Fund to provide

- Awareness Creation
- Innovative financing
- Promotion of ESCOs
- R&D, testing facilities and Demonstration projects

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Energy Conservation in Indian Industries

Industry	Absolute energy consumption (million G Cal)	Scope of energy conservation in the sector (%)	Energy cost as Percentage of mfg cost (%)
Fertilizers & Pesticides	112	10	60
Sugar	100	20	12
Cement	67	10	40
Textile	52.5	20-25	13
Aluminum	30.1	15-20	40
Paper	26	20	25
Glass	15	15	30

SOME ENERGY CONSERVATION DEVICES

High efficiency boiler

High efficiency motor

Industrial fan

SOME ENERGY CONSERVATION DEVICES

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Chiller

air compressors

PHILOSOPHY OF ENERGY AUDIT

- Through energy audit, we optimize the consumption of fuel i.e. coal, electricity petroleum products etc.

- To spread the benefits obtained through Energy Audit in any one industry to entire cluster

- To replicate the benefit obtained through Energy Audit in other industries through Education Campaign and ITPs

- Sponsor R &D projects identified from Energy Audit.

INDUSTRIES TOWARD ENERGY CONSERVATION

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ALUMINIUM :

- Energy consumption varies from plant to plants as their smelters are based on different design parameters

- NALCO has adopted the latest energy efficient systems au-Ml has the lowest specific heat consumption of 13,500 kwh per tonne of aluminium production

- potential energy saving up to 15-20%by energy saving projects

INDUSTRIES TOWARD ENERGY CONSERVATION

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CEMENT:

- India is the 4th largest producer of cement in the world
- Energy costs making up as much as 40% of the total cost of manufacturing .
- According to CII potential energy saving up to 10% by energy saving projects
- particulate emission that has a significant influence on the environment

Progress till now

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Guidelines for 'Energy Policy'for energy intensive industries framed

- Project supported by various agencies under Green Aid Plan (GAP)

- The Policy guidelines

  - ✓Top Management Commitment
  - ✓ Energy Management Cell
  - ✓ Small Group Activities
  - ✓ Capability enhancement/training & motivation
  - ✓ Monitoring and targeting
  - ✓ Role of industry association and 'task force'

- Energy Management Structure suggested
- Most of the big industries now have declared their 'Energy policy'

ENERGY POLICY IN INDIA

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- The Ministry of power has been designated as the nodal agency for energy conservation

Major Government initiatives towards energy conservation

- Depreciation allowance at 100% in the first year on certain energy saving devices and systems

- Reduced custom duty is applicable on specified equipment/devices used in the industry

Major Government initiatives towards energy conservation

- Soft loans from financial institutions for technology upgradation and introduction of energy conservation measure

- Subsidies for consultancy and training in the areas of energy management and conservation

Energy Efficient Motors

WHAT IS ENERGY EFFICIENT MOTOR?

An "**energy efficient**" motor, simply put, is a motor that gives you the same output strength by consuming lesser amounts of power

EXPERIMENTAL RESULTS

Type of motor	Annual Consumption of energy in kwh
Standard motors	870
Energy efficient motors	804.59

Energy Efficient Motors

- **Minimising Watts Loss in Motors**
  Improvements in motor efficiency can be achieved without compromising motor performance - at higher cost - within the limits of existing design and manufacturing technology. Any improvement in motor efficiency must result from reducing the Watts losses. All of these changes to reduce motor losses are possible with existing motor design and manufacturing technology. They would, however, require additional materials and/or the use of higher quality materials and improved manufacturing processes resulting in increased motor cost.
  - **Simply Stated: REDUCED LOSSES = IMPROVED EFFICIENCY**

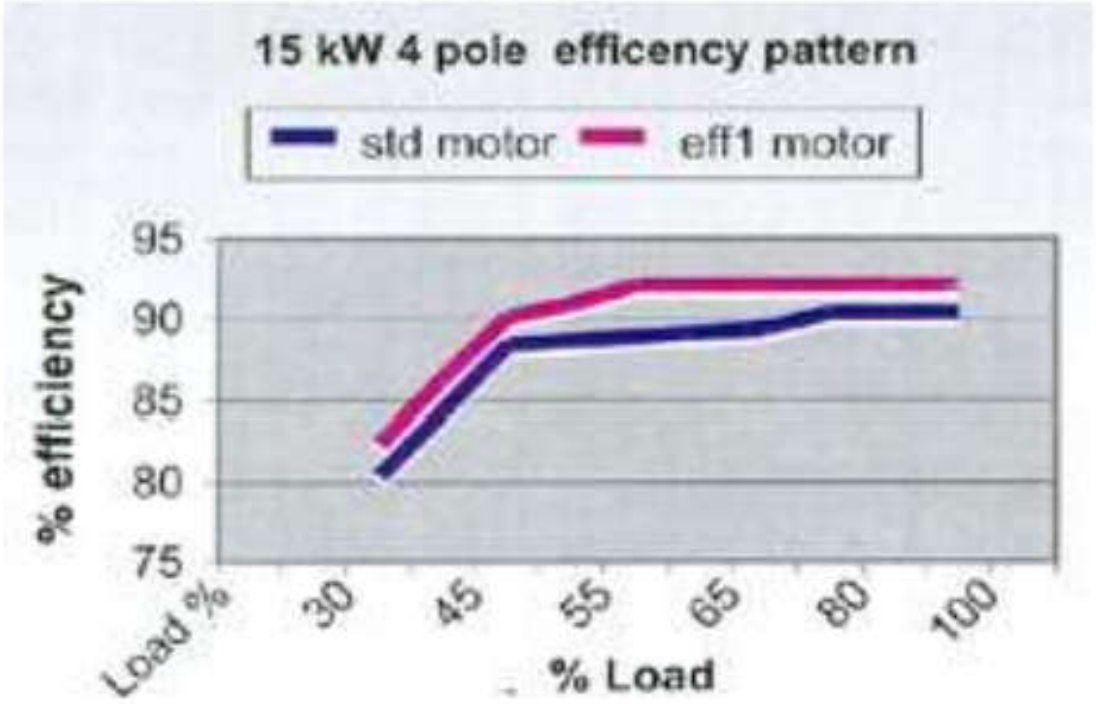
DIFFERENCE BETWEEN STANDARD MOTOR AND ENERGY EFFICIENT MOTOR

- More copper in the windings.
- Reduced fan loses.
- Energy efficient motors operate with efficiencies that are typically 2-6% higher than standard motors.

NEED:

- When there is a new installation or modification to your plant.
- Old motors are damaged and need rewinding.
- Existing motors are underloaded or overloaded.
- Protecting other devices.

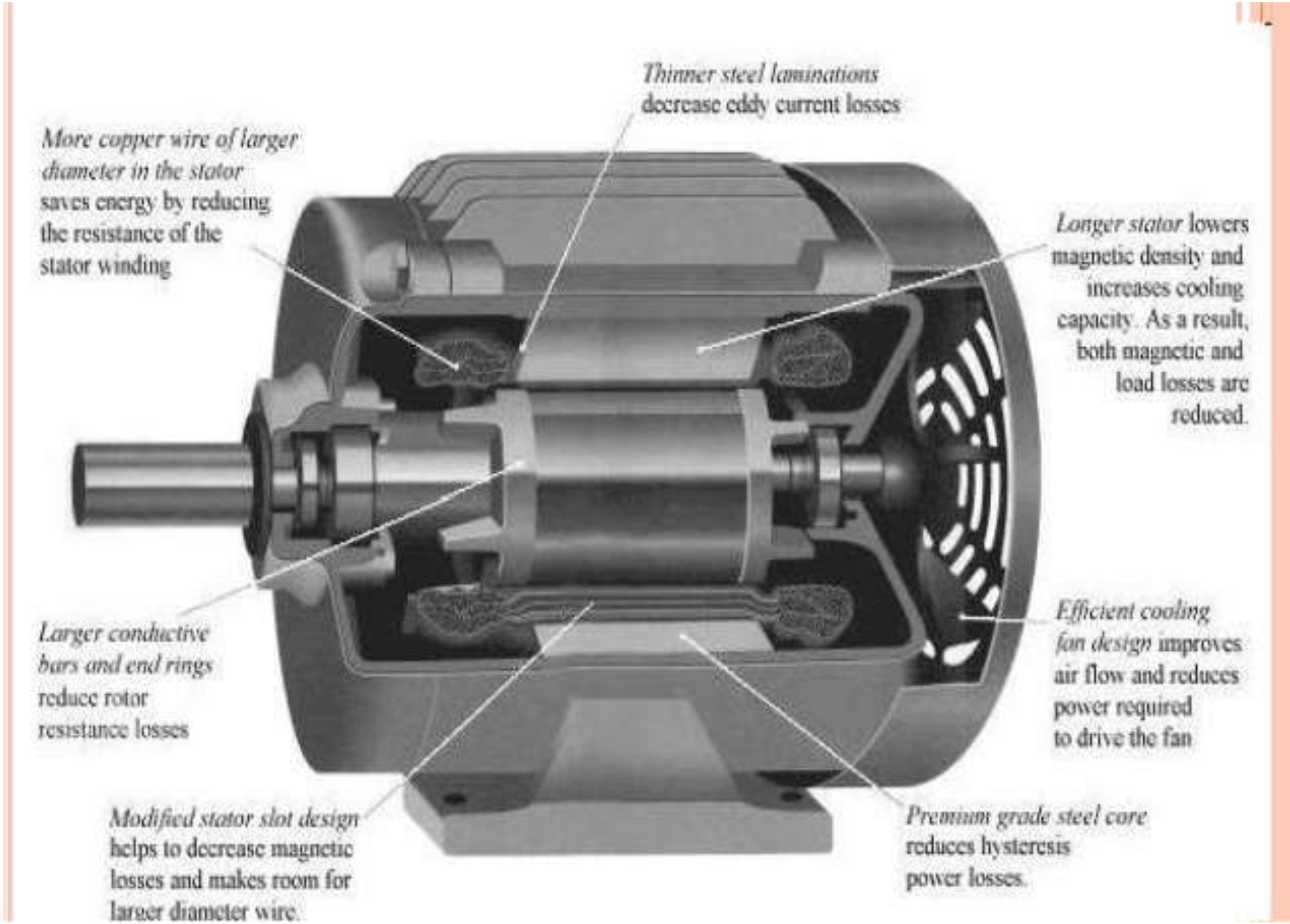
EFFICIENCY


15 kW 4 pole efficency pattern
std motor
eff1 motor
% efficiency
95
90
85
80
75
Load %
30
45
55
65
80
100
% Load

LOSSES :

Losses are primarily of two types i.e. core and copper losses.

- Copper loss
- Core loss
- Friction and windage Loss
- Stray load loss


Thinner steel laminations decrease eddy current losses
More copper wire of larger diameter in the stator saves energy by reducing the resistance of the stator winding
Longer stator lowers magnetic density and increases cooling capacity. As a result, both magnetic and load losses are reduced.
Larger conductive bars and end rings reduce rotor resistance losses
Efficient cooling fan design improves air flow and reduces power required to drive the fan
Modified stator slot design helps to decrease magnetic losses and makes room for larger diameter wire.
Premium grade steel core reduces hysteresis power losses.

SAVINGS

Table 2
Annual Value of a One-Point Efficiency Gain (Based on $0.04/kWh, 8000 Hours of Use, Full Load)

Horsepower	Annual Savings
5	$17
10	$32
20	$61
50	$142
100	$278
200	$537

Cost of energy efficient motors:

Usually it is of normal cost and slightly more than the normal motors. It is about 15% to 30% more than the normal motors.

In Future, the initial cost may be available at the same cost as a standard motor when the population of EE Motors increases

ADVANTAGES

- Operate more satisfactorily under abnormal voltage.
- Electric power saving.
- Operating temperature is less.
- Noise level is lower.

Disadvantages

- Portability.
- Initial cost is more.
- Speed Control .

Applications

Motors are suitable for wide industrial applications like paper, cement, textiles, cranes, material handling, machine tools and blowers etc.

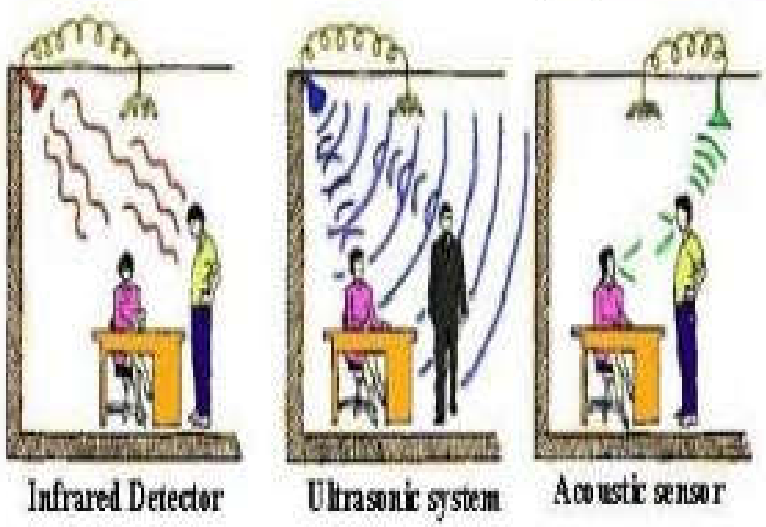
Energy Efficient Controllers & devices

Energy Efficient Lighting Controls

- **Occupancy Sensors** -Occupancy linked control can be achieved using infra-red, acoustic, ultrasonic or microwave sensors, which detect either movement or noise in room spaces. These sensors switch lighting on when occupancy is detected, and off again after a set time period, when no occupancy movement detected. They are designed to override manual switches and to prevent a situation where lighting is left on in unoccupied spaces.

TYPES OF OCCUPANCY SENSORS

- **Passive Infrared Sensors** detect movement and/or increased heat in an area caused by natural increase in movement and heat as people enter the area.
- **Ultra-Sonic Sensors** emit ultra-sonic waves that bounce off objects in a room with an echo sent to the sensors. The sensitivity of the sensors recognizes movement in the room and responds accordingly.
- **Micro-Phonic Sensors** listen to irregular sound patterns to detect motion in a room.



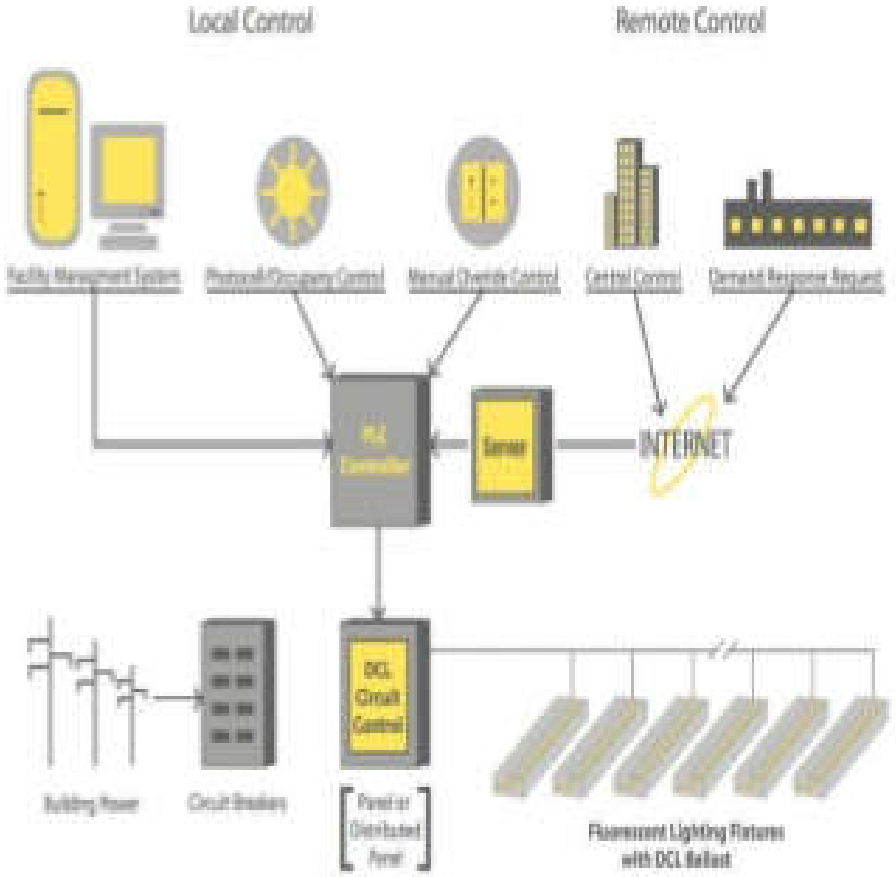
Occupancy Sensor Technologies

Localized Switching-- Localized switching should be used in applications which contain large spaces. Local switches give individual occupants control over their visual environment and also facilitate energy savings. By using localized switching it is possible to turn off artificial lighting in specific areas, while still operating it in other areas where it is required, a situation which is impossible if the lighting for an entire space is controlled from a single switch.

Daylight Linked Control-- Photoelectric cells can be used either simply to switch lighting on and off, or for dimming. By using an internally mounted photoelectric dimming control system, it is possible to ensure that the sum of daylight and electric lighting always reaches the design level by sensing the total light in the controlled area and adjusting the output of the electric lighting accordingly. If daylight alone is able to meet the design requirements, then the electric lighting can be turned off. The energy saving potential of dimming control is greater than a simple photoelectric switching system.

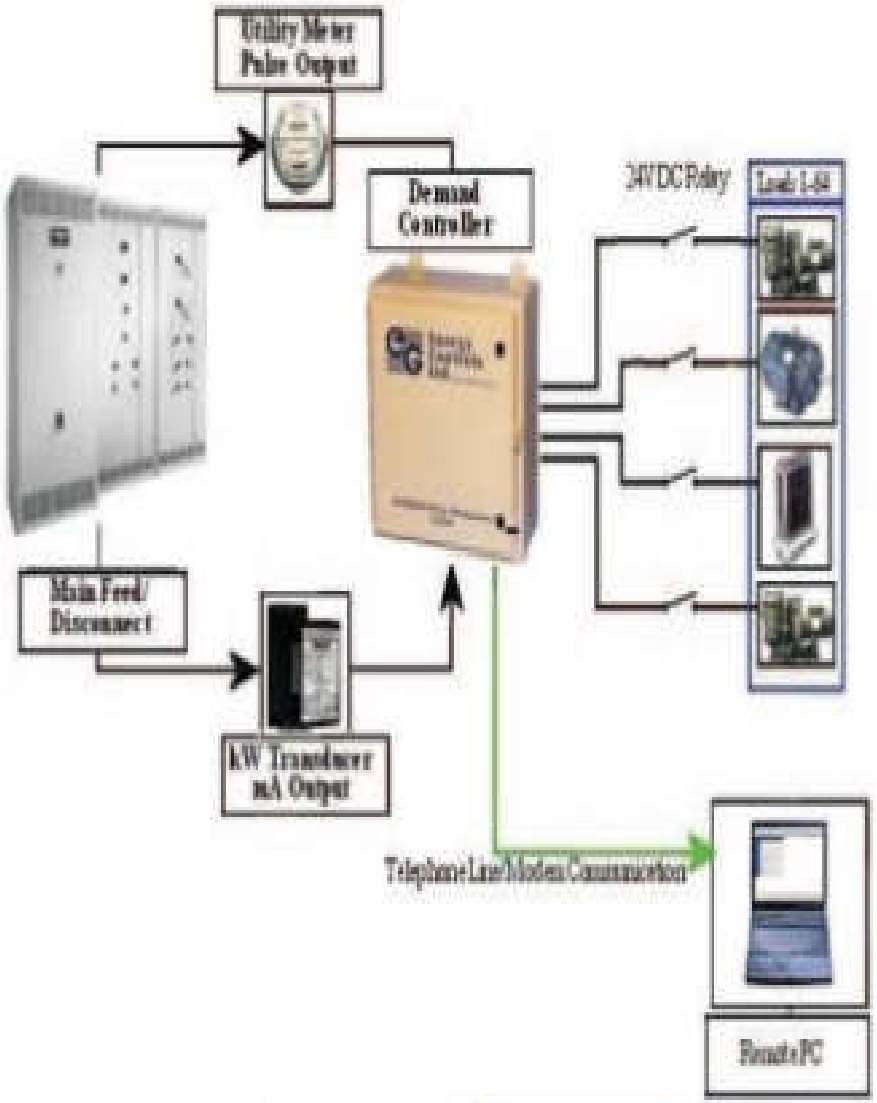
.....How It Works.....

- When the occupancy sensor is active (i.e., the room is occupied), then the photocell will determine how much artificial light is necessary to maintain the ideal level of illumination within the room. When there is no natural light, the photocell signals the ballasts to operate at their pre-programmed maximum level. When the photocell detects natural light, the ballasts will be dimmed by an equivalent amount so that the total illumination of the room does not change. This process is called Daylight Harvesting.
- When the occupancy sensor detects that the room is unoccupied, then the photocell initiates a shut-down program. It begins with a dimming sequence with a field-adjustable time of 30 seconds. Power to the ballasts will decrease to 35% power for ten minutes. Then, the fixtures will turn off. This process is called Dimming. Should the space be re-occupied prior to the system timeout, the occupancy sensor would alert the PLC, and ballast output would immediately return to the level established by the photocell.



Maximum Demand Controller

- High-tension (HT) consumers have to pay a maximum demand charge in addition to the usual charge for the number of units consumed. The maximum demand charge often represents a large proportion of the total bill and may be based on only one isolated 30 minute episode of high power use. Considerable savings can be realised by monitoring power use and **turning off or reducing non-essential loads** during such periods of high power use.



Maximum Demand Controller

- Maximum Demand Controller is a device designed to meet the need of industries conscious of the value of load management. Alarm is sounded when demand approaches a present value. If corrective action is not taken, the controller switches off non-essential loads in a logical sequence. This sequence is predetermined by the user and is programmed jointly by the user and the supplier of the device. The plant equipments selected for the load management are stopped and restarted as per the desired load profile.

SOFT STARTER

When starting, AC Induction motor develops more torque than is required at full speed. Rapid acceleration also has a massive impact on electricity supply charges with high inrush currents drawing +600% of the normal run current. Soft starter provides a reliable and economical solution to these problems by delivering a controlled release of power to the motor, thereby providing smooth, stepless acceleration and deceleration. Motor life will be extended as damage to windings and bearings is reduced.

Automatic Power Factor Controllers

Various types of automatic power factor controls are available with relay/microprocessor logic. Ex-Voltage Control and kVAr Control

Voltage Control- Voltage alone can be used as a source of intelligence when the switched capacitors are applied at point where the circuit voltage decreases as circuit load increases. Generally, where they are applied the voltage should decrease as circuit load increases and the drop in voltage should be around 4-5 % with increasing load. Voltage is the most common type of intelligence used in substation applications, when maintaining a particular voltage is of prime importance. This type of control is independent of load cycle. During light load time and low source voltage, this may give leading PF at the sub-station, which is to be taken note of.

KILOVAR Control

Kilovar sensitive controls are used at locations where the voltage level is closely regulated and not available as a control variable. The capacitors can be switched to respond to a decreasing power factor as a result of change in system loading. This type of control can also be used to avoid penalty on low power factor by adding capacitors in steps as the system power factor begins to lag behind the desired value. Kilovar control requires two inputs - current and voltage from the incoming feeder, which are fed to the PF correction mechanism, either the microprocessor or the relay.

Electronic Ballast

- In an electric circuit the ballast acts as a stabilizer. The high frequency electronic ballast has following basic functions :-

  1. To ignite the lamp
  2. To stabilize the gas discharge
  3. To supply the power to the lamp.

- One of largest advantages of an electronic ballast is the enormous energy savings it provides. First is its amazingly low internal core loss, quite unlike old fashioned magnetic ballasts. And second is increased light output due to the excitation of the lamp phosphors with high frequency. If the period of frequency of excitation is smaller than the light retention time constant for the gas in the lamp, the gas will stay ionized and, therefore, produce light continuously. This phenomenon along with continued persistence of the phosphors at high frequency will improve light output from 8-12 percent. This is possible only with high frequency electronic ballast

Energy Efficient Transformers

- Most energy loss in dry-type transformers occurs through heat or vibration from the core. The new high-efficiency transformers minimise these losses. The conventional transformer is made up of a silicon alloyed iron (grain oriented) core. The iron loss of any transformer depends on the type of core used in the transformer. However the latest technology is to use amorphous material - a metallic glass alloy for the core with unique physical and magnetic properties- these new type of transformers have increased efficiencies even at low loads - 98.5% efficiency at 35% load.
- 1600 kVA Amorphous Core Transformer