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Energy Audit Report On a Technical Institute

[1]Dr.K.Umesha, M.E, Phd, [2]Miste.Mieee (Madras Section)
Jawaharlal College of Engineering and Technology, Lakkidi, Palakkad district, Kerala, India, Vice Principal and HOD/ECE,

***Abstract**: Energy auditing has been conducted to the Jawaharlal College of Engineering & Technology to estimate the Energy consumed in a day, week and monthly. The Energy Auditing for a day is the index of the consumption which normalizes the situation of Energy crisis by providing the conservation schemes. Any organization so called bulk consumer of electrical energy propose to adopt suitable technology or scheme of energy conservation to minimize. The unwanted power shutdown either incidentally or by load shedding.*

Energy auditing has been a part and parcel of every consumer of any form of which energy is exhaustible and inexhaustible in nature. In olden days their practice used to exploitation of energy only when it is available for example during crops harvesting wind blow in one direction was very essential for that they used wait overnight whenever wind blows little heavily harvesting process used to be done.aslo they used select the season for harvesting exclusively for this purpose because ample labours were also available there will not rain and sufficient sun is available people will not be having any work in the field. That is how energy by nature was used by formers. Now we are being literate energy being used without bothering its existence further. Energy auditing is one tool through which balancing of demand and supply is determined and the positive mismatch cannot be compensated either by organic way or it might be difficult task.

***Keywords:** conservation, feasibility, recommendations, payback period.*

I. Introduction

Energy auditing in a integral part of energy conservation and energy management is also part and parallel of conservation. Damage and supply gap is large energy to lead to similar natural defects. Energy disaster such as Tsunami and earth quake. The next generation generating yet to come will be completely light blind. It is because power never be available after this disaster and not ever rehabilitate the reconstruction of buildings. To avoid the energy calamity proposed auditing report use the innovative energy utilization schemes through which the ferocious of situation might blindness can be eradicated.

II. Energy Audit Options at a Glance & Recommendations

A. Energy Audit Types and Methodology

The "Energy Audit" is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with their use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Energy audit is an effective tool in defining and pursuing a comprehensive energy management program within a business. As per the Energy Conservation Act, 2001, passed by the government of India, energy audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical reports containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption."

B. Need for Energy Audit

In an organization like Engineering College, the top operating expense is often found to be electrical energy. In most assessments of the manageability of the cost or potential cost savings in the above component, would invariably emerge as a top priority, and thus energy Audit.

Energy constitutes a strategic area for cost reduction. A well done energy audit will always help owners to understand more about the ways energy is used in their organizations, and help to identify areas where waste can occur and where scope for improvement exists.

The energy audit would give a positive orientation to the energy cost reduction, preventive maintenance, and quality control programs which are vital for production and utility activities. Such an audit program will help to keep focus on variations that occur in the energy costs, availability, and reliability of supply of energy, help decide on the appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment, etc.In general, the energy audit is the translation of conservation ideas and hopes into reality, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.

The primary objective of the energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. The energy audit provides a benchmark, or reference point, for managing and assessing energy use across the organization and provides the basis for ensuring more effective use of energy.

C.Types of Energy Audits

The type of energy audit to be performed depends on:

- Function and type of organization
- Depth to which a final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus energy audits can be classified into the following two types:

- Preliminary audit
- Detailed audit

D.Preliminary Energy Audit Methodology

The preliminary energy audit uses existing or easily obtained data. It is a relatively quick exercise to:

- Determine energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and easiest areas) for attention
- Identify immediate (especially no-cost/low-cost) improvements/savings
- Set a reference point
- Identify areas for more detailed study/measurement

E.Detailed Energy Audit Methodology

A detailed energy audit provides a comprehensive energy project implementation plan for a facility, since it evaluates all major energy-using systems.

This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

In a detailed audit, one of the key elements is the energy balance. This is based on an inventory of energy-using systems, assumptions of current operating conditions, and calculations of energy use. This estimated use is then compared to utility bill charges.

F.Detailed Energy Auditing Is Carried Out In Three Phases:

Phase I – Pre-Audit
Phase II – Audit
Phase III – Post-Audit

G.The Information To Be Collected During The Detailed Audit Includes:

1. Energy consumption by type of energy, by department, by major equipment.
2. Energy cost and tariff data
3. Sources of energy supply (e.g., electricity off the grid or self-generation)
4. Energy Management procedures and energy awareness training programs within the establishment

H. Process Flow Diagram To Identify Energy Wastage

1. Investment

Equipment cost
Cost of Civil works
Cost of Instrumentation
Cost of Auxiliaries

2. Annual operating cost

Cost of capital
Maintenance cost
Manpower
Energy cost
Depreciation cost

3. Annual Savings
Electrical energy
Net Savings / Year = (Annual savings- Annual operating costs)
Payback period in months = (Investment/net savings/year) / 12

III. Classification Of Energy Conservation Measures

Based on the Energy Audit and analysis of the organization, a number of energy saving schemes may be identified. These may be classified into three categories:
1. Low cost – high return
2. Medium cost – medium return
3. High cost – high return

IV. Priority Economic Feasibility

Priority of energy audit reveals that the replacement of LCD desktop computers little economically not feasible if the issue is taken as short term but as long term goal it is recommended.
Similarly the immediate replacement of conventionally controlled fans with remote controlled fans is also economically not feasible only it is the recommendation for the use in newly constructed buildings.

V. Technical Feasibility

All issues taken for energy saving are considered as technically feasible ,in all the cases there is a technical importance to promote the energy conservation measures in all levels of infrastructure development and modernization of existing system in the coming years.

VI. Risk Feasibility

Risk factors of any change or alteration or modification of the existing system are the prime factors of implementation careful planning and execution as per set plan with minimum depreciation and maintenance cost may reduce the invest burden reasonably. Corrective and preventive measures always indicate the progressive economic stability for the organization which reduces the risk factor mean time technology change will act as beneficial fact for further implementation.

VII. Instruments Used In The Energy Audit

A. Energy Audit Instruments

The requirement for an energy audit such as identification and quantification of energy necessitates various 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 the energy audit may include the following:

Basic Electrical Parameters in AC & DC systems – Voltage (V), Current (I), Power factor, Active power (kW),, Energy consumption (kWh), Harmonics, etc.

Parameters of importance other than electrical such as temperature, radiation

B.Electrical Measuring Instruments

These are instruments for measuring major electrical parameters such as, kW, PF, Hertz, amps and volts. in addition some of these instruments also measure harmonics. These instruments are applied on-line, i.e., on running motors without stopping the motor. Instantaneous measurements can be taken with hand-held meters,

C.Lux Meter

Illumination levels are measured with a lux meter.

VIII. Table 1: Type And Priority Of Energy-Saving Measures Annual Electrical Energy Savings Priority

A: No Investment **(Immediate**
Operational improvement
Housekeeping

B: Low Investment **Short to medium term)**
Controls Equipment modification
Process change

C: High Investment (Long term)

Energyefficientdevices
Product modification Technology Change

IX. Sample Reporting Format For Energy Conservation Recommendations

A. Recommendations

1) Pump the cooled water to cold storage plant during night to thermally insulated tank. Advice people not to use cold water till 12 noon of the day .Only they have to use the cold water plant between 12 noon to-10 PM for 10 hours.
2) Workers/Employees are advised to use only cotton clothes. White or relatively white cloth during summer. Therefore they can avoid too much sweating with that the effect of dehydration can be minimized and the water consumption can be minimized through which cold water storage burden will reduce at least by 10-20% of total consumption.
3) They can use cotton mini size umbrella it is not for rain protection it is exclusively to protect for direct attack of solar radiations, when they walk outside during afternoon. So that soon after reaching home fan use can be minimized and it is healthy .after going home immediate use of AC or FAN should be avoided as biologically certain harmonically imbalance takes place .gradual body cooling is better.
4) Use focused light for reading place or table lamp. Sometime recommended to avoid full room lighting it leads to wastage of illumination and disturbance of sleep to housemates which disturb their work efficiency at working place. Man-hour efficiency reduction is the national waste.aslo insufficient sleeps leads to health problems.
5) All Interior walls should be painted using Enameled paint which would reflect light
6) All Air conditional rooms should be Air light and doors should be Hydraulic closing system. Outside air entry in to the air conditioned room is not hygienic.
7) One special provision can be made for cooled water storage facility wherever possible attached AC room, so that multipurpose utilization of AC to cool the water will reduce the power consumption by 30% .
8) Good light ventilation and Air ventilation to classrooms may solve the problem of Energy Consumption.
9) Replacement of CRT monitor by LCD monitor not only gives the cost benefit interns of energy saving but also play a significant role of radiations due high potential .when CRT is used high voltage level handling by CRT at HT electrodes may emit harmful radiations beyond the screen which affect the vision .human being get in touch for trouble shooting may receive great risk of deadly shock if they touch the charged body which is normally charged up to 10000volts(approximately) In LCD monitor all such problems can be minimized.
10) Energy saving by replacing LCD desktop with LAPTOP illustrate the benefits in terms of portability, space saving, maintenance cost of desktop computers and additional cost of peripherals. Also cost of damage and other electrical problems. Critical space management and cost involved can be removed. Wiring for LAN and labour cost can also be prevented.
11) Unnecessary power consumption by negligence of user and system administrator for not switching off while leaving the office will have more vulnerability for damage due to short circuit and heavy voltage due to lightning .
12) It is recommended to replace fluorescent lamps by CFL which are handy by construction and possibility of breakage is less. Installation is easy and the labour charge required for replacement of burnt tubes and defected choke lamps is a costly affair. Disposal of burnt tubes will disturb the habitat place of both human being and animals. The release of krypton and argon gases is more dangerous, it may lead to ecological imbalance if it in mass destruction.
13) Switch off the photocopier machine at the main outlet itself when not in use or in other words machine should not be kept in stand by and sleep mode which consumes power.
14) Avoiding individual mobile phone facility at the working place during working hours is better; as they use charging facility which consume power and substandard battery chargers draws more current leads to more power consumption. There is also possibility66 of electrical short circuit. Common communication facility may lead to harmony among employs due to uniform facility it keeps the working atmosphere very clean and calm in addition to the cost benefit.
15) Use good lighting system will reduce the power burden as a whole.
16) Energy recycling, when Equipment is operating or motor is running is the research area where young generations have to address.
17) Fans running without capacitor or under rated capacitor will draw more current therefore use of correct rated capacitor will reduce the power consumption.

18) All major equipments should run with good power factor and the integration of Instrument to read the P. F online should be made mandatory. Therefore immediate care can be taken to improve the power factor.
19) Recommended to use Online harmonics measurement system to monitor the harmonics higher level harmonics lead generate heat in the equipment may lead to greater power loss .Harmonics suppression equipment is necessary.
20) Recommended to use solar water cooler in place of conventional one

B.List of Utilities

Fluorescent & CFL lamps
Regulator Controlled ceiling and wall mounted Fans
Modem Power pack
Desktop Computer with LCD Monitor
Laser Printer
Laptop Computer
Mobile Phone Charger
Photocopier
Telephone Power pack
Water cooler
Air conditioning

X. Description Of Existing System And Its Operation:

Location selected: Administrative Block. Jawaharlal College of Engineering & Technology, Jawaharlal, Jawahar Gardens, Lakkidi, Palakkad (District).

I. Existing system consists of the following

I. Low level space: total built area =417.28sqm
Physics lab measuring =12.19x16.53sqm
Store measuring =12.19x9.14sqm

II.Ground Floor: Total built up area=1433.36sqm
Office1 measuring =12.10x16.38sqm
Office-2 measuring =12.19x9.14sqm
CAD lab measuring =12.19x9.14Sqm
Computer lab: measuring =12.19x21.49Sqm
Principal measuring =29.6x16 feet
Staff room-1measuring =12.19x8.13Sqm
Ladies rest room measuring =12.108.23Sqm

Administrative office: Total area=1433.36sqmor 15423sqft
Establishment / account sector-OFFICE-1
Office-2: measuring =12.19X16.38sqm
Principal Room - 1: Total area =10sqm 290x160sqft

Office-2 consists of the following
Management and Director Room
Chairman rooms
Managing Trustee room
Secretary room
Academic director room
Personal assistant open space
Cabin – 1
Cabin – 2
Public utility area
Internet Lab =40X108 sqft or 12.19X21.48sqm
Faculty room.
Ladies rest room:
Examination Section
Staircase – 1& 2
CAD LAB

III. First floor-total built-up area=1898.23sqmtr
Library measuring =12.19x38.10sqm.
Ups room =4.58x4.38sqm
CR – 1 to4 measuring =12.19x9.14sqm
Toilet – 1 & 2 measuring =4.48x7.06sqm
Chemistry Lab – 1measuring =12.19x16.38sqm
Electronics Lab 1 & 2measuring =12.19x16.38sqm
Board room measuring =9x4.56sqm

IV.Second Floor: Total Built Up Area 21580sqft or 2005.57sqm
Seminar Hall / Auditorium measuring 12.19x38.56sqm,
Class room 1, 2&3&4AREA =12.19X9.14 each,
Electronics Lab – 1 & 2 =12.19X16.38,

B. Description of Proposed System and its Operation

As per the Energy audit report and recommendations .class rooms of first floor are proposed to shift to second floor so as to increase the air and light ventilation for the class rooms .no further major investment has been made.

All computer labs are proposed for multipurpose utilization example for placement training and language labs.

XI. Energy Saving Calculations

A. Energy Saving By Changing the Location of Class Rooms:

2^{nd} floor and 3^{rd} floor class room are better balance of more light & air.
GF labs are operated for 3hr/day or 5hr/day.
During 10AM-12.30PM&12.10-4.30 PM
Where class rooms at the GF shall operate between 9PM-4PM
Number of classes to be relocated =8
Total number of operating hours per week= 6hrsx6days (excluding labs 6hrs/week) = 36 hrs
Energy consumption/week/classroom
HoursxLightsxWatts =36 x10x50
=18000Wh
Energy consumption per week for 8 classrooms
=8x18000Wh
=144000Wh
Total Annual Energy consumption from lighting for 8 classrooms=weekly consumptionxNo of weeks
=144000x42weeks
= 6048000Wh
Total Annual Energy consumption from lighting for 8 classrooms in Kwh
=6048000/1000
=6048kWh
Saving cost from lighting =6048x3
(Assume Tariff-1unit=Rs3/-) =Rs18144/--①
Energy consumption by fans load per week per classroom
hours x Lights x watts =36 x10 x80
(Assume 1 fan=80wattage) =28800Wh
Energy consumption by fans per week for 8 classrooms
=8x28800Wh
= 230400Wh
Total Annual Energy consumption from fan load for 8 classroom=Energy consumption/weekxno of weeks=230400x42
= 9676800 Wh
Total Annual Energy consumption from lighting for 8 classrooms in Kwh
=9677kWh
Saving cost from fan load =9677x3
=Rs29031/--②
In practice 50% total working hours has been allowed to use hence the cost of saving=50%of the total cost
=Rs14516/-

Total Annual Energy cost saving from both lighting and fan load ①+②
=Rs47175/-----③

If elevator of 900Kg operates for consumes power of average value (Up-and-down) 6Kw
It may operate for Extra load and time of students carrying to the second and third floor
Energy consumed by lifts operating for 3 hours per day
= Elevator Power rating x operating hours = 6000x3
=18000Wh
=18kWh
Energy cost/day (1kWh=Rs3/-) =18x3
=Rs54/-
Annual energy consumption =54x288
=Rs15552/----------④

Net energy saving by changing the class room locations with additional facility of lift operating for limited hours

③-④= Rs (47175-15552)
= Rs31623/-

Note: Investment for elevator is optional therefore the payback period is not estimated

B. Energy Saving By Replacing Water Cooler Operating Switch with Solar Operating Switch

I. Water Cooler: It uses temperature switch work on heater Uses the switch working on temperature

Calculation:

If 1000 W Cooker consumes Electrical Power as long as the power is on then Energy consumed for full day in the conventional type water cooler:

Energy consumption = Power rating of water cooler x operating hours =1000 x 24
= 24000 Wh
=24 kWh
Energy cost per day =24 x 3
=Rs72/-
Annual Energy cost =72x365days
=Rs 26280/----------⑤

C. Switch Solar Water Cooler:

It uses a automated operating on solar radiations based on day hot condition

II.Replaced by Solar Switch Operating Cooler.

If operating up to the sun hot with charging facility for 4 more hours during night between 8 A.M to 8 P.M = 12 hours.

If1000 W Cooler consumes electrical power by solar operating automated switch then Energy consumed for only day in the solar operating automated switch:

=1000 W x 12hrs
= 12000 Wh
= 12 kWh
Energy cost per day =12 x 3
=Rs36/-
Annual Energy cost =36x365days =Rs 13140 /----------⑥
Cost saving due to energy saving ⑤-⑥ =R13140/-
Additional cost for providing solar switch =Rs3000/-
Payback period for providing solar switch =3000/36
=83days

C. Energy Saving By Remote Controlled Fans

I. Remote controlled fans versus conventionally controlled fans

Energy savings by controlled fans and conventionally controlled fans=80w x operating hours (perdayperfan)
=80W x 10 hours/day
=800Wh/day/fan
Energy cost per day per fan =0.8 x 3=2.4/-

Cost of Energy consumption for 290 fans per day =Rs2.4x290
= Rs696/-
Annual Cost of Energy consumption by regulator controlled fans
=Rs696x288days
=Rs 200448 /--⑦

II. Remote Controlled Fans Can Be Operating Based On User Requirement May Reduce The Operating Time.

Let us operate the fans on need basis as remote control is available, it will reduce the operating hours (Assume that the wattage is same) =80W x 7 hr
= 560 Wh/day
=0.56 kWh/day
= 0.56 x 3
= RS1.68/day
Annual Energy consumption by remote controlled fan
= 1.68x290x288
= Rs. 140314 /--⑧
Cost saving ⑦-⑧ = Rs60134/-
Total cost of additional unit remote operating switch
= Rs.400 x290
=Rs174000
Payback period = 174000/60134=2years

D. Energy Saving By Replacing Desktopcomputter By Crt Monitor With Lcd Monitor

Computer with CRT monitor of 400w
Total Number of Systems =190
Total Power consumption = 190 x400
=76000w
=76kW
Total Energy consumption =Power Consumption x operating hours/day
=76 x 8 kWh
=608 kWh
Energy cost/ day =608 x 3
=Rs1824/-
Total Annual energy cost = Energy cost/ day x no of days
=Rs1824x288
=Rs525312-----⑨
Computer with desktop LCD monitor of 250w
Total Power consumption =190 x 250
=475000watts
=47.5 kW
Total Energy consumption per day =47.5 x 8hours
=380 kWh
Energy Cost/day =380 x 3
= Rs1140/-
Total Annual Energy Cost =Rs1140x288days
=Rs328320-----⑩
Annual Cost Saving ⑨-⑩ =Rs196992/-

E. Energy Saving By Replacing Desktop Lcd Monitor With Laptop

I. LAPTOP power consumption =40 W
Power consumption by replacing all desktop LCD monitor with laptop= 190computers x 40 watts each
=7600 w
=7600/1000
=7.6kw
Energy consumption /day with 8 hours operating =7.6 x 8
=60.8 kWh
Energy cost /day =Rs60.8 x 3
=Rs183/-
Energy cost per month =183 x 24

=Rs4392/-
Annual energy cost =4392x12
=Rs52704/-11
Cost Saving (10-11) = Rs328320-52704 =Rs 275616/---------12
Cost Of Computer =Rs 20000/- to 23000/-
Cost Of Laptop = Rs 30000/-to 40000/-
Extra Cost Of Replacement =Rs 7000/ System
Replacing All = Rs 7000 X 190
=Rs 1330000/------13
Payback period (13/12) = 4.8 year
58months

III. Additional Energy Save By Keep On All Systems Only When It Is Used Or Avoid Using The System In Sleepy Mode

Keep all the system in sleep mode during non operationg hours. Let systems are used effectively for 6 hours a day.

The duration of average sleeping mode=2 hours/system
Thus the power consumed by systems during sleeping mode
=190 x 2 hrs
(LCD monitor desktop) =380 hrs
Energy consumed by sleeping mode computer/day=11400Wh
Energy in kWh/day =11400/1000
=11.4 kWh
Cost /day =11.4 X3
=Rs34/-
Cost of Energy consumption/month =Rs34 x 24 day
=Rs816/-
Annual cost of energy = Rs816/-x12months
=Rs9792

As we use the laptop based on the charged facility as well as practice to use only when required by default the energy cost same will be added to the laptop facility
Net cost of saving by replacing all desktop LCD computers with LAPTOP
=Rs (275616+9792)
=Rs 285408/-
Net payable period for replacing all desktop systeswithlaptop
=Rs1330000/285408
=4.6years
=56months

F. Energy Saving By Operating The Photocopier Machine Only When Required Or Avoiding Using Machine In The Sleepy Mode Which Consume The Energy As Follows

Power Consumption of Xerox M/C in Non Operating Mode
= 1x100W
Energy Saving for Approximate Sleepy Mode Hours For 2hours In A Day
=100W x 2hr/day
= 200Wh/Day
Energy in kWh = 200/1000
= 0.2kWh/day
Energy for a Month = 0.2kWh x 24days
=4.8kWh
=4.8 Units
Monthly Energy Cost =4.8x 3
=Rs14.4/-
Annual Energy Cost Saving = Rs14.4x12
=Rs 173/--14

G. Energy Saving By Implementing All Staff/Employees Touse Centralized Communication System

No of Employees in the Organization =300
Power Consumption by Mobile Charger =20W
Total Power Consumption by Mobile Charger
= No of Employees X Wattage of Each Charger
Phone Charger Operating For 3 Hours Approximately All Together in a Day.
Energy Consumption in A Day = 300 x3x20
=18000 Wh
=18kWh
Energy Consumption Cost/Day =18 x 3
= Rs54 /-
Monthly Energy Consumption Cost = Rs54 x 24
Monthly Energy Consumption Cost = 1296 /-
Annual Energy Consumption Cost =Rs1296 x12
=Rs15552/---------15

If Mobiles Are Banned To Use by Providing Common Facility, Then Power Pack Along With Cordless Telephone Set Has To Used
Tele Phone Power Pack Power Consumption =10 W
No of Tele Phone Power Packs Required Will Be Based On the Number of Cordless Telephone We Use
= 6(2 Set To Each Floor)
Total Power Consumption =6 x10W
=600 W
Operating Time =10 Hours
Energy Consumed /Day =600 x 10
=6000 Wh
Energy Consumed /Day in Kwh =6 Kwh
Annual Energy Cost =6 x 3x288
= Rs5184/--16
Cost saving (15-16) - Rs (15552-5184)=Rs10368/-
Payback period calculation:-
Cost Of Power Pack =Rs500 x 6
=3000 /-
Payback period= 3000/10368 = 3months

H. Energy Saving By Replacing All Fluorescent Lamps by Cfl

I. Energy Saving Cost Estimation of FL

Total no. of F lamps = 266
Actual wattage of FL inclusive of choke =50W
Energy consumed by FL for an operating of 12 hour per day
=266x50x12
= 159600 watt-hours
Energy consumed by FL for an operating of 12 hour per month
= 159600 x24 working days
= 3830400 Wh
=3830.4kWh
Monthly Energy consumed cost by FL=Rs3830.4x3
=Rs11491/-
Annual Energy Consumed cost by FL=Rs11491x12
=Rs137894/--17

II.ENERGY SAVING BY REPLACING THE CFL OF EQUAL SIMILARITIES OF FLUROSCENT LAMP
13 watt CFL can give an illumination o/p =800 lumens
40 watt FL can give an illumination o/p =2400 lumens
Therefore Number of 13 watts of C FL required to get the illumination level of 2400 lumens = 3
45watts of CFL=50watts of FL in terms of illumination output (The actual wattage of 13 watt CFL=15 watt inclusive of choke)
Total power consumption by CFL =15X3
=45watts

Hence the total wattage of FL = 266 x 50watts
=13300 watts
Number of CFL required to replace all FL @ the rate of
13 watts x3, 39wattsCFL=50watts FL. =13300/39watts
=295
Power saving by CFL replacement = 295 x11 watts
=3245 watts
Energy consumption from CFL for an operated average hour/day for 12 hours =3245watts x12 hours
= 38940Wh
Daily cost of energy consumption by CFL =39x3kWh
Saving Cost of energy /day = Rs.117/-
Monthly Energy cost saving due to CFL = Rs. 117x 24 days
=Rs2808/-
Annual Energy cost saving 2808x12 =Rs33696/-

Payback Period Calculation:-
Investment on 1 CFL of 13 watts = Rs90/-
Total cost of replacement =Rs295 x 90
= Rs26550/-
Payback Period = 26550 / 33696
=9 months 11days
Formula used:

$$\text{Number of fittings required} = \frac{\text{E} \times \text{A}}{\text{O} \times \text{UF} \times \text{MF}}$$

Where N=Number of fittings required
E=Required illumination (lux)
A=working area (sqmtr)
O=Luminous flux produced per lamp (lumens),
UF=Utilization factor
MF=Maintenance factor

I. REPLACING LASER PRINTER BY INKJET PRINTER
Number of printers to be replaced =12
I. Energy and Cost Saving Calculation for Laser Printers
Power consumption by Laser printer = 12x150 watts
Power Consumption by Laser printers =1800W
Normalized operating hour -8 hr in a day
Energy consumed /day =1800watts x8hours
=14400Wh
(1 kWh=1unit) =14.4units
Energy cost /day =14.4X3
=Rs43.2/-
Energy cost per month for 24 working day =43.2 x 2
=Rs1036.8/-
Annual Energy cost =Rs1036.8x12
=Rs12442/-------18
II.Energy and cost saving calculation for inkjet printers

Power consumption by inkjet printers =12x80
=960watts
Normalized operating hour -8 hr
Energy consumption /day =960x8
=7680Wh
Energy consumption in kWh/day =7680/1000
=7.6kWh
Daily Cost of energy consumption =7.68x3
=Rs23.04/-
Monthly cost of Energy consumption for 24 working days in a month
=23.04x24
=Rs552/-

Annual cost of Energy consumption =Rs552x12
=Rs 6624/--------19
Annual energy cost saving (18-19) = Rs 12442 – 6624
=Rs5818/-

A Typical Summary Of Energy Expenses Based On <u>Monthly and Annual</u> Utility Bills

Energy Auditing Of Jawaharlal College Of Engineering And Technology, Lakkidi, Palakkad District, Kerala, India

Mode of energy saving	Cost to be saved in Rupees	Investment in Rupees	Payback period	feasibility
Replacing Fluorescent Lamps By CFL	33696	26550	9 months	Technically & Economicall y feasible
Replacement Of Laser Printer By Inkjet Printer	5818	Nil	Nil	Technically feasible
changing the location of class rooms	31625	Nil	Nil	Technically feasible
Using solar operating water cooler	13140	3000	83days	Technically feasible
Using remote controlled fans	60134	174000	2years	Technically & economicall y feasible
Replacing desktop crtcomputer with lcd monitor	196992	133000	58months	Technically & economicall y feasible
Replacing LCD Desktop with LA PTOP	285408	133000	56months	Technically feasible
Replacing CRT monitor with LCD monitor	196992	5700000/-	5 years	Technically feasible
Operating the photocopier machine in active mode	180/-	Nil	Nil	Technically feasible
Centralized Communication System	5184/-	9000/-	3months	Technically feasible

ANNEXURE-1

Energy Auditing: Office Equipment

Note: SL = Sleep Mode, ST = Standby, OP = In Operation, SR = Surge

Equipment	Wattage	Comments
ADSL Modem Power pack	OP 10-20W	In most offices and many households, this represents a relatively small but continuous load as the modem operates 24 hours a day.
CRT Monitor	OP 100-120W	CRT monitors consume a lot of power, much of which is wasted as heat, and represent the largest power consumption component in a typical desktop computer. Emit potentially harmful radiation. Fortunately, most CRT monitors these days

		are legacy equipment as new computers are generally supplied with LCD monitors. Unfortunately, most CRT monitors end up in landfill.
Desktop Computer	OP 150W	Power consumption will differ significantly depending on whether a CRT or LCD monitor is used. In home and office situations where it is necessary to run multiple desktop computers, it may be possible to make significant power savings by running a single terminal server computer with several LCD monitors and keyboards attached. Terminal server computers can also greatly simplify network management, software upgrades, etc.
Fax Machine	ST 10-30W OP 100W	Fax machines generally sit idle most of the time, so stand-by power consumption is the biggest factor in their overall energy consumption. Thermal fax machines and inkjet fax machines have a stand-by power consumption of around 10W to 20 W, while laser faxes have a stand-by power consumption of around 30W. Thermal fax machines are generally cheaper to purchase, but thermal paper costs a significantly more than plain paper, is not recyclable, and must be photocopied for long term storage.
Inkjet Printer	OP 120W	Inkjet printers use relatively little power in comparison to laser printers. From an energy consumption point of view, inkjets are preferable to lasers. Unfortunately, they typically cost more to run on a cost-per-print basis and sometimes produce less than optimum results.
Laptop Computer	OP 15-40W	Laptop computer power consumption is typically 10% to 25% of that of a desktop computer. In situations such as an office or home office, where computers may operate for 8 to 10 hours a day, this difference is significant and could represent an energy saving of up to 1kWh per day.
Laser Printer	ST 25-80W OP 150-1100W	Laser printers consume significant amounts of power even when in standby mode. Over the course of an 8 - 10 hr working day, a laser printer could consume around 1kWh of energy. On the other hand, laser printers are cheaper to run on a cost-per-page basis and generally produce better results. Both the number of laser printers used, and the number of hours the are operated for, should be minimized. As with printing of any kind, office procedures should be developed which minimize the need for printing to paper.
LCD Monitor	OP 30-50W	LCD monitors typically require about 30% of the power required for a CRT monitor with the same screen area. In addition, the amount of heat generated by an LCD monitor is considerably less than a CRT monitor, resulting in a lower load on air conditioning. Building cooling needs may be decreased by up to 20%.
Mobile Phone Charger	OP 10-20W	Most of the mobile charger consumes power during charging.
Photo copier	SM 7-30W ST 40-300W OP 200-1300W	Most of the energy used in a photocopier is consumed by the hot rollers, which are usually kept hot on stand-bay, consuming from 40 to 300W. Significant energy savings (40% to 60%) can be made by ensuring that photocopiers are switched off at night and on weekends. Some photocopiers consume up to 30 watts even when switched off, so photocopiers should be switched off at the power outlet to ensure they are really "off".
Tele phone Power pack	OP 10W	Many landline telephones today (eg. portable/wireless phones) use power packs, which represent a relatively small but continuous load as the telephone operates 24 hours a day. If possible, this type of telephone should be avoided.

ANNEXURE-2

Light Level Recommendations in LUX

Stairways and corridors	150 - 300
Storage rooms	100 - 500
General Classrooms	250 - 550
General Offices	300 - 750
Restrooms/toilet rooms	150 - 300
Gymnasiums general exercise basketball	 300 - 400 750 - 1000
Auditoriums and assembly rooms	100 - 200
Library	300 - 500
Maintenance room	300
Science laboratory	300 - 500
Woodworking shop	300 - 750
Office Landscapes	500 - 750
Public areas with dark surroundings	20 - 50
Simple orientation for short visits	50 - 100
Warehouses, Theaters, Archives	150
roceries, Show Rooms, Laboratories	300 - 500
Supermarkets, Mechanical Workshops	500 - 750
Normal Drawing Work, Detailed Mechanical Workshops, Operation Theatres	1,000
)etailed Drawing Work, Highly)etailed Mechanical Works	1500 - 2000
Performance of visual tasks of low contrast and very small size for prolonged periods of time	2000 - 5000
Performance of very prolonged and exacting visual tasks	5000 - 10000
Performance of very special visual tasks of extremely low contrast and small size	10000 – 20000

XII. Conclusion

The Proposed project gives strong warning to the consumer not only interms of the energy bills also the energy crisis in the near future to all sectors of people and in this project the recommendations reduces the around 15-20% of the energy and 25-30% of cost reduction excluding some issues takes more payback period and some are economically not fit will also be taken in to account in a long run. There is a scope of improvement to include the advanced lighting scheme to reduce further 10% of the cost.

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References

[1] Utilization of Electric power by N.V.Surya Narayana.New age international publishers.
[2] Utilization of Electrical power byR.K.Rajput.New age international publishers
[3] Designing with Light- A lighting Handbook - Anil Walia-International Lighting Academy
[4] Handbook of Functional requirements on Industrial Buildings-SP-32- Bureau of Indian Standards
[5] Efficient Use of Electricity In Industries- Devki Energy Consultancies Pvt. Ltd., Vadodara
[6] Websites/Product Information CDs of the following manufacturers:

I. Crompton Greaves Lighting Division
II. Bajaj Electricals
III. GE lighting, USA
IV. Watt Stopper Inc, USA
V. Vergola India Ltd
VI. Lighting research centre, USA
VII. LBNL , USA

[7] Free guide to achieving financial success as an energy auditor by Energy audit Institute-USA.
[8] working manual on energy auditing by the asian productivity organization(apo) and national productivity council (npc) in new delhi, india, conducted in 2007,