Energy Audit Report On a Technical Institute

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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)
Energy efficient devices
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. Also 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 radiation 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 10000 volts 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 possibility of electrical short circuit. Common communication facility may lead to harmony among employes 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 = 12.19 x 16.53sqm
Store measuring = 12.19 x 9.14sqm

II. Ground Floor: Total built up area= 1433.36sqm
Office1 measuring = 12.10 x 16.38sqm
Office-2 measuring = 12.19 x 9.14sqm
CAD lab measuring = 12.19 x 9.14sqm
Computer lab: measuring = 12.19 x 21.49sqm
Principal measuring = 29.6 x 16 feet
Staff room-1 measuring = 12.19 x 8.13sqm
Ladies rest room measuring = 12.10 x 8.23sqm

Administrative office: Total area= 1433.36sqm or 15423sqft
Establishment / account sector-OFFICE-1
Office-2: measuring = 12.19 x 16.38sqm
Principal Room - 1: Total area = 10sqm 290 x 160 sqft

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 = 1898.23 sqmtr
Library measuring = 12.19 x 38.10 sqm.
Ups room = 4.58 x 4.38 sqm
CR – 1 to 4 measuring = 12.19 x 9.14 sqm
Toilet – 1 & 2 measuring = 4.48 x 7.06 sqm
Chemistry Lab – 1 measuring = 12.19 x 16.38 sqm
Electronics Lab 1 & 2 measuring = 12.19 x 16.38 sqm
Board room measuring = 9 x 4.56 sqm

IV. Second Floor: Total Built Up Area 21580 sqft or 2005.57 sqm
Seminar Hall / Auditorium measuring 12.19 x 38.10 sqm,
Class room 1, 2&3&4 AREA = 12.19 x 9.14 each,
Electronics Lab – 1 & 2 = 12.19 x 16.38

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:
2nd floor and 3rd floor class rooms 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 = 6hrs x 6days (excluding labs 6hrs/week) = 36 hrs
Energy consumption/week/classroom
Hours x Lights x Watts = 36 x 10 x 50
= 18000 Wh
Energy consumption per week for 8 classrooms = 8 x 18000 Wh
= 144000 Wh
Total Annual Energy consumption from lighting for 8 classrooms = weekly consumption x No of weeks
= 144000 x 42 weeks
= 6048000 Wh
Total Annual Energy consumption from lighting for 8 classrooms in Kwh
= 6048000 / 1000
= 6048 Kwh
Saving cost from lighting = 6048 x 3
(Assume Tariff-1 unit = Rs3/-) = Rs 18144/-

Energy consumption by fans load per week per classroom
hours x Lights x watts = 36 x 10 x 80
(Assume 1 fan = 80 wattage)
= 28800 Wh
Energy consumption by fans per week for 8 classrooms
= 8 x 28800 Wh
= 230400 Wh
Total Annual Energy consumption from fan load for 8 classroom = Energy consumption/week x no of weeks
= 230400 x 42
= 9676800 Wh
Total Annual Energy consumption from lighting for 8 classrooms in Kwh
= 9677 Kwh
Saving cost from fan load
= 9677 x 3
= Rs 29031/-

In practice 50% total working hours has been allowed to use hence the cost of saving = 50% of the total cost
= Rs 14516/-
Total Annual Energy cost saving from both lighting and fan load \( \text{Rs}\, 47,175/- \)

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
\[ \text{Elevator Power rating} \times \text{operating hours} = 6000 \times 3 = 18,000 \text{Wh} = 18 \text{kWh} \]

Energy cost/day (1kWh=Rs3/-)
\[ = 18 \times 3 = \text{Rs} 54/- \]

Annual energy consumption
\[ = 54 \times 288 = \text{Rs} 15,552/- \]

Net energy saving by changing the class room locations with additional facility of lift operating for limited hours
\[ \text{Rs} (47,175 - 15,552) = \text{Rs} 31,623/- \]

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 \( \times \) operating hours
\[ = 1000 \times 24 \text{ Wh} = 24 \text{kWh} \]

Energy cost per day
\[ = 24 \times 3 = \text{Rs} 72/- \]

Annual Energy cost
\[ = 72 \times 365 \text{ days} = \text{Rs} 26,280/- \]

Cost saving due to energy saving \[ \text{Rs} (47,175 - 15,552) = \text{Rs} 31,623/- \]

**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.
If 1000 W Cooler consumes electrical power by solar operating automated switch then Energy consumed for only day in the solar operating automated switch:
\[ = 1000 \times 12 \text{ hrs} = 12,000 \text{ Wh} = 12 \text{ kWh} \]

Energy cost per day
\[ = 12 \times 3 = \text{Rs} 36/- \]

Annual Energy cost
\[ = 36 \times 365 \text{ days} = \text{Rs} 13,140/- \]

Cost saving due to energy saving \[ \text{Rs} (47,175 - 15,552) = \text{Rs} 31,623/- \]

Additional cost for providing solar switch
\[ = \text{Rs} 3,000/- \]

Payback period for providing solar switch
\[ = 3,000/36 = 83 \text{ days} \]

**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 \( \times \) operating hours (per day per fan)
\[ = 80 \times 10 \text{ hours/day} = 800 \text{ Wh/day/fan} \]

Energy cost per day per fan
\[ = 0.8 \times 3 = 2.4/\text{-} \]
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Cost of Energy consumption for 290 fans per day =Rs2.4x290 =Rs696/-
Annual Cost of Energy consumption by regulator controlled fans =Rs696x288days =Rs 200448/-

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/-

Cost saving = Rs60134/-
Total cost of additional unit remote operating switch = Rs.400 x290
=Rs17400
Payback period = 174000/60134=2years

D. Energy Saving By Replacing Desktopcomputer 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-----®

Computer with desktop LCD monitor of 250w
Total Power consumption =190 x 250
=475000watts
=47.5 kW

Total Energy consumption per day
=380 kWh

Energy Cost/day
=380 x 3
= Rs1140/-

Total Annual Energy Cost
=Rs1140x288days
=Rs328320-----®

Annual Cost Saving =Rs196992/-

E. Energy Saving By Replacing Desktop Lcd Monitor With Laptop

1. LAPTOP power consumption =40 W

Power consumption by replacing all desktop LCD monitor with laptop= 190computers x 40 watts each
=7600w
=7600/1000
=7.6kw

Energy consumption /day with 8 hours operating
= 7.6 x 8
=60.8 kWh

Energy cost /day
=Rs183/-

Energy cost per month
=183 x 24
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Annual energy cost

=Rs4392/-
=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
=380 hrs
(LCD monitor desktop)
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 systems with laptop
=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/-
G. Energy Saving By Implementing All Staff/Employees To Use 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 x 3 x 20 = 18000 Wh = 18kWh
Energy Consumption Cost/Day = 18 x 3 = Rs54 /
Monthly Energy Consumption Cost = Rs54 x 24 = 1296 /
Annual Energy Consumption Cost = Rs1296 x 12 = 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 x 10W = 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 3 x 288 = Rs5184/-
Cost saving (15-16) - Rs (15552-5184) = Rs10368/-
Payback period calculation:-
Cost Of Power Pack = Rs500 x 6 = 3000 /
Payback period = 3000/10368 = 3 months

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 = 266 x 50 x 12 = 159600 watt-hours
Energy consumed by FL for an operating of 12 hour per month = 159600 x 24 working days = 3830400 Wh = 3830.4kWh
Monthly Energy consumed cost by FL = Rs3830.4 x 3 = Rs11491/-
Annual Energy Consumed cost by FL = Rs11491 x 12 = Rs137894/-

II. ENERGY SAVING BY REPLACING THE CFL OF EQUAL SIMILARITIES OF FLUORESCENT 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
45 watts of CFL = 50 watts of FL in terms of illumination output (The actual wattage of 13 watt CFL = 15 watt inclusive of choke)

Total power consumption by CFL = 15 x 3 = 45 watts
Hence the total wattage of FL = 266 x 50 watts = 13300 watts
Number of CFL required to replace all FL @ the rate of 13 watts x3, 39 watts CFL = 50 watts FL.
= 295
Power saving by CFL replacement = 295 x 11 watts = 3245 watts
Energy consumption from CFL for an operated average hour/day for 12 hours = 3245 watts x 12 hours = 38940 Wh
Daily cost of energy consumption by CFL = 39 x 3 kWh
Saving Cost of energy /day = Rs. 117/-
Monthly Energy cost saving due to CFL = Rs. 117 x 24 days = Rs 2808/-
Annual Energy cost saving 2808 x 12 = Rs 33696/-

Payback Period Calculation:-
Investment on 1 CFL of 13 watts = Rs 90/-
Total cost of replacement = Rs 295 x 90 = Rs 26550/-
Payback Period = 26550 /
Formula used:
Number of fittings required = \( \frac{E \times A}{O \times UF \times MF} \)

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 = 12 x 150 watts
Power Consumption by Laser printers = 1800 W
Normalized operating hour -8 hr in a day
Energy consumed /day = 1800 watts x 8 hours = 14400 Wh = 14.4 units
Energy cost /day = 14.4 x 3 = Rs 43.2/-
Energy cost per month for 24 working days = 43.2 x 2 = Rs 1036.8/-
Annual Energy cost = Rs 1036.8 x 12 = Rs 12442/-

II. Energy and cost saving calculation for inkjet printers
Power consumption by inkjet printers = 12 x 80 = 960 watts
Normalized operating hour -8 hr
Energy consumption /day = 960 x 8 = 7680 Wh
Energy consumption in kWh/day = 7680/1000 = 7.6 kWh
Daily Cost of energy consumption = 7.68 x 3 = Rs 23.04/-
Monthly cost of Energy consumption for 24 working days in a month = 23.04 x 24 = Rs 552/-
Annual cost of Energy consumption = Rs552 x 12
=Rs 6624/-
Annual energy cost saving (18-19) = Rs 12442 – 6624
=Rs5818/-

A Typical Summary Of Energy Expenses Based On Monthly and Annual Utility Bills

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

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

ANNEXURE-1

Energy Auditing: Office Equipment
Note: SL = Sleep Mode, ST = Standby, OP = In Operation, SR = Surge

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Wattage</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADSL Modem Power pack</td>
<td>OP 10-20W</td>
<td>In most offices and many households, this represents a relatively small but continuous load as the modem operates 24 hours a day.</td>
</tr>
<tr>
<td>CRT Monitor</td>
<td>OP 100-120W</td>
<td>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</td>
</tr>
</tbody>
</table>
are legacy equipment as new computers are generally supplied with LCD monitors. Unfortunately, most CRT monitors end up in landfill.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>OP</th>
<th>Power Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop Computer</td>
<td>150W</td>
<td>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.</td>
</tr>
<tr>
<td>Fax Machine</td>
<td>ST 10-30W</td>
<td>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.</td>
</tr>
<tr>
<td>Inkjet Printer</td>
<td>OP 120W</td>
<td>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.</td>
</tr>
<tr>
<td>Laptop Computer</td>
<td>OP 15-40W</td>
<td>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.</td>
</tr>
<tr>
<td>Laser Printer</td>
<td>ST 25-80W</td>
<td>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.</td>
</tr>
<tr>
<td>LCD Monitor</td>
<td>OP 30-50W</td>
<td>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%.</td>
</tr>
<tr>
<td>Mobile Phone Charger</td>
<td>OP 10-20W</td>
<td>Most of the mobile charger consumes power during charging.</td>
</tr>
<tr>
<td>Photocopyer</td>
<td>SM 7-30W</td>
<td>Most of the energy used in a photocopyer 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 &quot;off&quot;.</td>
</tr>
<tr>
<td>Telephone Power Pack</td>
<td>OP 10W</td>
<td>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.</td>
</tr>
</tbody>
</table>
Energy Audit Report On a Technical Institute

Light Level Recommendations in LUX

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

XII. Conclusion

The Proposed project gives strong warning to the consumer not only in terms 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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I also thank my wife and daughter for their encouragement to complete this assignment.

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[6] Websites/Product Information CDs of the following manufacturers:
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   III. GE lighting, USA
   IV. Watt Stopper Inc, USA
   V. Vergola India Ltd
   VI. Lighting research centre, USA
   VII. LBNL, USA
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[8] working manual on energy auditing by the asian productivity organization(apo) and national productivity council (npc) in new delhi, india, conducted in 2007,