# Grenada Capacity Building Programme for Energy Management and Energy Audits

## Webinar III : **Save Energy, Save Money**

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***Target audience:*** *Training institutions, government ministries and statutory organisations*

Date: 21- 21 April 2022
Time: 9:00 am to 12:00 pm Grenada Time

# Content

- **Day-2: Energy Efficiency Measures & Financial Planning**
  - *Review of Energy Use*
  - *Activities to do During Site Assessment*
  - *Identification of Energy Conservation Measures*
  - *Energy Saving Calculations*
  - *Financial Viability of The Project*
  - *Energy Audit Report Format*
  - *Q&A*

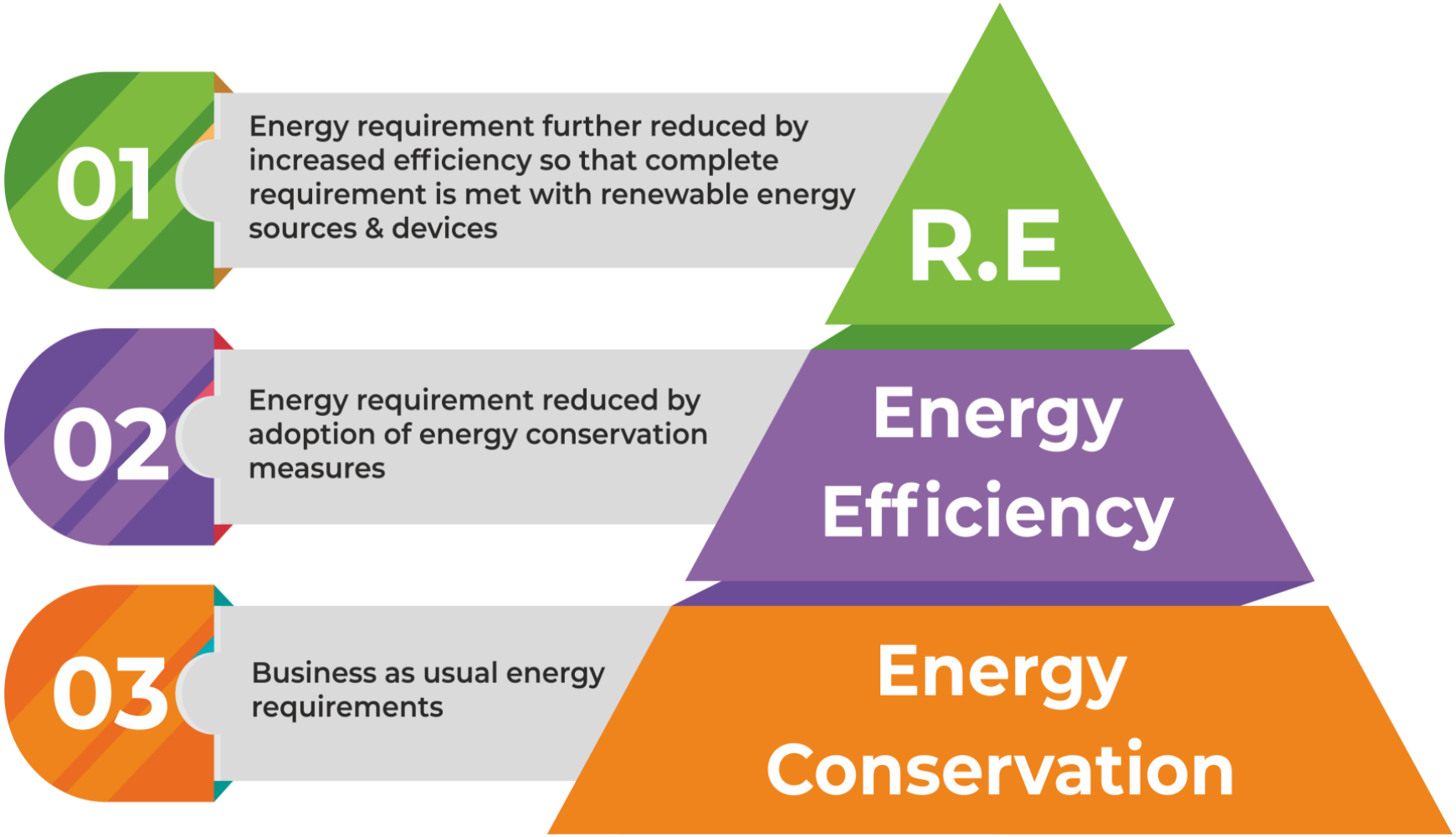
# Recap From Day-1

# Energy Efficiency v/s Energy Conservation

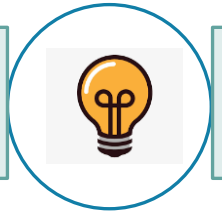
Energy efficiency is **“using less energy to provide the same service”** through technology upgradation.

Energy conservation is any **“behavior change that results in the use of less energy”** to do same work**.**

# Energy Pyramid - Approach



# 5 T's for Energy Conservation

| | | |
|---|---|---|
| Turn it **OFF** |  | Turn OFF/ Unplug the appliances from switchboard after using. |
| Turn it **DOWN** |  | Turning down the temperature of heating appliances |
| Turn it **UP** |   | Increase the thermostat temperature of cooling appliances |
| Turn it **AROUND** |   | Look around and use appliances efficiently. |
| Turn it **OUT** |  | Replace old inefficient devices with new energy efficient devices. |

# Question…??

1. Who will consume more power

**Heating Appliances**

**Cooling Appliances**

Water Kettle = 1200 Watts

Bread Toaster = 850 Watts

Refrigerator = 120 Watts

# Need of Energy Audit

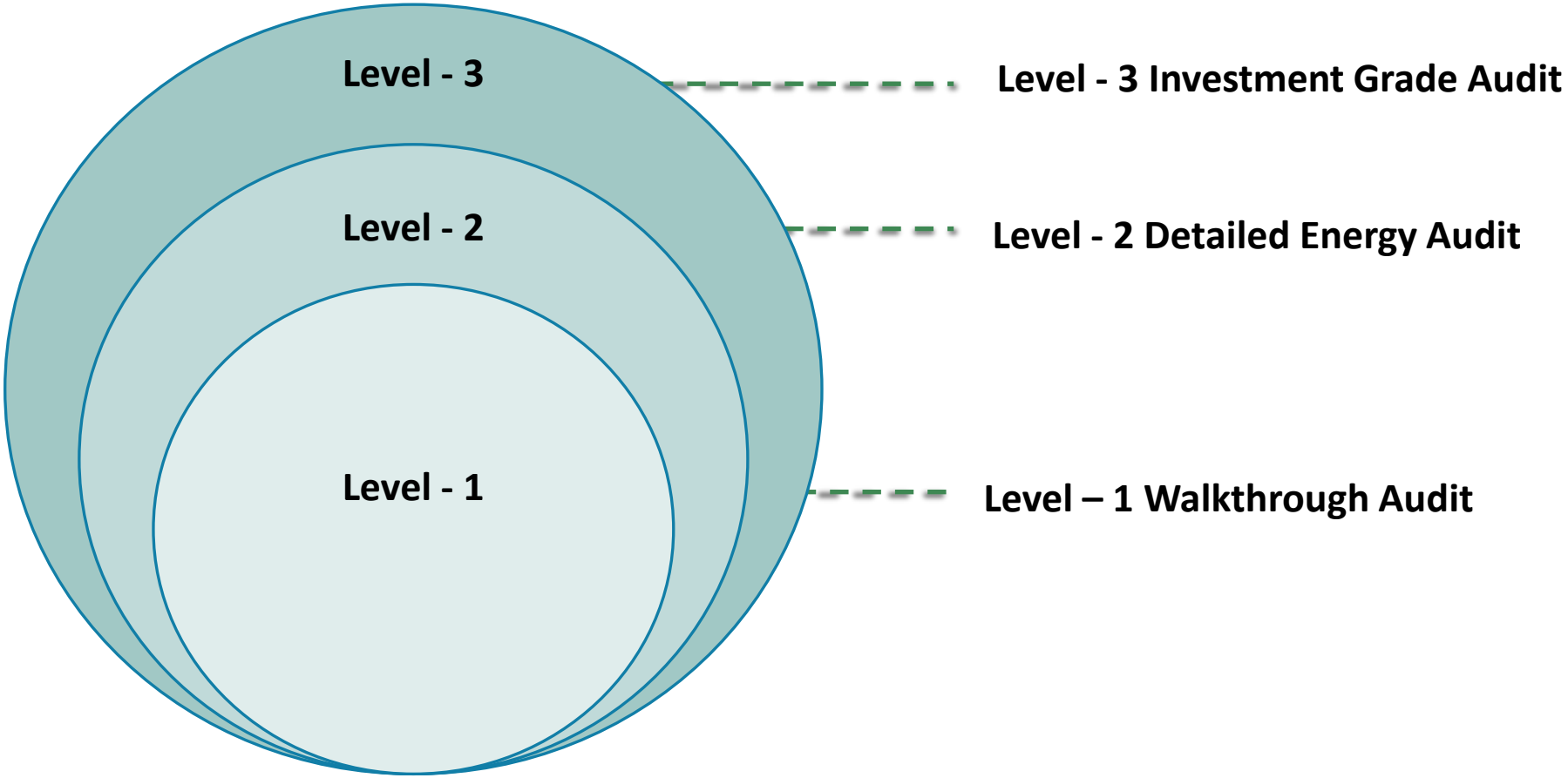
## An energy audit will

- Help to understand how energy (both electrical and thermal) are used
- Identify where waste occurs and where there is a scope of improvement

## Stages of Energy Audit

# Types of Energy Audit

Based on the methodology, Energy Audit can be categorized into three types



# Energy Audit Instruments

- To conserve energy, it is necessary to know where & how much energy is being consumed.
- Hence, Instruments Play a vital role in energy audit to characterize and quantify energy.
- Instruments also provide a means to monitor equipment performance and check condition
- Various categories of portable energy audit instruments are

**Thermal** | **Mechanical** | **Chemical**

**Electrical** | **Lighting**

# Example: Energy Consumption By Different Home Appliances

| Appliances | Number | Rated Watts (W) | Operating Hours Per Day | Daily Energy Consumption (kWh/Day) | Operating Days Per Year | Annual Energy Consumption (kWh/Year) |
|---|---|---|---|---|---|---|
| LED Lamp | 3 | 28 | 10 | 0.84 | 365 | 306.6 |
| Ceiling Fan | 2 | 75 | 13 | | 365 | |
| Refrigerator | 1 | 120 | 24 | | 365 | |
| Water Heater | 1 | 3000 | 4 | | 90 | |
| Water Pump | 1 | 150 | 2 | | 365 | |

$$\text{Energy Consumption Per Day (kWh/Day)} = \frac{\text{Number of Appliances} \times \text{Rated Input Power (W)} \times \text{Operating Hour Per Day (Hrs.)}}{1000}$$

$$\text{Energy Consumption Per Year (kWh/Year)} = \text{Energy Consumption Per Day (kWh/Day)} \times \text{Operating Days in a Year}$$

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|---|---|---|---|---|---|---|
| LED Lamp | 3 | 28 | 10 | **0.84** | 365 | **306.6** |
| Ceiling Fan | 2 | 75 | 13 | **1.95** | 365 | **711.7** |
| Refrigerator | 1 | 120 | 24 | **2.88** | 365 | **1051.2** |
| Water Heater | 1 | 3000 | 4 | **12** | 90 | **1080.0** |
| Water Pump | 1 | 150 | 2 | **0.30** | 365 | **109.5** |

# Sample Calculation : I

To help students at training institution realize that conscious effort helps in conserving energy

**Practice**

- ☞ Make a list of equipment's/ appliances / gadgets used in the Training Institution;
- ☞Find out the wattage of each;
- ☞Find out the electric consumption of each;
- ☞Find out the number of hours each in used per day;
- ☞Find the rate of electricity per unit from the institution electricity bill;
- ☞Calculate the electricity consumed per day by each and the cost incurred.

# Sample Calculation : I

| Appliance / Gadget | Number | Number of hours | Total energy per day | Total energy per month | Cost, ECD |
|---|---|---|---|---|---|
| Tube Light (28W) | 8 | 10 | | | |
| Computer (150W) | 6 | 6 | | | |
| Printer (120W) | 2 | 3 | | | |
| Ceiling Fan (75W) | 10 | 12 | | | |

$$\text{Energy Consumption Per Day (kWh/Day)} = \frac{\text{Number of Appliances} \times \text{Rated Input Power (W)} \times \text{Operating Hour Per Day (Hrs.)}}{1000}$$

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**Number of Days in a month : 30**
**Per Unit Electricity Cost: 0.78 EC$/kWh**

# Sample Calculation : I

| Appliance / Gadget | Number | Number of hours | Total energy per day | Total energy per month | Cost, ECD |
|---|---|---|---|---|---|
| Tube Light (28W) | 8 | 10 | **2.24** | **67.2** | **52.4** |
| Computer (150W) | 6 | 6 | **5.40** | **162.0** | **126.3** |
| Printer (120W) | 2 | 3 | **0.72** | **21.6** | **16.8** |
| Ceiling Fan (75W) | 10 | 12 | **9.75** | **292.5** | **228.1** |

$$\text{Energy Consumption Per Day (kWh/Day)} = \frac{\text{Number of Appliances} \times \text{Rated Input Power (W)} \times \text{Operating Hour Per Day (Hrs.)}}{1000}$$

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**Number of Days in a month : 30**
**Per Unit Electricity Cost: 0.78 EC$/kWh**

# Sample Calculation : II

A fuel-efficient vehicle will cover more distance and hence not only conserve energy but also helps in reducing air pollution

**Practice**

- ☞ Observe the odometer reading of 2-3 common cars/Pick-ups in use under Ministry;
- ☞ Note the odometer reading when the fuel tank is filled up;
- ☞ Note the reading again when the tank needs to be filled up again;
- ☞ Note the quantity of fuel required to fill the tank;

| Vehicle | Odometer reading when tank is being filled (a) | Odometer reading when tank needs to be filled (b) | Distance covered C = b - a | Quantity of fuel required to fill tank (fuel required to cover distance) (d) | Fuel Efficiency E = c/d |
|---|---|---|---|---|---|
| Car : Model 1 | 8,723 | 9,000 | | 50 | |
| Car : Model 2 | 8,723 | 9,000 | | 80 | |
| Pick-up : Model 1 | 8,723 | 9,000 | | 40 | |
| Pick-up : Model 2 | 8,723 | 9,000 | | 45 | |

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|---|---|---|---|---|---|
| Car : Model 1 | 8,723 | 9,000 | **277** | 50 | **5.54** |
| Car : Model 2 | 8,723 | 9,000 | **277** | 80 | **3.46** |
| Pick-up : Model 1 | 8,723 | 9,000 | **277** | 40 | **6.92** |
| Pick-up : Model 2 | 8,723 | 9,000 | **277** | 45 | **6.15** |

# Day - 2

# Session II

# Review of Energy Use and Site Assessment

# Preliminary Review of Energy Use

Preliminary evaluation of energy use is important to know

- Energy End Use
- Yearly or Seasonal Variation in Power Consumption
- Energy Utilization Index (EUI) of Buildings
- Specific Energy Consumption (SEC) in Manufacturing Industries

$$EUI = \frac{Annual\ Energy\ Use}{Square\ Footage}$$

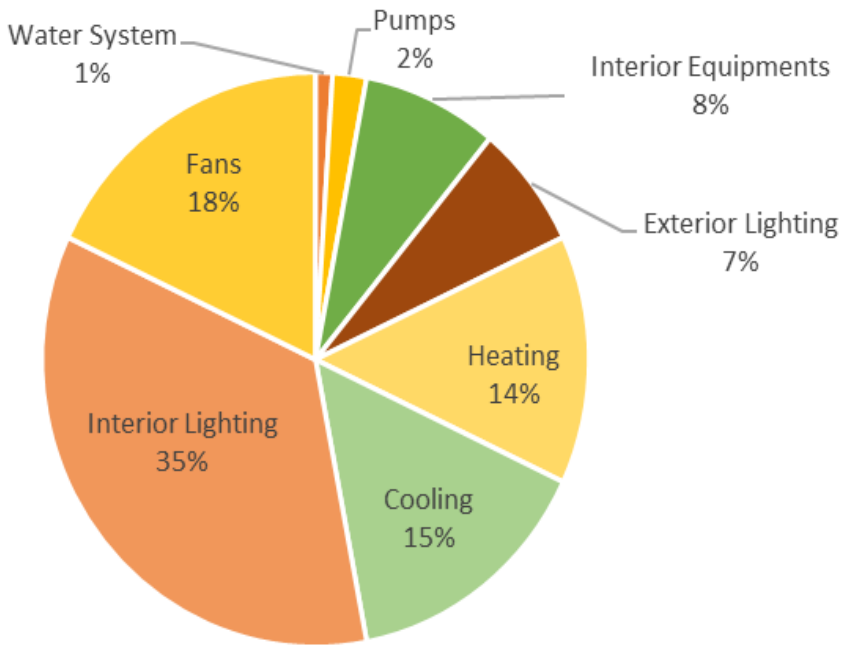
$$SEC = \frac{Annual\ Energy\ Use}{Annual\ Production}$$

**EUI and SEC** would help to **benchmark** the data against energy use in similar buildings or industries. This also helps to find the potential magnitude of **energy efficiency opportunities** and provide an early estimate of potential savings

# Preliminary Review of Energy Use

Information required for preliminary review of energy use

- Monthly Utility Bill
- Building or System Schematics
- Equipment Lists
- Other Relevant Information's




Monthly utility bill would help to identify any changes in energy use over time and potential causes for those changes

# Site Assessment

- After the preliminary review, the energy auditor will conduct a physical assessment of facility and its operations.
- The energy auditor will meet with key operations and maintenance staff to know about equipment performance and discuss any concerns or issues with the facility

| On-Site Survey | |
|---|---|
| Monitor electrical energy use by equipment's | Monitor thermal energy use by equipment’s |
| Heat balance of thermal energy | Electric energy balance |
| Calculate operating efficiency of different appliances/equipment's | Identify energy saving potential |

Based on the requirement Energy Auditor will use energy audit instrument/meter to capture the usage electrical and thermal energy

# Case Study – 1 Review of Energy Use and Site Assessment

*(Same procedure can be followed for Educational institutes, government buildings, hotels and other facility)*

Following data was collected for the preliminary review of the energy use

- Equipment details
- One-year electric energy consumption detail (Monthly electricity bill)

| Equipment | Quantity | Rating (Wattage) |
|---|---|---|
| T8 FTL | 124 | 36 |
| Ceiling Fan | 50 | 75 |
| Projector | 15 | 150 |
| Desktop Computer | 20 | 200 |
| Deep Freezer *(-80oC)* | 1 | 2500 |
| Deep Freezer *(-20oC)* | 1 | 1000 |
| Water Pump | 1 | 1500 |

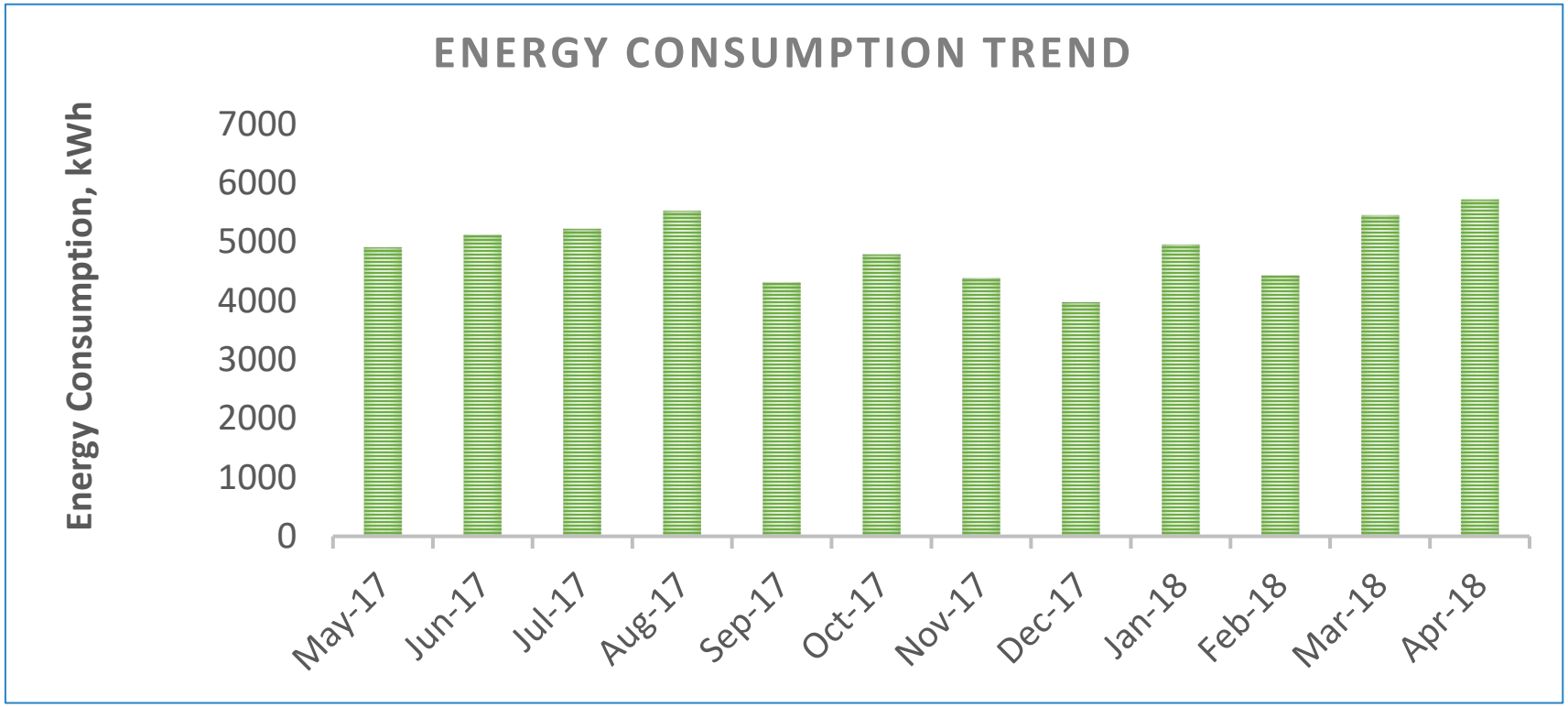
| Equipment | Quantity | Rating (Wattage) |
|---|---|---|
| Water Heater | 2 | 1200 |
| Autoclave | 1 | 500 |
| Ice flakes Maker | 1 | 500 |
| Incubator | 1 | 500 |
| Air Conditioner | 4 | 1300 |
| Distilled Water Unit | 1 | 500 |
| MV Lamp | 2 | 250 |

Other information collected are **Location, Operating Hours in a year and Switching Mechanism *(Manual or Automatic)***

**Equipment details would help to identify key energy consumption areas**

# Case Study – 1 Review of Energy Use and Site Assessment

## Monthly Electrical Energy Consumption

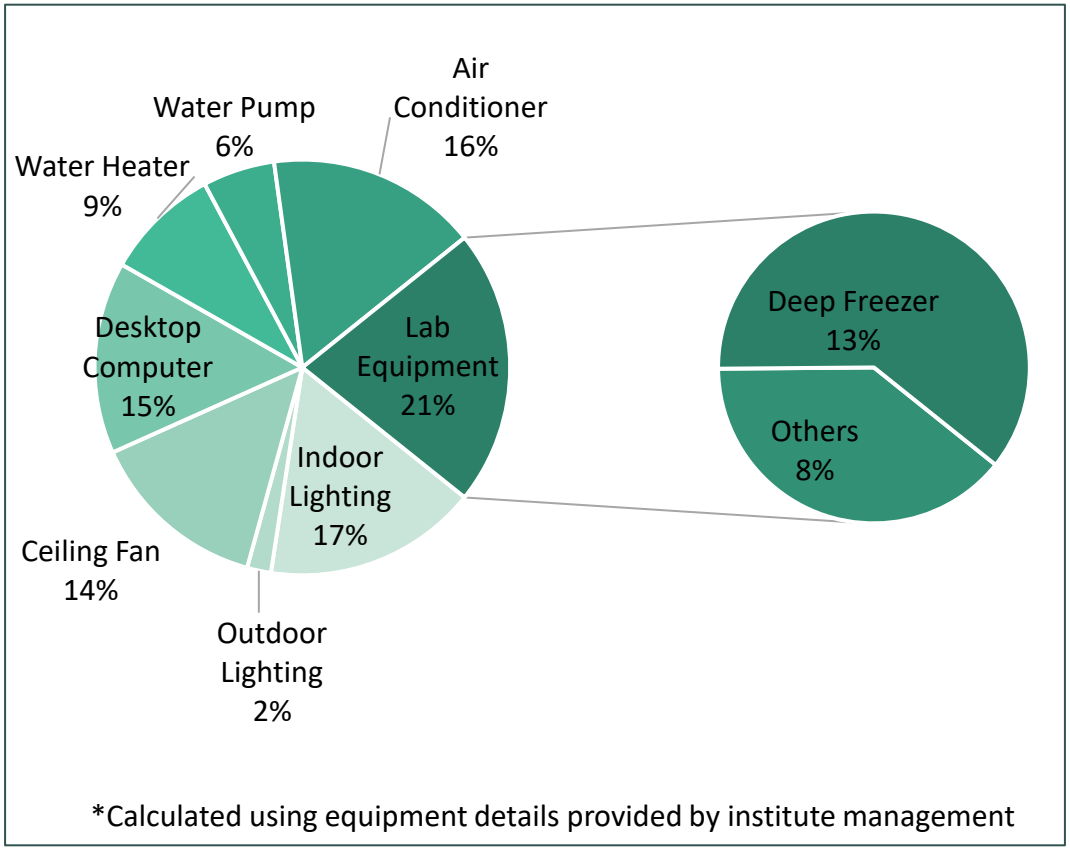



| Annual Energy Consumption, kWh | Annual Electricity Charges, ECD |
|---|---|
| 58740 | 16,209 |

# Case Study – 1 Review of Energy Use and Site Assessment

## Conclusion from the preliminary review of the energy use

- Major energy consuming area
- Potential magnitude of energy efficiency opportunities.
- Provide an early estimate of potential savings
- Average daily electrical energy consumption
- Seasonal variation in load



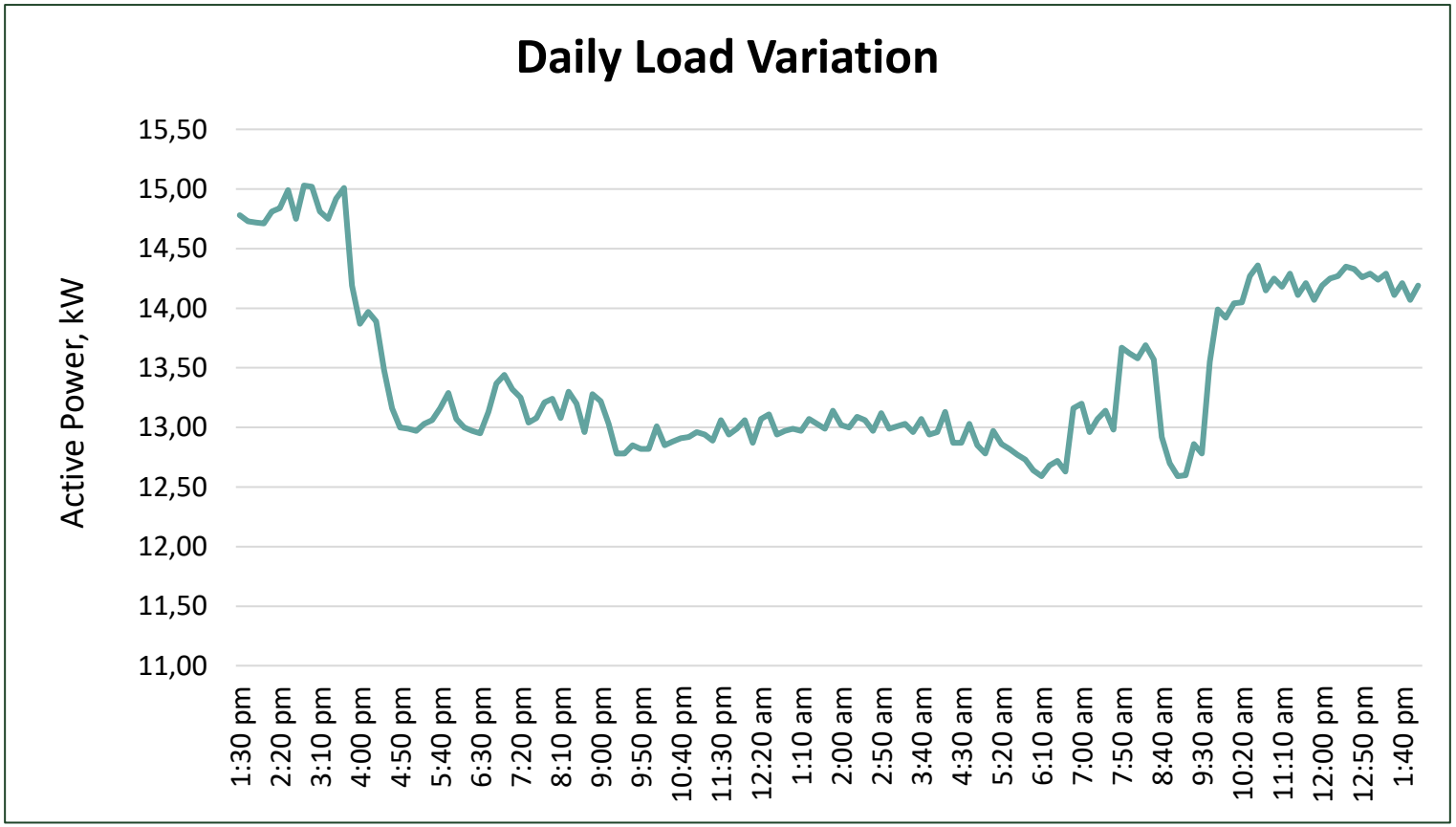
# Case Study – 1 Review of Energy Use and Site Assessment

## Site Assessment

- Monitor load variation during day and night time; using portable three phase power analyzer.
- Check load current variation in three phases and neutral
- Visual inspection of
  - Rated efficiency of the equipment's
  - Manual, timeclock or automated HVAC control methods
  - Interior and exterior lighting systems and related controls
  - Hot water systems
  - Operating practices of all equipment's

# Case Study – 1 Review of Energy Use and Site Assessment

**Load variation during day and night-time**



# Case Study – 1 Review of Energy Use and Site Assessment

**Observation during site assessment**

- Lights in classrooms and staffrooms was found ON during daytime. Sufficient daylight is coming in classroom and staffroom.
- During night-time, all corridor lights were switched ON.
- Projector & Desktop Computers was found to be in standby mode
- Installed air conditioner units was found to be inefficient (non-inverter type)
- Set AC temperature was found to be 20$^{o}$C
- In all the classrooms and laboratories, individual switches were provided for each light and fan. This is a very good practice as it enables only the required number of lights and fans being switched ON

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 1** Replace the conventional Fluorescent Tube Light with energy efficient LED tube lights.

| FTL Tube Light | | LED Tube Light |
|---|---|---|
| 55W | → | 22W |
| 38W | | 20W |
| 28W | | 18W |

**Energy Conservation Measure - 2** During day time, **switch OFF** the tube lights wherever not required and use **Natural Day Light** - Create awareness among students and staff to promote energy conservation

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 3** During night time, **switch OFF** alternate lights in corridor and maintain minimum lux level.

OR

Provide motion sensor to alternate lights in corridor. By doing so only alternate lights would be ON during night time and remaining lights would automatically switch ON during any movement.

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 4** Replace the conventional ceiling fan with energy efficient BLDC fan.

| BLDC Fan | Traditional Fan |
|---|---|
| 35 W | 57 W |


- BLDC motor fans consume less power as compared to the traditional ceiling fans.
- These fans come with a **remote control uni**t thereby allowing you to switch ON and OFF the fans easily.
- BLDC motor fans come with a **Timer and Sleep mode** that will enable you to set a specific time limit (number of hours) while sleeping.

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 5** Set the temperature of AC around 24 - 27 $^{o}$C.

By doing so **3-4% power can be saved.** *(Savings in lower temp (<24$^{o}$C) – 6% for every rise in 1$^{o}$C and in higher temp (>24$^{o}$C) – 4% for every rise in 1$^{o}$C)*

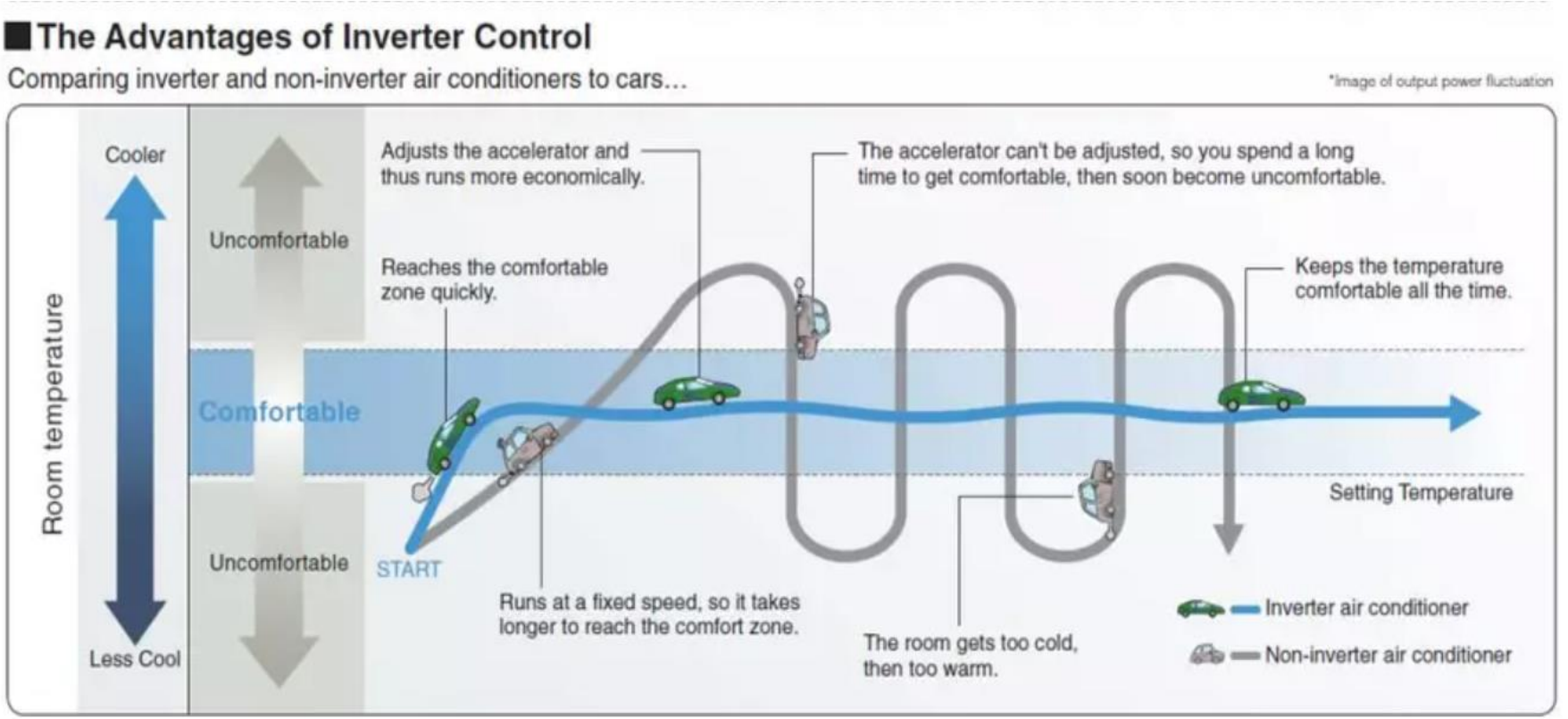
Feeling **HOT** at 27$^{o}$C

**Set the temperature of AC at 27$^{o}$C and use fan at optimum speed.**

Avoid using ceiling fans because hot air will be redistributed. Rather, use floor fans to provide better airflow for added comfort and cooling

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 6** Replace the old non-inverter AC with new energy efficient inverter AC.



# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 7** Reduce the heat load of room to reduce electricity consumption by Air Conditioner.

- By putting curtain on windows.
- Close door and windows.
- Arrest air leakage near door and windows.
- Avoid ironing of clothes in AC room.

**Energy Conservation Measure – 8** Keep AC outdoor unit (Condenser Unit) in shade and ventilated area.

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure - 9** After educational hour, switch OFF the desktop computer and projectors from main power supply. This will help to save **Stand-By** power.

**Other devices which consume stand-by power are:**

| | | | |
|---|---|---|---|
| Television | Microwave | Music System | DVD Player |
| Set-Top Box | Internet Modem | Game Console | |

# Case Study – 1 Review of Energy Use and Site Assessment

**Energy Conservation Measure – 10** Replace Electric Water Heater With Solar Water Heater

1. **Electric Water Heater**
    - Convert electric energy into heat energy.
    - Easy installation, Less expensive & require less maintenance.
    - Operating cost is high and don't give instant hot water

2. **Solar Water Heater**
    - The light radiations from the sun are converted into heat energy.
    - Operation cost is ZERO. As sun rays are FREE.
    - Hot water is available even during power cut.
    - Need additional rooftop space and also required annual maintenance.

# Case Study – 1 Review of Energy Use and Site Assessment

# Energy Saving opportunities - Commercial Sector

- Retrofit interior corridor fixtures with LED lamps, where continuous usage is required
- Replacing conventional exit signs with energy-efficient LED (or) colour reflector;
- Extensively use of daylighting, which may require installation of sky tubes, blinds or shades to control heat gain and glare;
- Gardens, outdoor building perimeter areas, pavements and footpaths can be lit with solar-based outdoor lamps with an inbuilt battery;
- Lack of shading increases heat loads in the hot/humid climate and increases air conditioning costs;
- Install level control or pressure switch based control to switch ON/OFF the booster pumps;
- Use ENERGY STAR$^{TM}$ rated appliances (UPS, Data servers, Printers etc.) for office or commercial usage where they are operated for long hours ( ~ 30% reduction)

# Energy Saving opportunities - Industrial Sector

- Provided interlock or process control logic to avoid the idle operation of electric motors;
- Replacing conventional exit signs with energy-efficient LED (or) colour reflector;
- Avoid multiple rewinding of motors. The greater the number of rewinds more is the efficiency drop;
- Avoid idle cooling water circulation in DG sets, compressors and refrigeration systems;
- Conduct a water balance study to minimize water consumption and leaks;
- Use of blower air instead of compressed air (aeration in effluent treatment plants, drying applications etc.);
- Use of hydraulic or electrical tools in place of pneumatic tools;
- Use variable speed drives and direct digital controls on water circulation pumps, motors and controls.

# Energy Saving opportunities - Agriculture Sector

- Use of sprinkler maintains uniform water application to the crops; it reduces pumping energy demand compared to conventional methods for crops;
- Use of Solar PV pumps for agriculture (including A brushless DC pumps);
- Use of high-efficiency water pumps at agro-processing plants;
- Use of fibre-reinforced plastic (FRP) fan blades for the drying section (ventilation fans);
- Use less energy consumption LED fixtures, which will last longer than fluorescent lamps bulbs, sodium and mercury lamps across agricultural facilities.

# Interactive Session

1) During the Site assessment, it is not so important to consider the power variation trend of the incomer. **True /False** **False**

2) What is the name of Energy Efficient replacement of a conventional fan motor?

**BLDC motor**

3) Mention two major contributors of Energy consumption in a Commercial facility.

**1. Lighting** **2. Air conditioning**

4) Which is the most common source of energy being used in all the sectors.?

**Electricity**

5) Replacing old equipment with new equipment which consumes less energy

**Energy Conservation / Energy Efficiency** **Energy Efficiency**

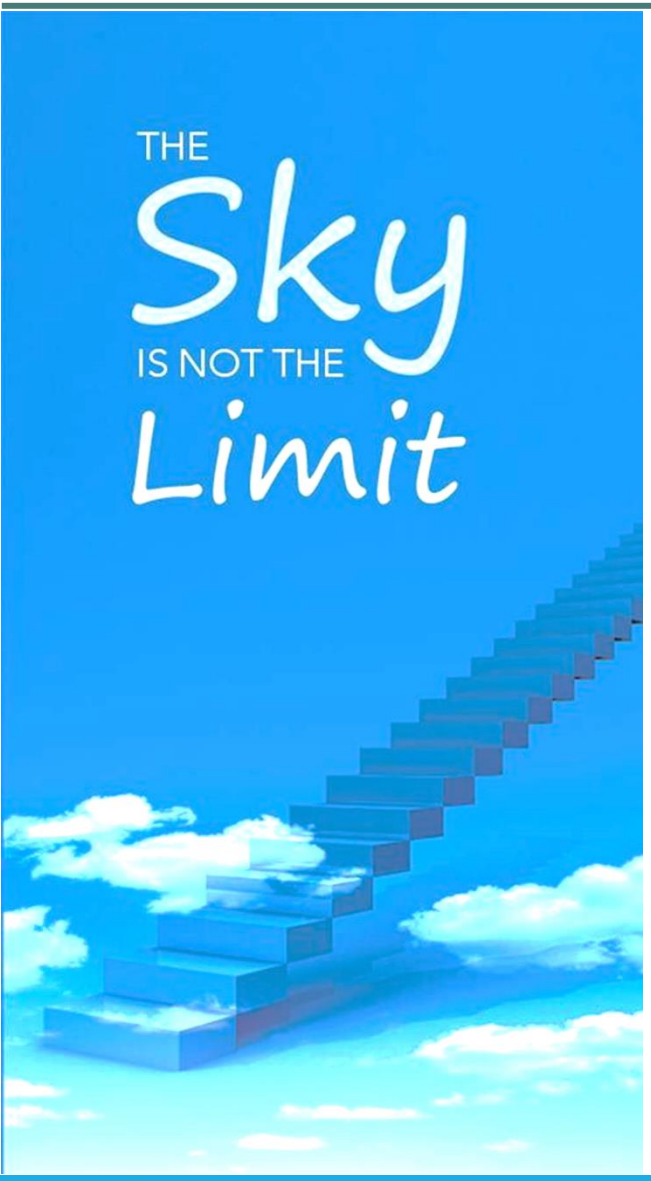
# Question…??

1. What all energy efficiency measures can be implemented in your facility.

## Session III

# Data Analysis and Audit Report

# Energy Data Analysis



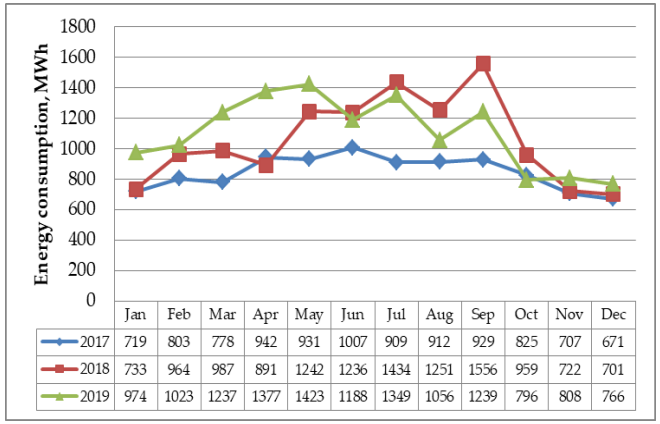

- Energy data analysis methodology varies with respect to the **type of facility** and **study objectives to be achieved.**
- Analysing the collected information will help in understanding the historical and present performance level of the respective facility.
- In order to manage day-to-day energy consumption efficiently, it is highly essential to analyse the energy consumption data, benchmark energy use and set targets that can result in significant energy cost savings along with carbon emission reduction.

***"we can't manage what we can't measure"***

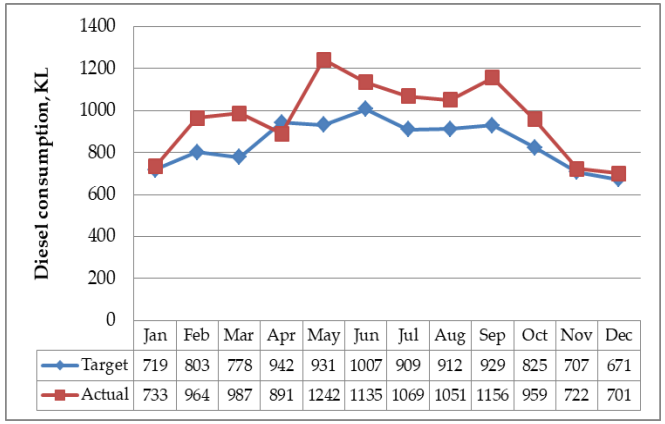
# Energy Data Analysis

- Typical Analysis methods:
  - Spreadsheet based analysis using engineering formulae taking into account time variation based analysis.
  - Analysing hourly, daily, weekly and seasonal load variation pattern of the incomer – Activity based and Equipment based.
  - Simulation based analysis by incorporating sensors with data loggers.
  - Develop performance metrics using some key performance indicators (KPIs) such as
    - Energy intensity (kWh/Sq.m)
    - Energy Utilization Index
    - Specific energy consumption
    - Specific water consumption
- Benefits: Not just identifying energy savings
  - Develop a complete insight of the facility on use of various resources
  - Helps in detecting anomalies
  - Develop awareness and engage the end user
  - Impact the culture positively

# Typical Energy Performance Assessment Dashboard

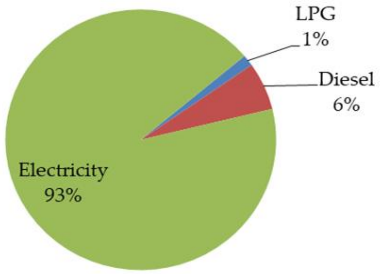


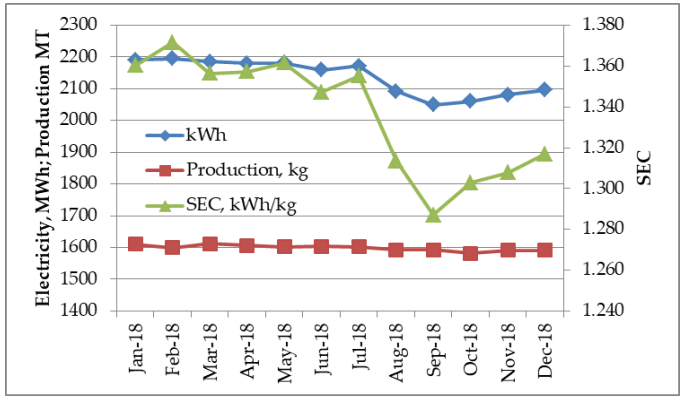

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 719 | 803 | 778 | 942 | 931 | 1007 | 909 | 912 | 929 | 825 | 707 | 671 |
| 2018 | 733 | 964 | 987 | 891 | 1242 | 1236 | 1434 | 1251 | 1556 | 959 | 722 | 701 |
| 2019 | 974 | 1023 | 1237 | 1377 | 1423 | 1188 | 1349 | 1056 | 1239 | 796 | 808 | 766 |

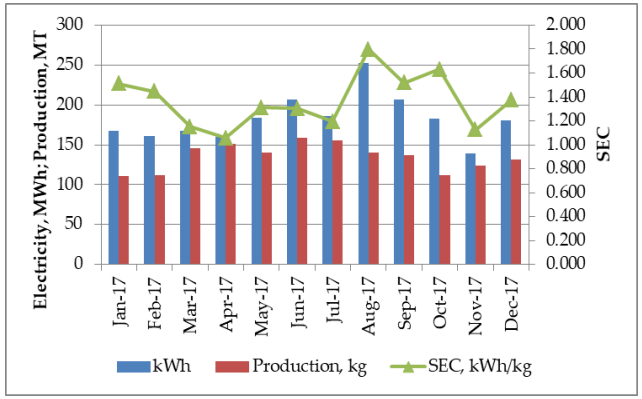



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Target | 719 | 803 | 778 | 942 | 931 | 1007 | 909 | 912 | 929 | 825 | 707 | 671 |
| Actual | 733 | 964 | 987 | 891 | 1242 | 1135 | 1069 | 1051 | 1156 | 959 | 722 | 701 |

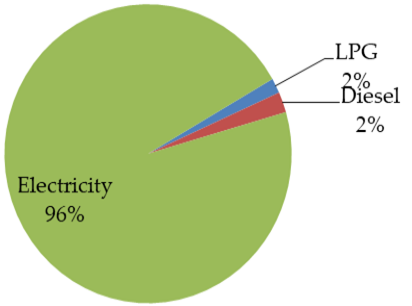
## Break-up of energy consumption



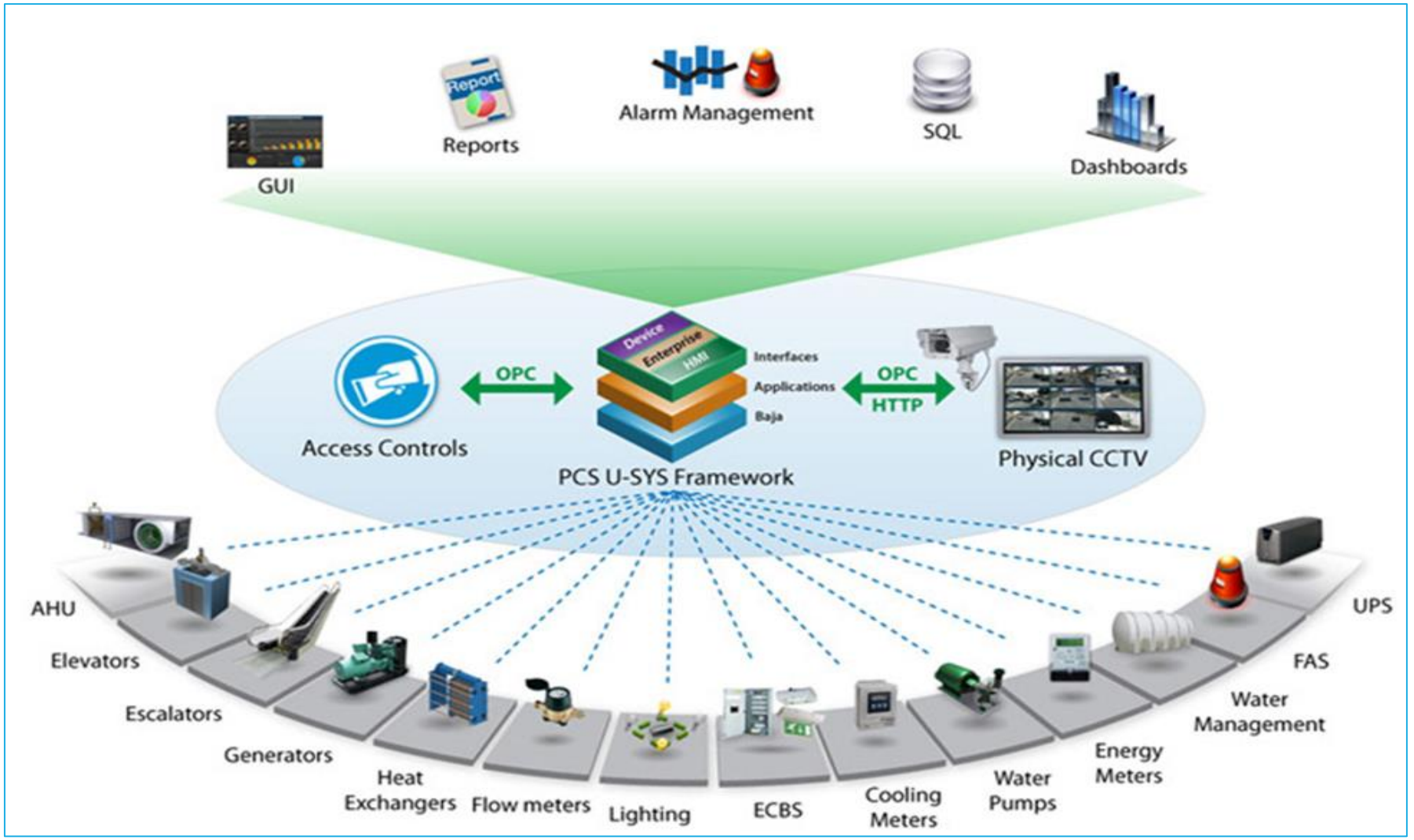




## Break-up of energy cost



# Typical Energy Management System



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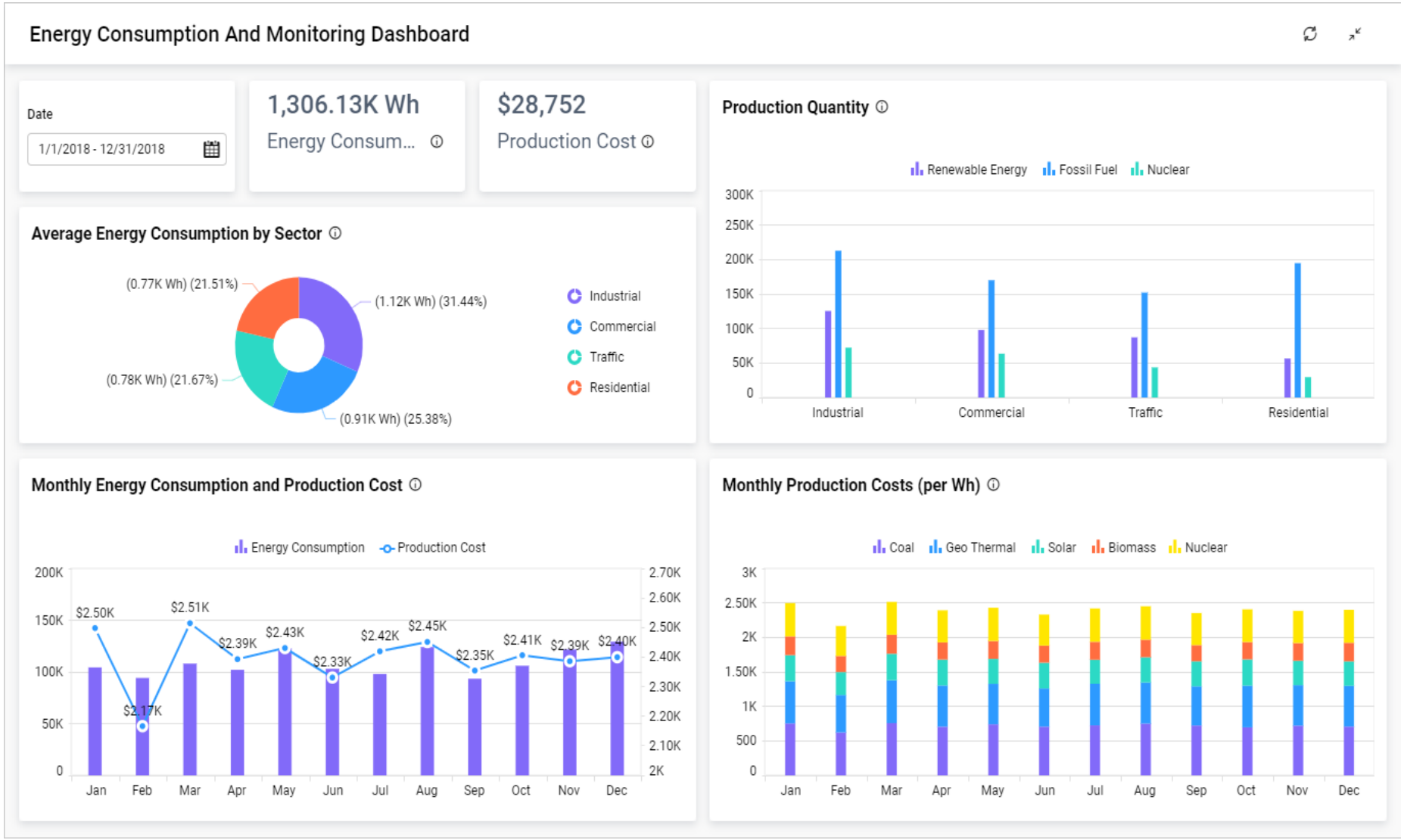

# Economic Analysis

- Current Energy cost(Utility rates per unit of Electricity or Diesel) is used for estimating the annual energy cost savings of identified ECMs.
- Investment for implementation of measures depends on the type of the ECMs:
  - O & M (Operational and Maintenance)
  - Retrofitting
  - Technology upgradation

***ATTRACTIVENESS OF THE INVESTMENT FOR A PARTICULAR ECM DEPENDS ON THE PROJECT VIABILITY PRACTICALLY AS WELL AS FINACIALLY.***

- Tools for evaluating financial viability:
  - Simple Payback period
  - Return on Investment (ROI)
  - Lifecycle analysis
  - Internal Rate of Return (IRR)
  - Net present Value

- ***Accurate Investment cost data*** *to avoid underestimating or over estimating of funds.*
- ***Detailed cost analysis*** *to ensure valid economic analysis for high investment EC projects.*

# Economic Analysis

- Tools for evaluating financial viability:

| Name | Usage | Application areas |
|---|---|---|
| Simple payback period (SPB) | SPB is a simple analysis tool used frequently in energy efficiency project upgrades and maintenance activities to calculate energy payback period. | Home energy assessment, Industries & Businesses (Small or big) depending on the type of investment. ***"Smaller the SPB, the attractive is the investment."*** |
| Return on Investment (ROI) | ROI is a Profitability metric used to evaluate the attractiveness of an investment. Majorly useful for measuring success over time and making investment decisions by apple-to-apple comparison. | Factory expansion, Stock market investments, Real estates, commercial vehicle procurement etc. ***"A Positive ROI indicates profit and a negative ROI indicates loss."*** |
| Net Present Value (NPV) & Internal Rate of Return (IRR) | NPV is the difference between the present value of cash inflows and the present value of cash outflows over a period of time.<br>IRR is a calculation used to estimate the profitability of potential investments. | NPV and IRR concepts are applied majorly in Capital budgeting for large and long term projects. ***"If a project's NPV is above zero, then it's considered to be financially worth considering. And IRR generates the percentage return that the project is expected to create."*** |
| Life cycle cost analysis (LCCA) | LCCA is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process | Asset monitoring, Large infrastructure projects etc. |

- ***Accurate Investment cost data*** *is needed to avoid underestimating or over estimating of funds.*
- ***Detailed cost analysis*** *to ensure valid economic analysis for high investment EC projects.*

# Important Aspects to be considered

***While analyzing potential analyzing energy saving opportunities:***

- ❑ *Feasibility of system replacement*
- ❑ *Ease of implementation*
- ❑ *Risk of failure*
- ❑ *Improved system reliability*
- ❑ *Positive or Negative impact on the operational and maintenance costs*

# Energy Saving Calculations

*Calculations for some of the frequently used measures were listed below:*

- *Type-1**: **Operational and maintenance***
  - ✓ *Switching OFF devices (eg: lights or fans) when not in use or reduced hours of operation*
    - *Manual operation*
    - *Automatic operation using sensors and actuators*
- *Type-2: **Energy improvement payback calculator for retrofit opportunities***
  - ✓ Changing old inefficient devices with new efficient devices
    - ✓ Example: Old inefficient lights with new energy efficient LED lights
    - ✓ Conventional fans with BLDC fans
    - ✓ Old Air conditioning units with latest technology AC units

# Analysis of Energy Conservation Measures

Analysis of Energy Conservation measures has three major steps involved.

Step 1:Energy Saving Calculations

Step 2. Investment Assessment

Step 3. Economic Analysis

# Basic Formula Used For Energy Saving Calculations

## Daily Energy Consumption

$$\text{Energy Consumption Per Day (kWh/Day)} = \frac{\text{Number of Appliances} \times \text{Rated Input Power (W)} \times \text{Operating Hour Per Day (Hrs.)}}{1000}$$

## Annual Energy Consumption

$$\text{Energy Consumption Per Year (kWh/Year)} = \text{Energy Consumption Per Day (kWh/Day)} \times \text{Operating Days in a Year}$$

## Annual Energy Saving

$$\text{Annual Energy Saving (kWh/Year)} = \text{Annual Energy Consumption in Present Case} - \text{Annual Energy Consumption after implementing Energy Conservation Measure}$$

# Basic Formula Used For Energy Saving Calculations

**Annual Cost Saving**

Annual Cost Saving (EC$) = Annual energy Saving (kWh) x Per Unit Electricity Cost (EC$/kWh)

**Investment Assessment**

Investment cost of the equipment, project management charges, Annual O & M charges.

**Financial Analysis**

$$\text{Simple Payback Period (Years)} = \frac{\text{Investment (EC\$)}}{\text{Annual Cost Saving (EC\$)}}$$

# Scenario Description

A facility has the following equipment which are being used for certain hours during the day.

The list of equipment are provided below:

| Name | Wattage, W | Quantity | Op. load, W | Op. hours/day | Energy consumption, kWh/day |
|---|---|---|---|---|---|
| | | A | B | C | D = (AxBxC) /1000 |
| Fluorescent tube lights | 36 | 10 | 36 | 15 | 5.4 |
| Split air condition units | 2600 | 3 | 1320 | 15 | 59.4 |
| Water pump | 750 | 1 | 700 | 5 | 3.5 |
| Street lights | 150 | 5 | 150 | 12 | 9.0 |
| Total | | | | | 77.3 |

Q1) Calculate the total daily energy consumption of the facility?

Total daily energy consumption of the facility = 77.3 kWh/day

# Interactive Session - Energy Saving Opportunities

Based on the Understanding, propose some of the possible energy consumption opportunities that exist based on the currently used equipment

| Name | Energy saving opportunities |
|---|---|
| Fluorescent tube lights | 1) Minimising the operating hours by switching off lamps when not required.<br>2) Replace the existing lamps with energy efficient LED tube lights |
| Split air condition units | |
| Water pump | |
| Street lights | |

# Identified energy saving measures

The following are the energy saving measures identified

| Name | Wattage, W | Proposed measure |
|---|---|---|
| | | |
| Fluorescent tube lights | 36 | Replacement with LED |
| Fluorescent tube lights | | Minimizing Operating hours |
| Split air condition units | 2600 | Replacement with Inverter based Split AC |
| Split air condition units | | Minimizing Operating hours |
| Water pump | 750 | Minimizing Operating hours by using level controller |
| Street lights | 150 | Replacement with LED |

# Energy saving calculations - Reducing op.hours

| | Old Scenario | | | | | New Scenario - 1 (Reducing op.hours) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Wattage, W | Quantity | Op. load, W | Op. hours/day | Energy, kWh/day | Wattage, W | Quantity | Op. load, W | Op. hours/day | Energy, kWh/day |
| | | A | B | C | D=(AxBxC) /1000 | | E | F | G | H=(ExFxG) /1000 |
| Fluorescent tube lights | 36 | 10 | 36 | 15 | **5.4** | 20 | 10 | 36 | 12 | 4.32 |
| Split air condition units | 2600 | 3 | 1320 | 15 | **59.4** | 2600 | 3 | 1320 | 12 | 47.52 |
| Water pump | 750 | 1 | 700 | 5 | **3.5** | 750 | 1 | 700 | 4 | 2.8 |
| Street lights | 150 | 5 | 150 | 12 | **9.0** | 70 | 5 | 150 | 12 | 9.0 |
| Total | | | | | **77.3** | | | | | **63.64** |

Q2) Calculate the total daily energy consumption of the facility?

# Energy saving calculations - Equipment replacement

| | Old Scenario | | | | | New Scenario - 2 (Equipment replacement) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Name | Wattage, W | Quantity | Op. load, W | Op. hours/day | Energy, kWh/day | Wattage, W | Quantity | Op. load, W | Op. hours/day | Energy, kWh/day |
| | | A | B | C | D=(AxBxC) /1000 | | E | F | G | H=(ExFxG) /1000 |
| Fluorescent tube lights | 36 | 10 | 36 | 15 | 5.4 | 20 | 10 | 20 | 15 | 3.0 |
| Split air condition units | 2600 | 3 | 1320 | 15 | 59.4 | 2600 | 3 | 690 | 15 | 31.05 |
| Water pump | 750 | 1 | 700 | 5 | 3.5 | 750 | 1 | 700 | 5 | 3.5 |
| Street lights | 150 | 5 | 150 | 12 | 9.0 | 70 | 5 | 70 | 12 | 4.2 |
| Total | | | | | 77.3 | | | | | **41.75** |

Q2) Calculate the total daily energy consumption of the facility?

# Energy saving calculations

Q3) Calculate total energy saved by New Scenario - 1?

**Total Energy savings = $\Sigma$ (Energy consumption in old scenario – Energy consumption from new scenario)**

Total Energy savings by New Scenario - 1 = 77.3 – 63.34

Total Energy savings by New Scenario - 1 = 13.96 kWh/day

Q4) Calculate total energy saved by New scenario - 2?

Total Energy savings by New scenario - 2 = 77.3 – 41.75

Total Energy savings by New scenario - 2 = 35.55 kWh/day

# Investment cost assessment

| Name | Proposed Measure | Investment | Total Investment, EC$ |
|---|---|---|---|
| Fluorescent tube lights | Replacement with LED | 30EC$/20W LED tube light | **300** |
| Fluorescent tube lights | Minimise op. hours | Nil | **Nil** |
| Split air condition units | Replacement with Inverter AC | 3000 EC$/unit | **9000** |
| Split air condition units | Minimise op. hours | Nil | **Nil** |
| Water pump | Minimise op. hours | 100 EC$/unit | **100** |
| Street lights | Replacement with LED | 180EC$/70W LED light | **900** |

Calculate total investment cost of each measure?

# Energy saving calculations

| Name | Proposed measure | Energy, kWh/day | Energy from New Scenario -1, kWh. day | Energy from New Scenario -2, kWh. day | operating days/year | Annual Energy consumption from old scenario | Annual Energy consumption, kWh (New Scenario-1) | Annual Energy consumption, kWh (New Scenario-2) |
|---|---|---|---|---|---|---|---|---|
| | | A | A1 | A2 | B | C=AxB | D=A1xB | E=A2xB |
| A) Fluorescent tube lights | Replacement with LED | 5.4 | | 3.0 | 365 | 1971 | | 1095 |
| B) Fluorescent tube lights | Minimise op. hours | | 4.31 | | 365 | | 1573 | |
| C) Split air condition units | Replacement with Inverter AC | 59.4 | | 31.05 | 365 | 21681 | | 11333 |
| D) Split air condition units | Minimise op. hours | | 47.52 | | 365 | | 17345 | |
| E) Water pump | Minimise op. hours | 3.5 | 2.8 | 3.5 | 365 | 1278 | 1022 | 1278 |
| F) Street lights | Replacement with LED | 9.0 | 9.0 | 4.2 | 365 | 3285 | 3285 | 1533 |
| **Total** | | **77.3** | **63.64** | **41.75** | | **28215** | **23225** | **15239** |

# Energy saving calculations

| Name | Proposed measure | Energy saving with old & New scenario-1, kWh/day | Energy saving with old & New scenario-2, kWh/day | Energy Cost saving from scenario-1, EC$ | Energy Cost savings from scenario-2, EC$ | Investment, EC$ | Simple Payback period, years |
|---|---|---|---|---|---|---|---|
| | | F=C-D | G=C-E | H=F x 0.78 | I=G x 0.78 | J | K = J/H or I |
| A) Fluorescent tube lights | Replacement with LED | | 876 | | 683.3 | **300** | **0.44** |
| B) Fluorescent tube lights | Minimise op. hours | 398 | | 310.4 | | **Nil** | **Immediate** |
| C) Split air condition units | Replacement with Inverter AC | | 10348 | | 8071.4 | **9000** | **1.11** |
| D) Split air condition units | Minimise op. hours | 4336 | | 3382.1 | | **Nil** | **Immediate** |
| E) Water pump | Minimise op. hours | 256 | 0 | 199.7 | | **100** | **0.50** |
| F) Street lights | Replacement with LED | 0 | 1752 | | 1366.6 | **900** | **0.66** |
| **Total** | | **4990** | **12976** | **3892.2** | **10121.3** | **8800** | |

# Ranking of Energy conservation Proposals

Based on the values of Simple Pay back period, we can rank the projects.

- **Rank 1**: Short term measures – SPB < 1 year
- **Rank 2**: Medium term measures – SPB > 1 year and < 3 years
- **Rank 3:** Long term measures – SPB > 3 years

# Energy Audit Reporting – Table of contents

| Sl.No | Content | Coverage |
|---|---|---|
| | Executive Summary | ✓ Brief description of the facility<br>✓ Overall Energy use<br>✓ Summary of energy conservation measures<br>✓ Overall energy saved and energy cost savings<br>✓ Major Energy saving areas<br>✓ Energy conservation measures implementation strategy |
| 1.0 | Introduction | ✓ Detailed background of the facility |
| 2.0 | Methodology | ✓ Detailed list of areas being covered for the energy audit study in the facility<br>✓ Details of energy audit tools used for the study<br>✓ Audit Approach being followed |
| 3.0 | Energy Consumption Profile | ✓ Details of Energy sources being used in the facility (like Electricity, Diesel etc)<br>✓ Annual Energy consumption<br>✓ Annual Production (if it is a Processing Industry)<br>✓ Area and occupancy (If it is a commercial building)<br>✓ Energy Tariff (Cost of electricity and fuel) |
| 4.0 | Measurements – Observations & Analysis | ✓ Electrical System and distribution<br>➢ Background – Source of electricity, Electrical infrastructure<br>➢ Electricity Tariff and bill analysis<br>➢ Load profile of the incomer – Measurements and Analysis<br>➢ Power quality, Electric drives analysis<br>✓ Mechanical Equipment like fans, pumps, Air conditioning units<br>➢ Background – Equipment details and user areas identification<br>➢ Measurements and analysis of performance and end use practices<br>✓ Thermal Equipment – Boilers for hot water and cooking purposes<br>➢ Facility description – Equipment details and user areas identification<br>➢ Measurements and analysis of performance and end use practices |

# Energy Audit Reporting – Table of contents

| Sl.No | Content | Coverage |
|---|---|---|
| 5.0 | Energy Conservation measures | ✓ Identified Energy Conservation measures on Electrical, Mechanical and Thermal areas<br>❖ Background<br>❖ Recommendation<br>❖ Economic Analysis |
| 6.0 | Summary of potential energy savings | ✓ Identified Energy Conservation measures are segregated as per the Simple payback period (SPB)<br>❖ Short term measures – SPB < 1 year<br>❖ Medium term measures – SPB > 1 year and < 3 years<br>❖ Long term measures – SPB > 3 years |


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