# 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: 20 – 21 April 2022
Time: 9:00 am to 12:00 pm Grenada Time

# Content

- **Background**
  - *Objective, Methodology, Target audience*
  - *Grenada's Energy Sector*
- **Day-1: Concepts of Energy and How to Conduct Energy Audit**
  - *Fundamentals of Energy, Efficiency and Conservation*
  - *Importance of Energy Management*
  - *Step by step Approach in Conducting Energy audit*
  - *Energy Audit Tools and Its Importance*
  - *Q&A*

# 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*

# Introduction

## Background

Government of Grenada recognized that **reducing the energy consumption, managing and increasing the efficiency of energy usage** - is the quickest and cheapest way to have the highest returns on investment for energy transition.

## Objective

To strengthen various energy end users' capacity, to undertake energy audits and identify energy cost saving measures which can be implemented practically.

## Methodology

Conduct a series of webinars and a face-to-face training program

- ☞ Developing training materials
- ☞ Webinars – for various type of end users (First Webinar : **Homeowners and Youth**)
  (Second Webinar : **Hotels and Financial Institutions** )
- ☞ Training institutions, government ministries and statutory organisations

**Partners :** SIDS Lighthouses Initiative, IRENA
Ministry of Finance, Planning, Economic Development and Physical Development
Ministry with responsibility for Climate Resilience and the Environment
NDC Partnership

# Day - 1

# Session II

# Introduction to Energy and Electricity Concepts

# Introduction - Energy

- What is Energy…???

Energy is the ability to do work

….Reading a book.

….Running around the school.

….Riding a bike.

….Even resting needs energy.

# Definition of Energy

- ***Energy*** – It is the ability/capacity to do work
- ***Work*** – It is the transfer of energy. A force of moving a body over a distance is called work.
- ***Power*** – It is rate at which energy is converted to work

**Power = Energy / time (Joules per second or Watts, W)**

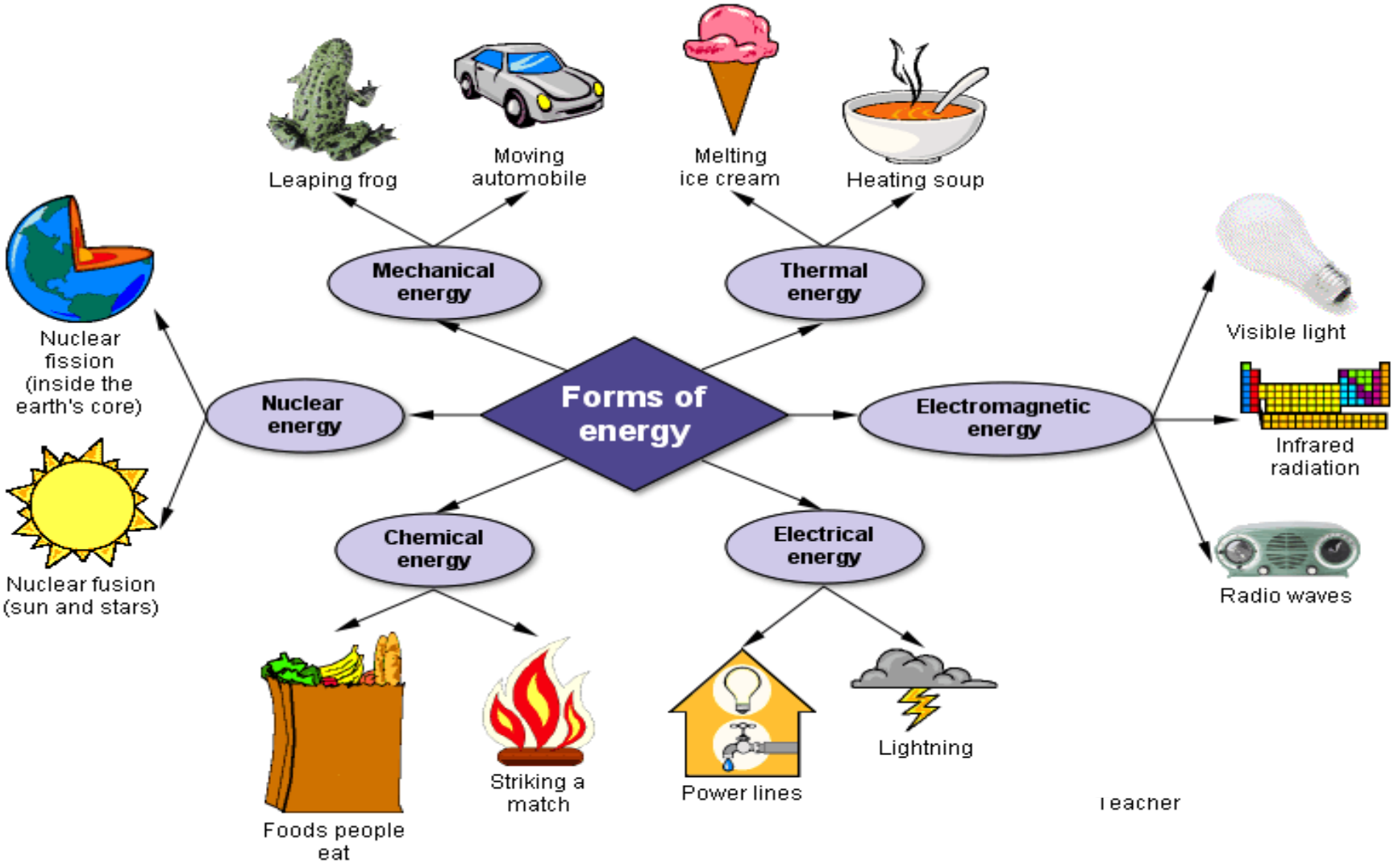
**Energy = power x time (kWh)**

- ***Kilowatt (kW)*** - A unit of measure of the amount of power needed to operate equipment, equivalent to one thousand (1,000) watts
- ***Kilowatt-Hour (kWh)*** - A measure of electrical energy equivalent to power consumption of 1000 watts for 1 hour. It is the most commonly used unit of measure indicating the amount of electricity consumed over time (*what you get charged*)

**1 Joule = Newton x meter**

**1 Watt = volt x ampere**

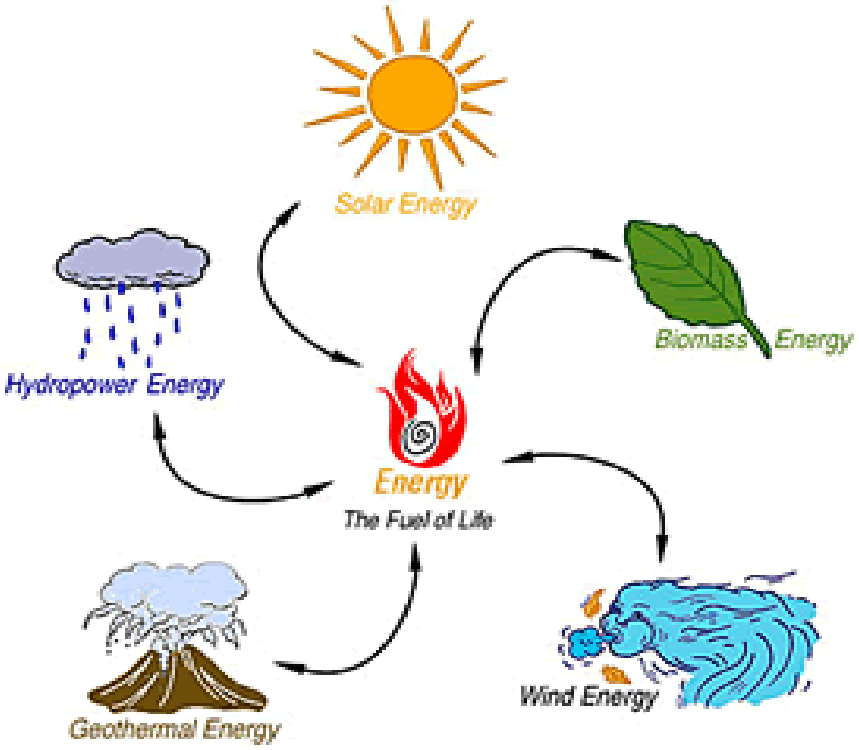
# Different forms of energy



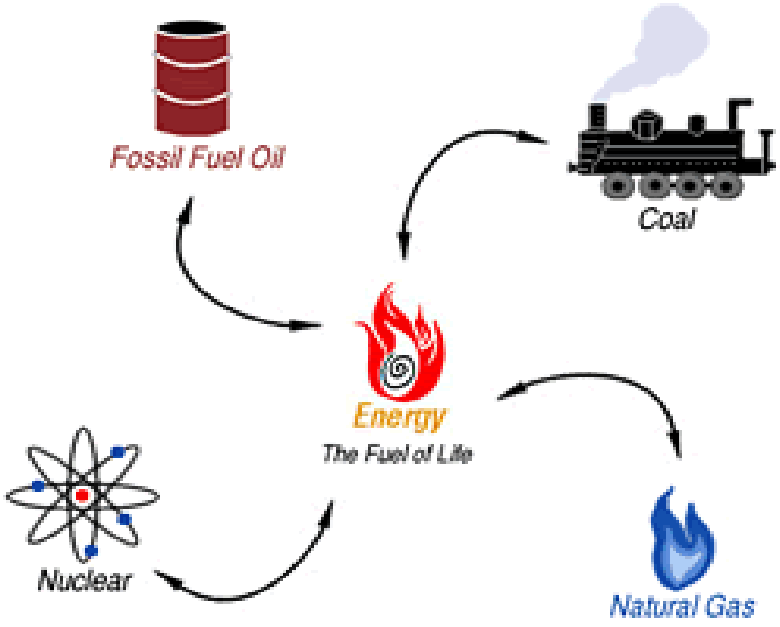
# Sources of Energy

Sources of energy refer to - from WHERE energy comes from.

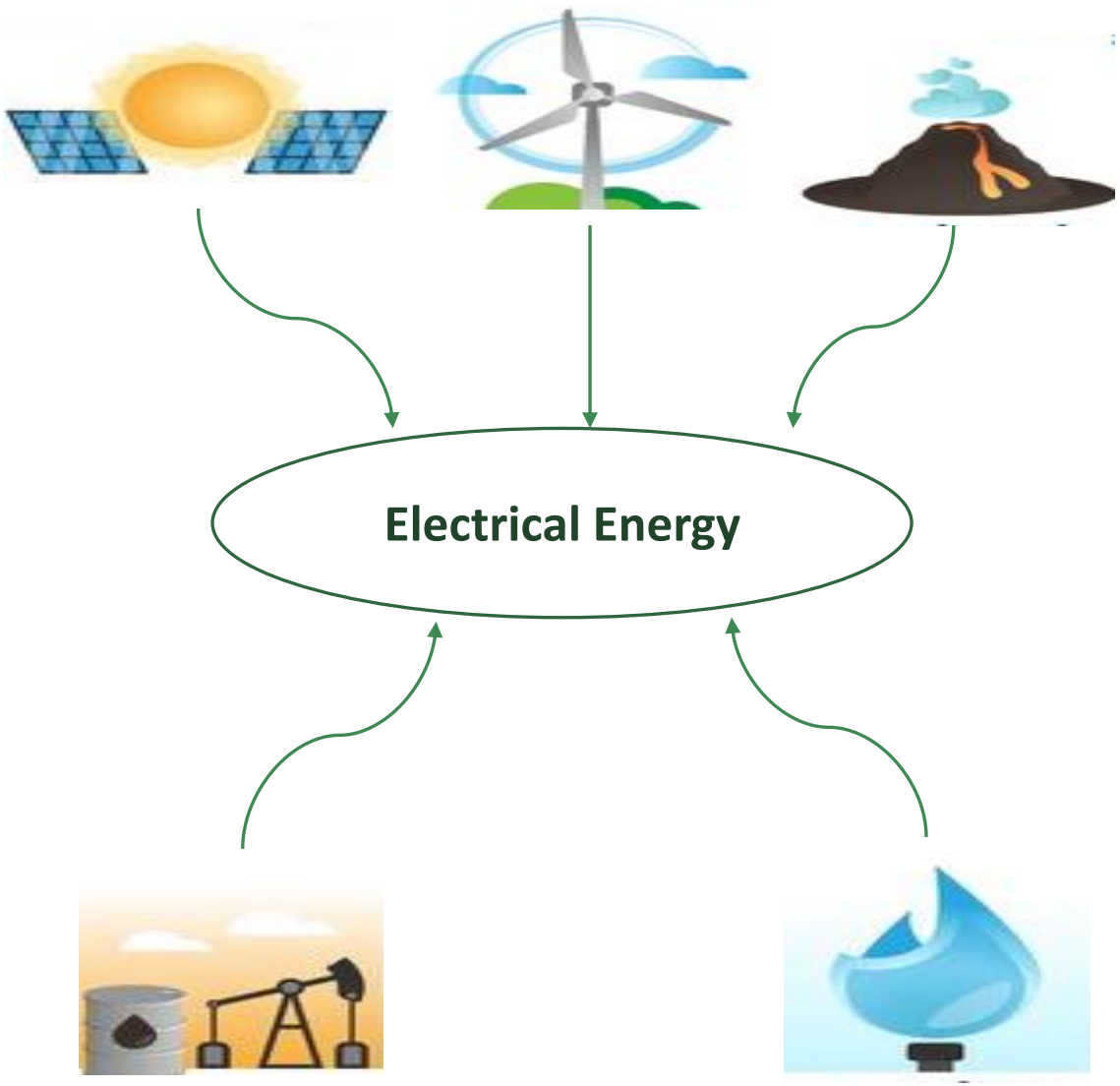
## Renewable Energy Sources

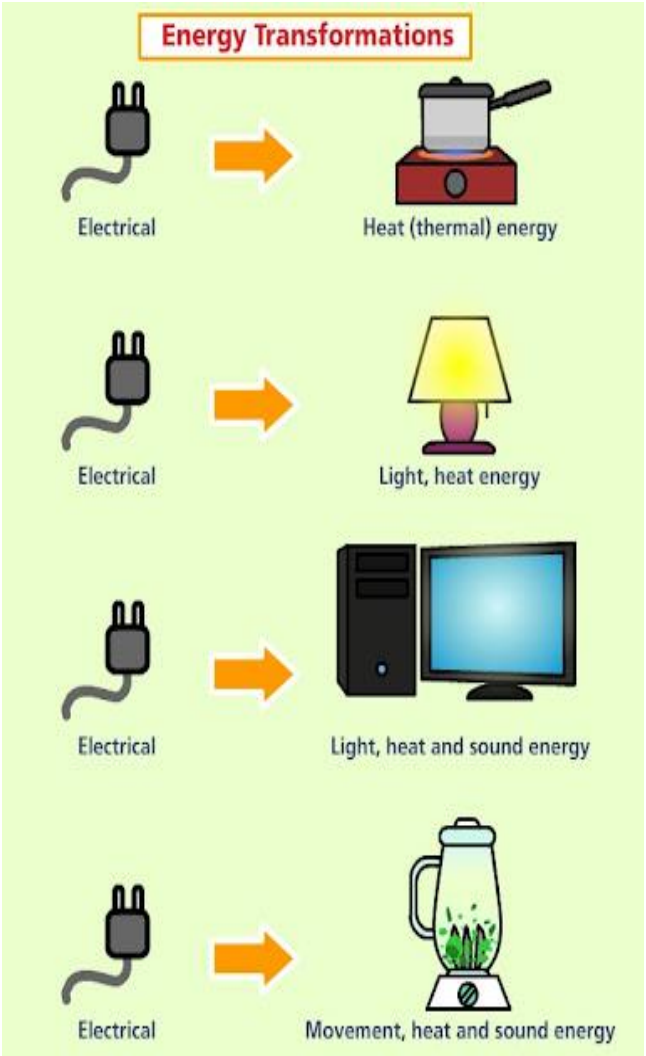



## Non-Renewable Energy Sources



# Electrical Energy and Transformations

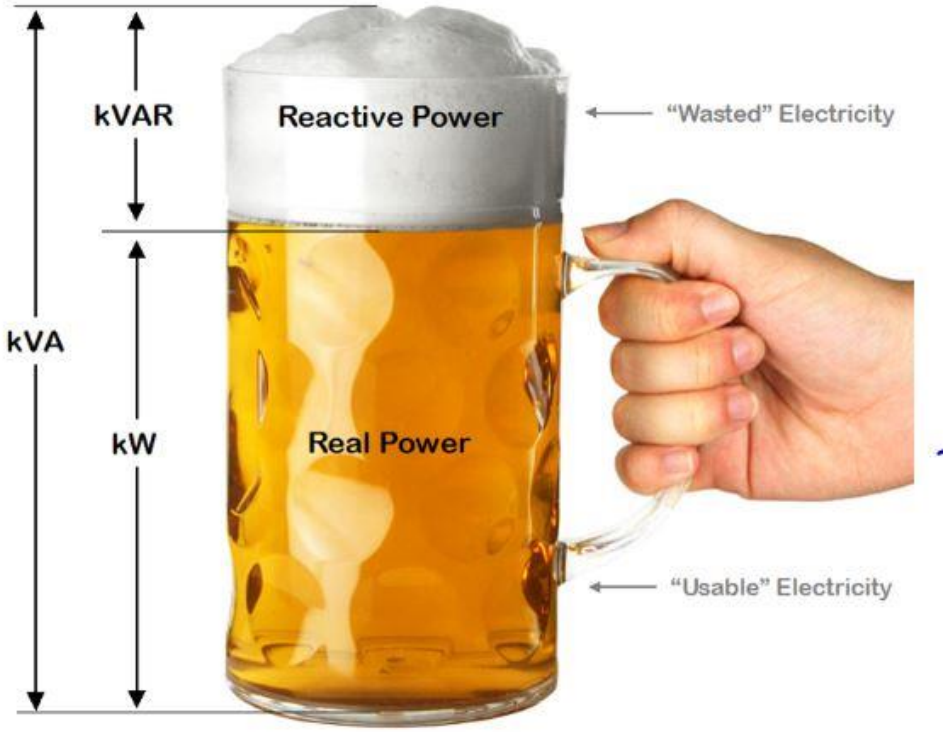


# Component of Electric Energy

Electric Energy

- Active Power or True Power (kW)
- Reactive Power (kVAR)
- Apparent Power (KVA)



# Electrical Energy : Metering

## How To Decide Which Appliance Will Consume More Energy

- Depends on **“INPUT POWER” or “Active Power”** of the appliance.
- Generally written on **“Product Information Tag”** and measured in **Watt (W) or Kilo Watt (kW)**

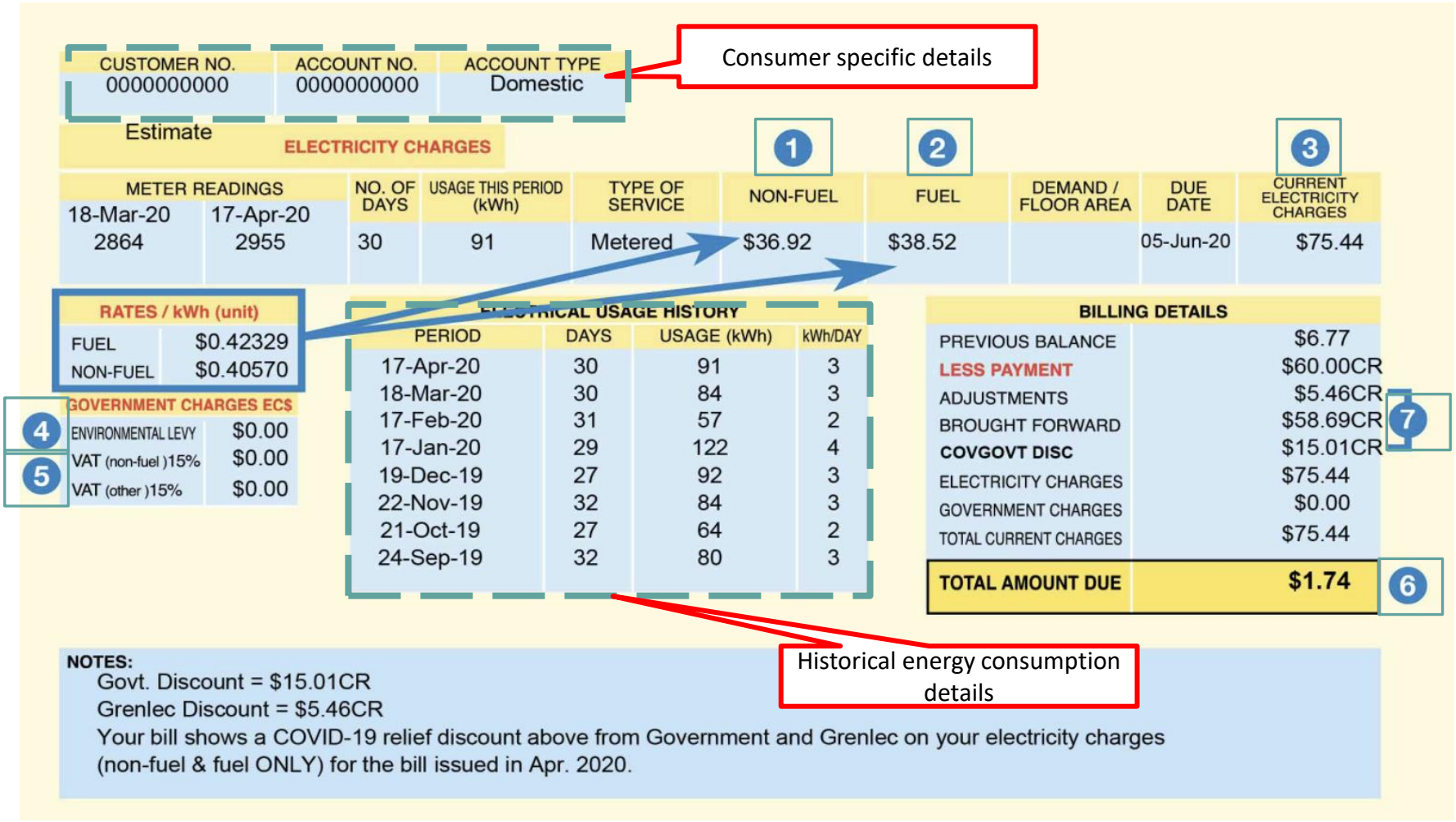

**1000 W = 1KW OR 1W = 1/1000 KW**

| INPUT POWER (kW) | X | TIME (Hr) | = | ELECTRIC ENERGY (kWh) |
|---|---|---|---|---|

1 Unit of Electric Energy Consumed = 1 kWh
It is the amount of active power or true power consumed in one hour

# Understanding your GRENLEC Bill

# Understanding your Household Electricity Bill




Source: https://grenlec.com/customers/tools-to-help-you/yourbill/

# Components of GRENLEC Electricity Bill

***1. Non-Fuel Charge:*** It is the average price involved in transmission and distribution of electricity. It also includes administration and maintenance of electricity poles, lines, generators, transformers, etc.

***2. Fuel Charge:*** It is the average price of the fuel used to generate electricity over the last 3 months and adjusted every month.

***3. Current Electricity Charges:*** It is the sum of Fuel and Non-Fuel charges for the billing period.

***4. Environmental Levy:*** It is collected on behalf of the Grenada Solid Waste Management Authority.

- Less than 99 units - $ 0.00
- Above 99 and up to 149 units - $ 5.00
- 150 units & above - $ 10.00

***5. Value Added Tax:*** Applied to the non-fuel portion and other GRENLEC services.

***6. Total amount due:*** Amount to be paid after subtracting "adjustments, brought forward and government discount" with "Total current charges".

***Total Electricity Bill= (Fuel charge + Non–Fuel Charge) x Number of units in kWh + Government Charges***

$$\boldsymbol{Total\ amount\ due}$$

$$= \boldsymbol{Total\ current\ charges} - (\boldsymbol{Adjustments} + \boldsymbol{Brought\ forward} + \boldsymbol{Governement\ discount})$$

***7. Adjustments:*** Any charges for other transactions processed on your account.
***Brought Forward:*** Credit or arrears from previous bills; credits are subtracted from and arrears are added to your current electricity charges. You must settle arrears urgently.

# Case Studies : Electricity bill Calculation

| Description | Quantity | Wattage | Operating hours/month | Month Energy consumption, kWh |
|---|---|---|---|---|
| | A | B | C | $D = A * B * C/1000$ |
| Television | 01 | 50 | 120 | **6.0** |
| Fridge | 01 | 120 | 250 | |
| Washing machine | 01 | 400 | 30 | |
| 1.0 Ton Air conditioner | 01 | 800 | 50 | |
| LED lights | 03 | 15 | 240 | |
| Outdoor lighting (MH type) | 02 | 40 | 300 | |
| **Total monthly energy consumption** | | | | |

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

# Case Studies : Electricity bill Calculation

| Description | Quantity | Wattage | Operating hours/month | Month Energy consumption, kWh |
|---|---|---|---|---|
| | A | B | C | $D = A * B * C/1000$ |
| Television | 01 | 50 | 120 | 6.0 |
| Fridge | 01 | 120 | 250 | 30.0 |
| Washing machine | 01 | 400 | 30 | 12.0 |
| 1.0 Ton Air conditioner | 01 | 800 | 50 | 40.0 |
| LED lights | 03 | 15 | 240 | 10.8 |
| Outdoor lighting (MH type) | 02 | 40 | 300 | 24.0 |
| **Total monthly energy consumption** | | | | **122.8** |

# Case Studies : Electricity bill calculation

**Fuel charges** = 0.4459 $

**Non Fuel charges** = 0.4057 $

**VAT** = 15% of non fuel charges for monthly consumption above 99 kWh

**Environmental levy** = 0 $ for <99 kWh monthly consumption;

5 $ for 99 kWh and <149 kWh monthly consumption;

10 $ for 150 kWh and above monthly consumption

***Total Electricity Bill = (Fuel charge + Non-Fuel Charge)x Number of units in kWh + Environmental levy + VAT***

Total Electricity bill with the existing equipment

*= {(122.8*0.4459)+(122.8*0.4057)} + (122.8*0.4057*0.15) + 5* = **117 $**

# Case Studies : Electricity bill saving option

***Option:*** If Outdoor lamps are replace with integrated solar lamps with 20 W LED lamps and battery backup and photo sensor. Calculate what is the reduction in the electricity bill?

- Monthly energy consumption for outdoor lighting = 0 kWh

**Total monthly electricity consumption with Solar outdoor lamps = 122.8 – 24 = 98.8 kWh**

Total Electricity bill after replacing all outdoor lighting with Solar outdoor lamps

*= {(98.8*0.4459)+(98.8*0.4057)} + 0 + 0*

= **84.1 $**

**Reduction electricity bill = 28% with an investment of 1000 $**

# Energy Efficiency v/s Energy Conservation

Energy efficiency is **"using less energy to provide the same service"** either through technology upgradation or through proper utilization of the appliances.

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

- ☞Turning off a light is energy conservation, not energy efficiency
- ☞Replacing conventional lamps with LED lamps, is energy efficiency
- ☞Setting air conditioner thermostat temperature at 24$^{o}$C, is energy conservation.
- ☞Replacing non-inverter air conditioner with inverter air conditioner, is energy efficiency.

# Energy Efficiency v/s Energy Conservation

Both energy efficiency and energy conservation refer to saving energy through its wise and rational use.

***Energy Efficiency*** looks to employment of different technologies to use less energy while providing the same output or function, for example using front load washing machine instead of top load.


**Energy Conservation** refers to behavioral practices, which results in using less energy, such as drying cloths outside in SUN.

# Energy Conservation Vs Energy Efficiency

| Energy Efficiency | Energy Conservation |
|---|---|
| **Energy Efficiency** is using technology that requires less energy to perform the same function (or) service<br>-**Technology improvement / advancement** | **Energy conservation** is using less energy by changing our **behavior or habits** (in addition to using energy more efficiently) |
| **Examples** | **Examples** |
| Use of high-efficiency lighting bulbs (LED) | Use of Staircase |
| Use of high-efficiency ceiling fans (BLDC) | Use of bicycle |
| Use of inverter-based air conditioner | Use correct size burner based on a cooking vessel |
| Use of induction technology – cook stove | Citizens interested in saving energy make use of solar or renewable energy sources (like solar battery back-up for mobile charging /recharging battery/ torch light etc.) |

# Energy Conservation Vs Energy Efficiency

Energy is particularly important to a country's economic growth and development

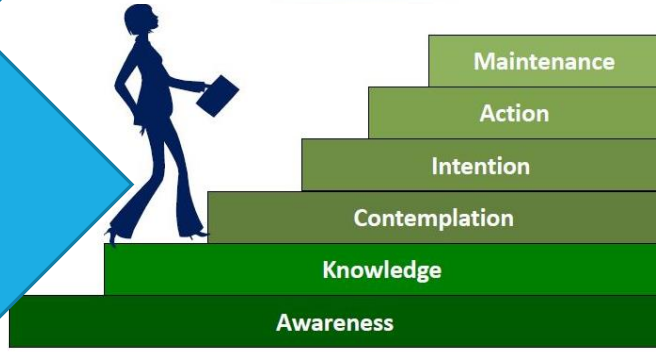
**Incandescent Bulb**

**Energy efficiency** is the goal to reduce the amount of energy required to provide products and services.

**LED**

**Energy conservation** is the saving of energy by any means including energy efficiency.


**Energy Management** is defined as the steps taken to minimize usage and wastage of energy.



# Energy Conservation Vs Energy Efficiency

**Scenario**: ***Commuting to 2rd Floor in a building in public place***

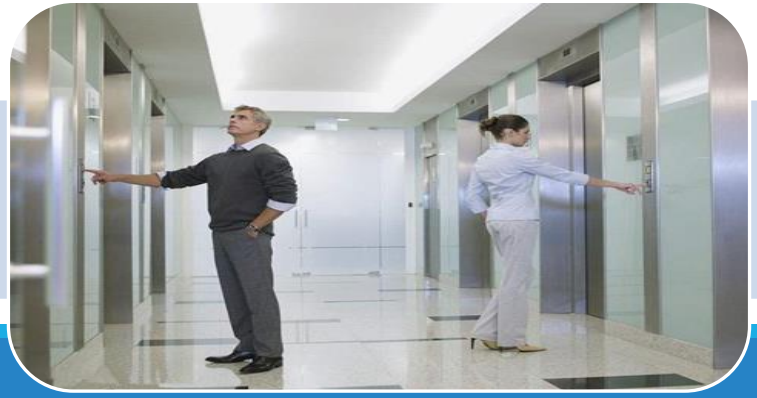
**Energy Conservation**

**Taking the stairs**

**Efficient Use of Energy**

**More than 3 people using the lift at the same time**

**Energy Intensive Process**



**Single person using the lift**

# Energy Conservation Vs Energy Efficiency

**Scenario**: ***Travelling to nearest supermarket***

**Energy Conservation**

**Using a bicycle for shopping**

**Efficient Use of Energy**

**Hatchback car for moderate shopping**

**Energy Intensive Process**

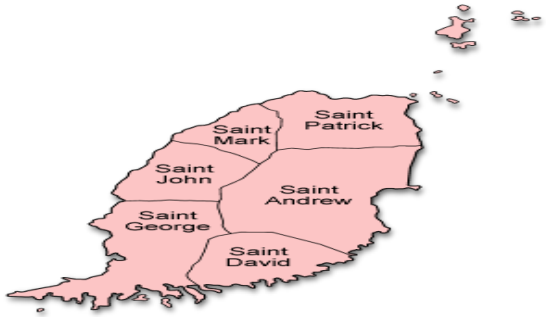
**Pick-up SUV car with minimal shopping**

# Benefits of Energy Conservation

## Homes/Buildings/Industry

- Reduced Energy Bills
- Increased comfort levels
- Increased productivity
- Reduced maintenance cost
- Increased profits.

## National




- Reduced fuel imports
- Resources to improve infrastructure
- Optimise the additional power demand
- Supports in meeting NDC commitments.

## Global

- Reduced Greenhouse gas emissions
- Maintains a sustainable environment.

# Importance of Energy Efficiency

Scarcity+ Cost +
Environment

&

Energy
Efficiency
is a must

Economic development
of Grenada

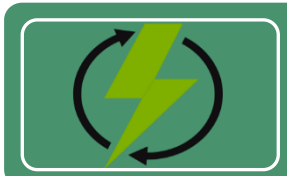
+

Released
capacity
**5 MW**

# Energy Management

Efficient energy use, is using less energy to provide the same level of energy service

Wastage of Energy



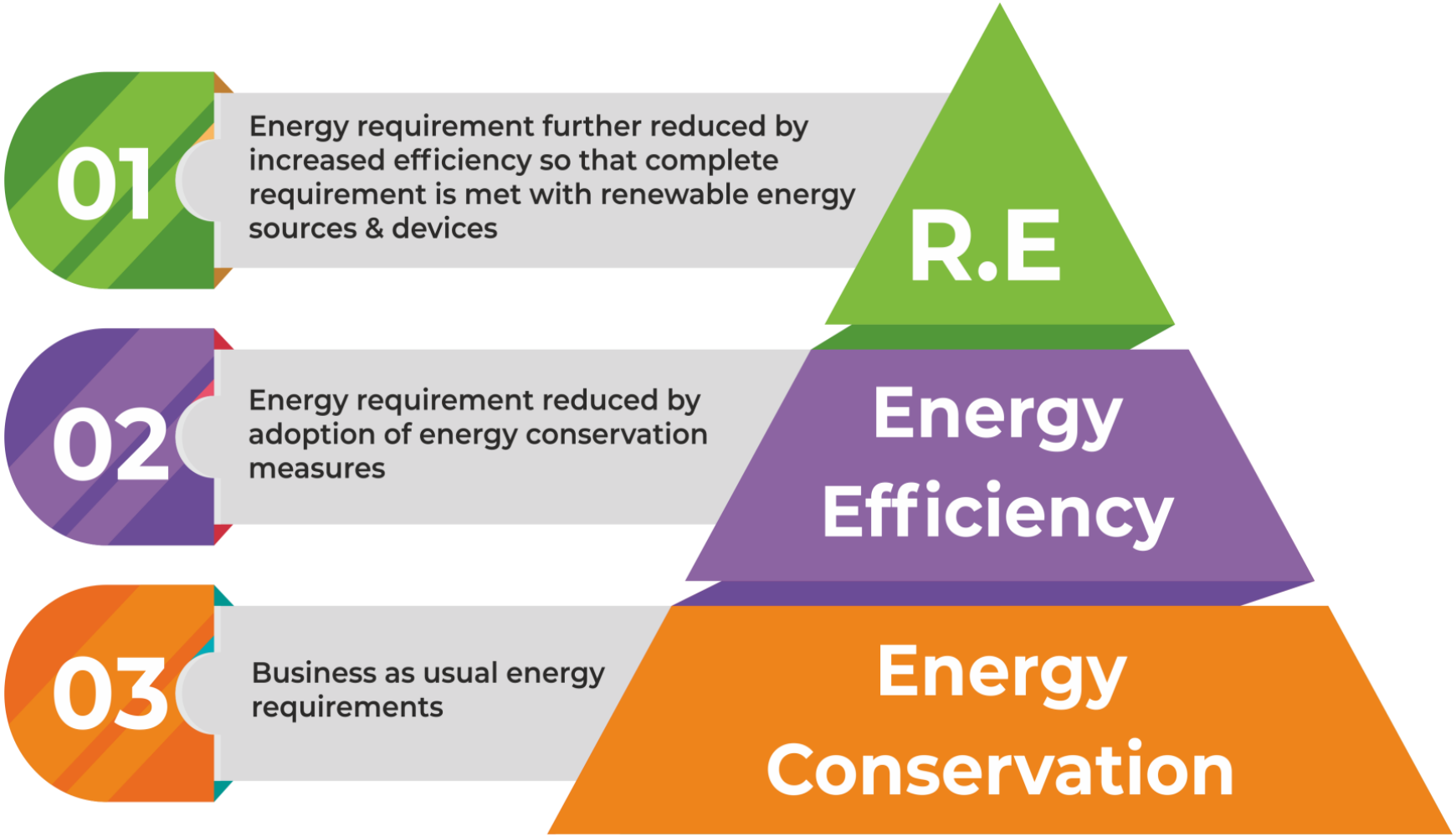
Minimise energy consumption

Energy Intensity


To look over again and again

“Energy Management Involves the utilization of the minimum quantity of energy required for the task at an appropriate quality, neither better nor worse than needed”

# Energy Pyramid - Approach



# Typical challenges – Energy Efficiency

- Energy is being monitored by electrical departments and they are responsible for power supply up to the equipment's;

- Separate departments for maintaining equipment's and instrumentation;

  - ❖ Difficulty in assessment and advice
  - ❖ Co-ordination problems
  - ❖ Limited focus, expertise in convincing end users and other department
  - ❖ Limited expertise in convincing budget heads to allot budget for Energy Conservation activities

- No procedure of re-looking the SOPs to refine the operating parameters based on todays or future requirements;

- Vendors / Equipment suppliers are not influencing the customer in terms of EE (only low-cost approach)

# Energy Efficiency drive to Overcome the Challenge

- Draw out an Energy Vision for Facility (Building, Hotel, School etc.,)
- Compliance to various local Acts / Standards;
- Dedicated and empowered team to initiate, convince all stake holders, create awareness & implement energy efficiency measures;
- Set Target, allocate budget, Monitor, control and verify;
- Holistic approach with external expert intervention;
- Look forward to the ISO EE 50000 standards;
- Draw up a monitoring plan based on metering features of facility

# Energy Saving Opportunities in Existing Buildings – Air Conditioner

Most of these buildings are having window and split air conditioners

- Absolutely no operational control
- Poor maintenance
- High specific consumption
- Porous envelop

Commercial buildings having fully air-conditioned space like shopping malls (or) Hotels have installed new generation equipment's. We find

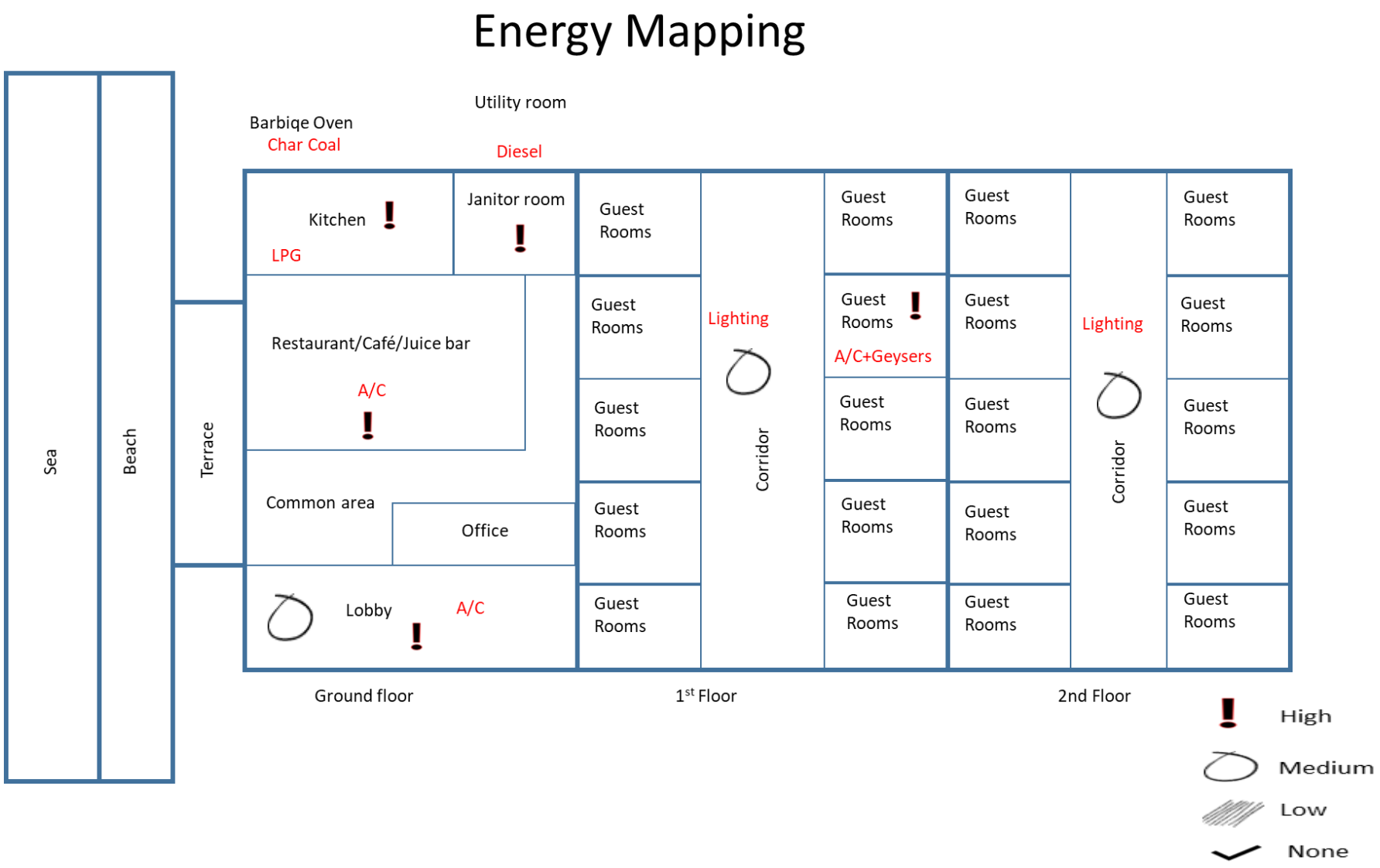
- Gaps in operation
- Gaps in maintenance
- No micro level monitoring plan

# Best Practices in Existing Buildings – Air Conditioner


Air conditioning outdoor unit on a roof  without shading

Air conditioner outdoor unit with shading

# Energy Profile Map : Hotel



# Identified Hotspots : Hotel

| S No | Priority Symbol | Area | Hotspot Identified | Impact | Indicator Value |
|---|---|---|---|---|---|
| 1 | ! | Guest Rooms & common areas | A/C High electricity usage due to split type A/Cs | Energy waste | Electricty consumption |
| 2 | ! | Kitchen | LPG & Char-Coal used for cooking and Barbiqe oven | Energy waste | Amount of Char-coal or LPG used per month |
| 3 | ! | Utility room | High diesel consumption for Diesel powered generator | Energy waste | Amount of diesel used per month |
| 4 | ! | Guest rooms | Energy consumption of water geysers | Energy waste | Electricity bill |
| 5 |  | Common areas/corridors | Lighting | Energy waste | Electricity bill |

# Action Plan : Hotel

| S. No. from priority table | Priority symbol | Improvement actions | Access to finance requirement | Assigned Person/ Responsibility | Timeline |
|---|---|---|---|---|---|
| 1. | ! | Switch to more energy efficient A/Cs. Use natural ventilation and avoid A/Cs in common areas | Yes | | |
| 2. | ! | Provide training to kitchen workers and reduce the time they are using fuel without utilizing the heat for cooking. | No | | |
| 3. | ! | Use solar powered water heaters | Yes | | |
| 4. |  | Use motion sensing switches | No | | |

# Example : Optimizing Lighting

Efficient Lighting system and day lighting

- Use of light shelves and Light Louvers
- Design for maximum day lighting without glare
- Provide light shelves to push natural light deep inside the building

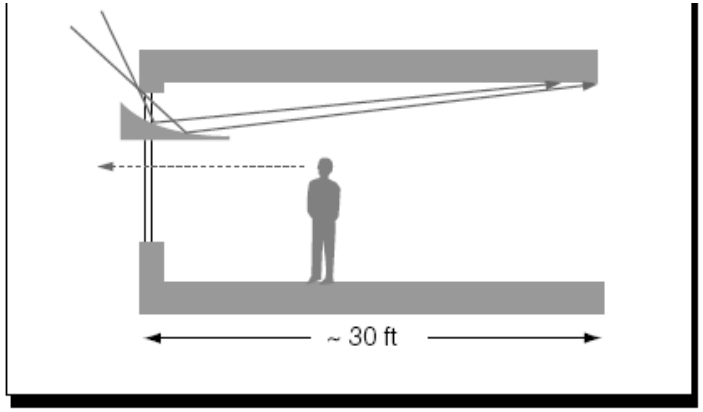
Efficient lamps and luminaries

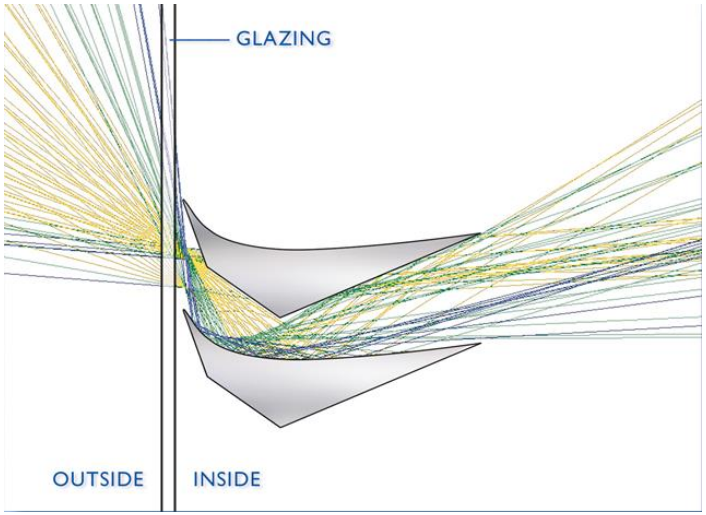
- LED lamps instead of conventional lamps
- Higher efficiency luminaries
- Dimmable electronic Ballasts
- Lighter colored and reflective finishes
- LED for Street lighting and special applications such as building facades

Efficient Controls

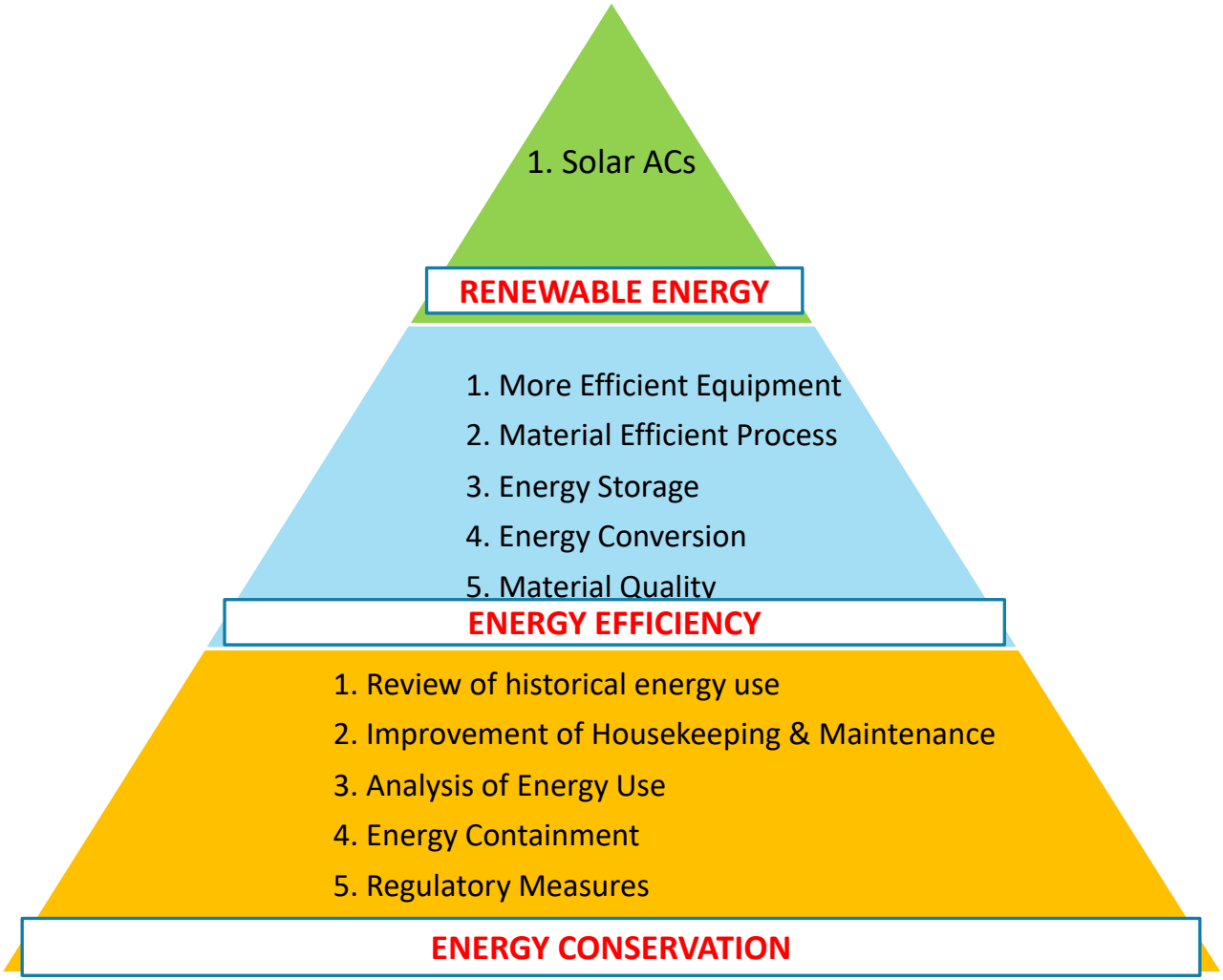
- Occupancy sensors
- Daylight sensors

Task Lighting



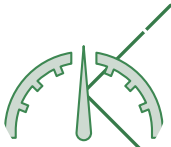
# Example : Air Condition



# Energy Use

Where it is needed

When it is needed

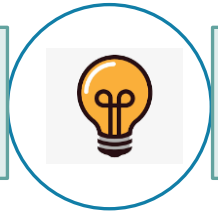


How much is needed

Of what quality is needed

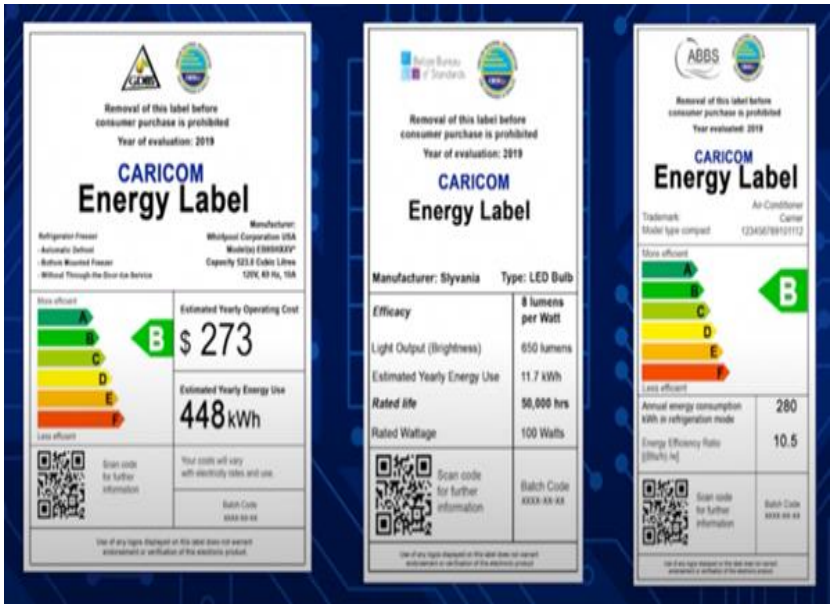
**Using most energy and resources efficient system operating on cleanest possible energy**

# 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. |

# Energy Efficiency Standards and Labels (EE S&L)

Based on Grenada's electrical system, high-efficiency split air conditioners (Power by R290 refrigerant technology having zero Ozone Depletion Potential) are demonstrated.

# Financial Assistance to Electric Vehicles (EV) for Tourism Sector

**Initial Cost of EV for Caribbean Region (Imported) : USD 40,000**

| | |
|---|---|
| Size of the battery | : 40 kWh |
| Travel distance per charge | : 240 KMs + |
| Operating Cost of Normal Car (Gasoline) | : US 25 cents per KM |
| Operating Cost of EV (Based on Grid Power) | : US 5 cents per KM |
| Return on Investment | : 200,000 KMs |

*Assume a tourist vehicle (car) travel for 200 KM per day*

Payback of investment cost : 4 Years

It is worth considering for **Financial Institutions** to establish solar powered EV charging stations at specified location and finance EV cars for tourism sector (existing tour operators / prominent players).

# Interactive Session

Exercise for First day:

1) What is important to collect during home energy audit from monthly Electricity Bill

**kWh**

2) Every home purchase solar based LED lamp for perimeter lighting. It means the household is promoting **Energy Conservation**

3) What type of electricity end users is predominant in Grenada? **Residential sector**

# Question…??

1. What are some of the energy challenges you face in your building/ facility/ sectors?

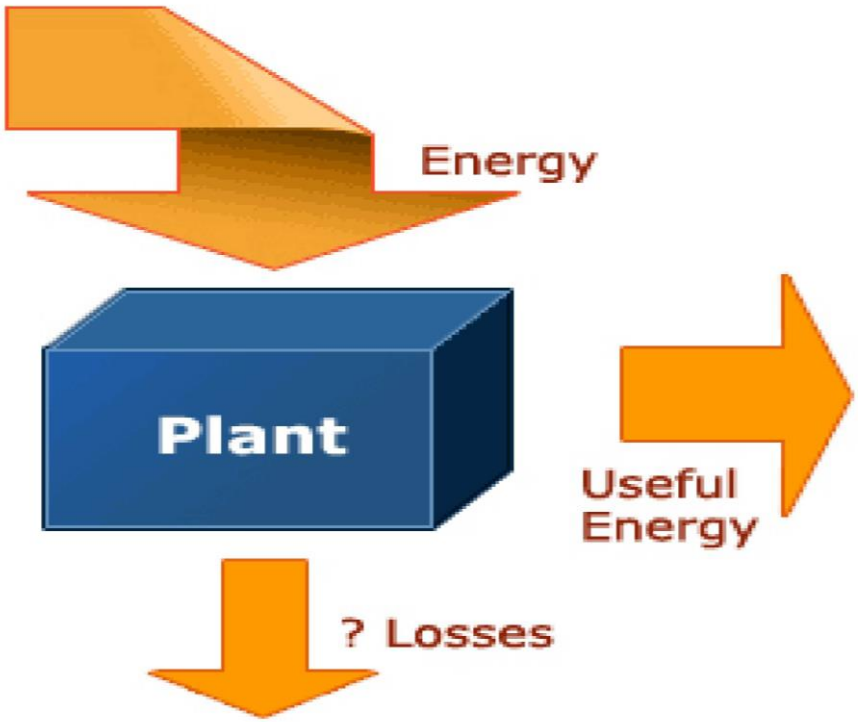
2. Have you ever conducted energy audit of your facility.

3. Steps taken to minimize the losses or to reduce monthly energy consumption.

# Session III

# Conduct of an Energy Audit

# What is Energy Audit




**Energy audit** is defined as " The verification, monitoring & analysis of energy use, including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption.

**Energy audit** is an activity or process to reduce the **losses** along with **energy consumption** without effecting the overall output.

# Need of Energy Audit

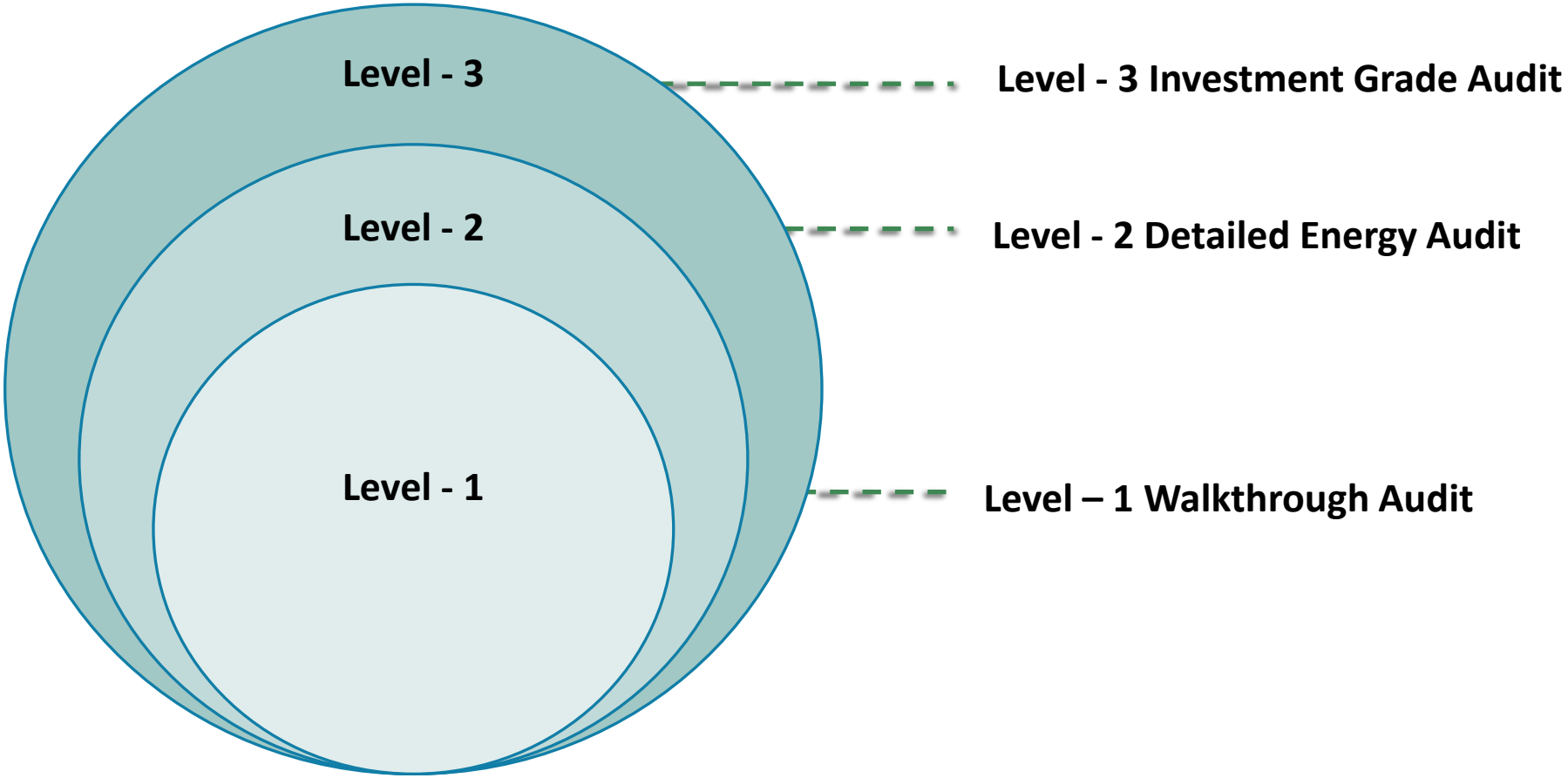
## An energy audit will

- Help to understand how energy (both electrical and thermal) are used
- Identify where waste occurs and where there is a scope of improvement
- Give a positive orientation to energy cost reduction
- Translate conservation ideas into reality

## Stages of Energy Audit

# Types of Energy Audit

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



# Level – 1 Walkthrough Audit

- Also called simple audit or walk-through audit.
- It involves:
  - **One** day or **half**-day visit to a plant.
  - Provides quick overview of **energy use patterns -** *Based on observation and historical data collected.*
  - Identify **energy – intensive** processes and equipment.
  - Identify **energy inefficiency**, if any
  - Estimate the **scope for saving** - *Findings will be a general comment based on **energy best practices***.
  - Identify the most likely **areas for attention**
  - Identify **immediate** (no-/low-cost) **improvements**
  - Identify areas for more **detailed study/ measurements**.

# Level -2 Detailed Energy Audit

Detailed Energy Audit evaluates all systems and equipment which consume energy and the audit comprises a detailed study on energy savings and costs.

Detailed Energy Audit is carried out in **THREE** phases

# Pre-Audit Phase

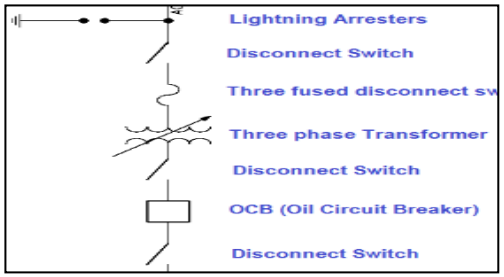
A pre-audit phase is the first phase or first step of a detailed energy audit.

During this phase, the energy auditor intends to take the following measure:

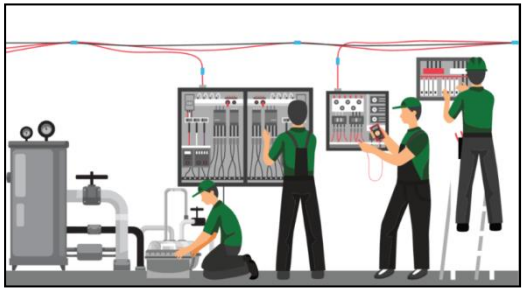
Discussion with the site manager about the energy audit

Explains the meaning of the energy audit and data needed

Analyzes the major area of energy consumption

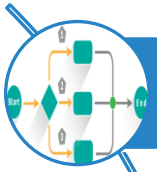



Obtains the site drawings such as a single line diagram of the electrical circuit, building layout, HVAC system



Energy audit team is finalized

# Audit Phase



Calculate efficiency of the equipment's installed

Preparing process flow diagram and do energy balance

Identification of Energy Conservation (ENCON) opportunities

Energy-saving and payback period

Technical and feasibility report


Implementation plan for energy-saving measures

# Post-Audit Phase

Assist and implement **E**nergy **C**onservation **M**easures and monitor the performance

## IMPLEMENTATION


## MONITORING

# Level – 3 Investment Grade Audit

- It includes steps of both **Level-1 & Level-2** energy audit.
- It provide, in detailed analysis of capital-intensive projects and provide in-depth financial analysis such as Net Present Value (NPV) and Internal Rate of Return method (IRR).

This type of audit recommends **Guarantied Saving Verification Plan** – Which includes energy saving measures along with financial analysis such as NPV & IRR

# 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**

## Power quality analysers/Load analysers

To measure various electrical power parameters such as

- The fundamental value of Voltage and Current,
- Voltage and Current total harmonic distortion,
- Individual Voltage and Current harmonics
- Active, Reactive and Apparent Power (P, Q, S);
- Power factor
- Frequency
- Voltage and Current Unbalance assessment
- Demand analysis
- Other power quality parameters such as surge/dip and transient analysis

# Mechanical Instruments

**Tachometer/ Stroboscope**

- Speed measurement of rotating equipment such as electric motors, pumps and blowers, conveyors etc.
- Available in contact and non-contact types.

**Ultrasonic flow meter**

- Measurement of the flow of liquids (Water) through pipelines of various sizes using ultrasonic sensors mounted on the surface of the pipelines.
- Flow can be recorded for the required period and downloaded for analysis

# Mechanical Instruments

**Anemometer**

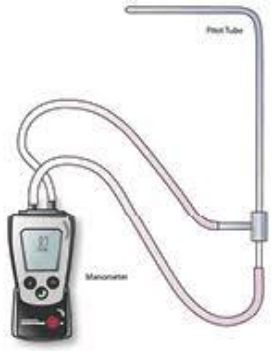
- Used to measure air velocity for estimating air flow rate
- Range: 0 – 30 m/s

**Hot wire Anemometer**

- Used to measure air velocity in duct to estimate air flow rate as well as air temperature
- Range: 0.25 to 30 m/s and 0 – 80 $^{o}$C

# Thermal Instruments

**Digital manometer**



- Used for measurement of differential pressure using pitot tubes
- Used to estimate efficiency of fan

**Analog/Digital pressure gauge**

- To measure the fluid or air pressure
- Suction and delivery side of pumps and fans

**Analog/Digital hygrometer**

- Measure temperature & humidity

# Thermal Instruments

**Infrared Thermometers**

- Measurement of Surface Temperatures

**Thermography Camera**

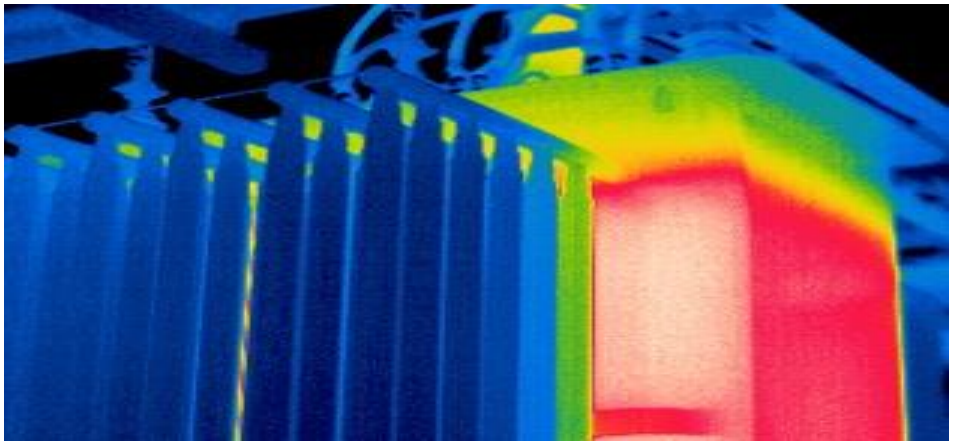
- Capture surface temperature and record it into memory card.
- Temperature variation over a given area.

**Thermocouples & Temperature Indicator**

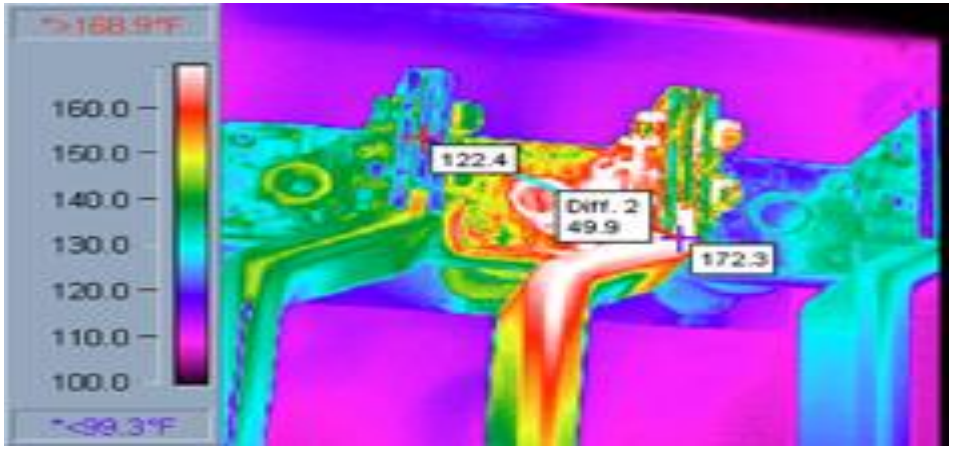
- Measurement of temperature
- Range : -50 to +400°C

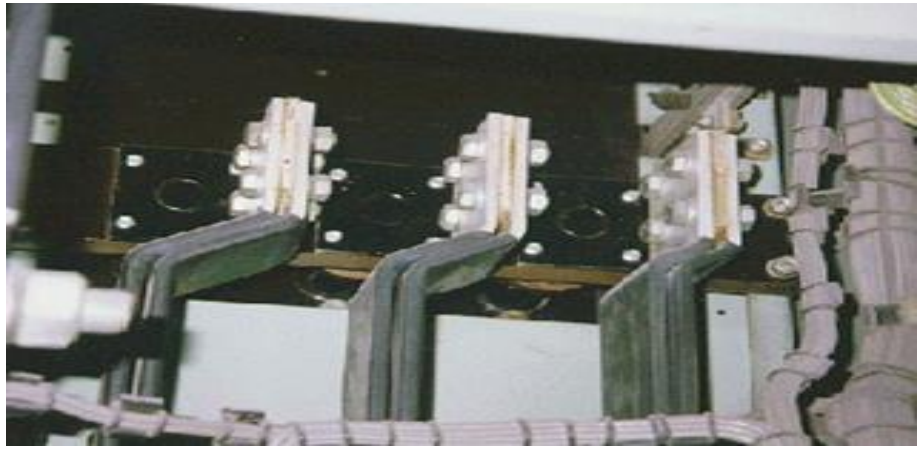
# Example of Thermography Images

## Hot cooling fins due to low oil level in a transformer



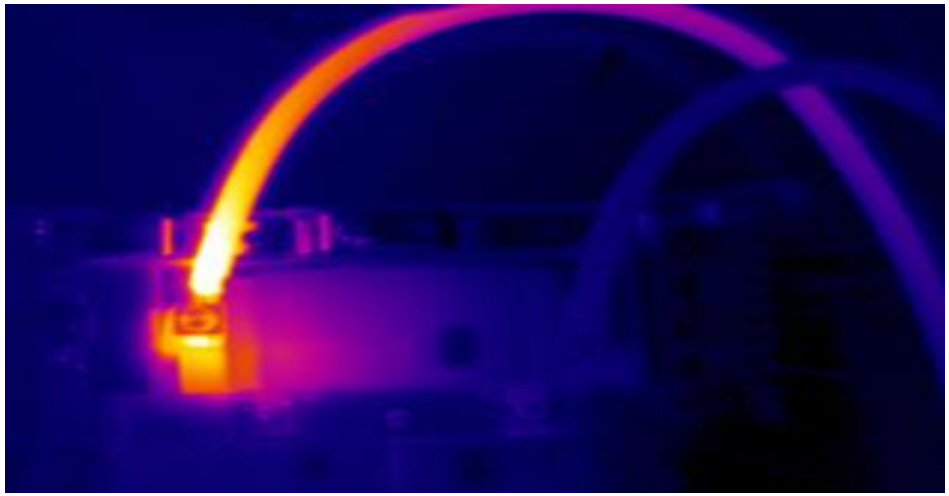

## Hot bolted bus bar connection

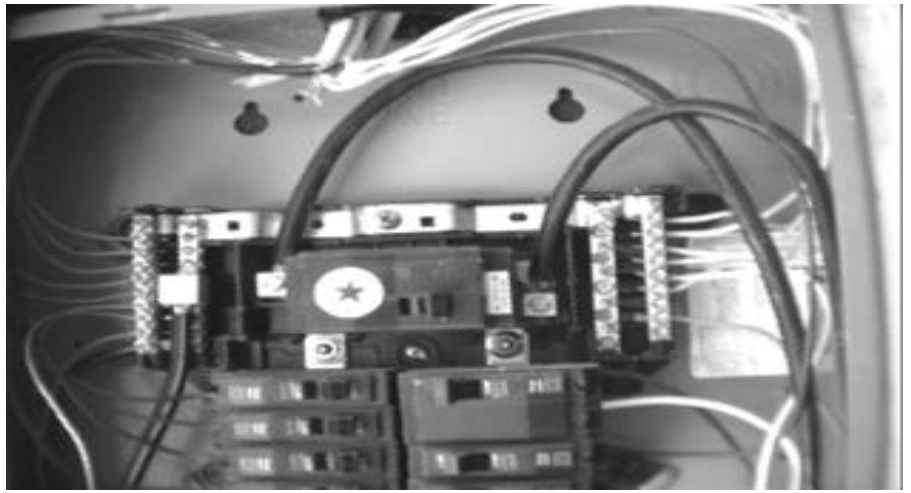


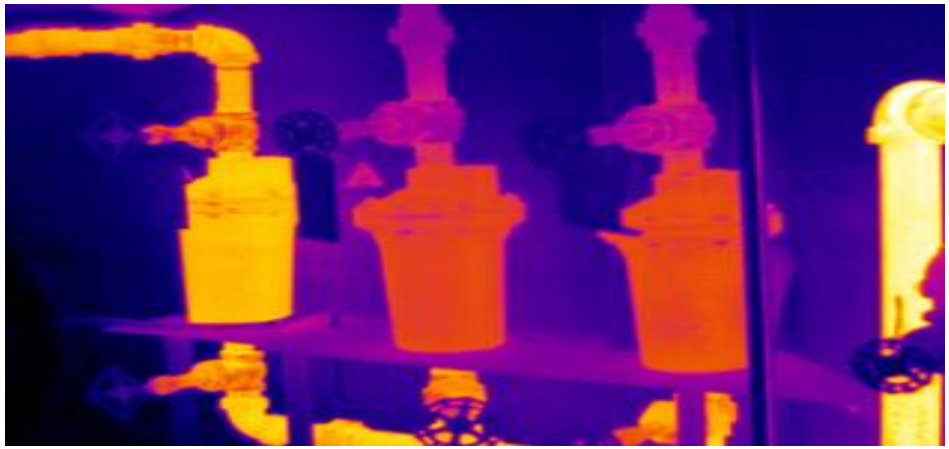
# Example of Thermography Images

## Hot lug connection





## Leakage in Steam Trap



# Thermal Instruments

**Digital temperature & humidity data logger**

- Dry bulb temperature & humidity
- Range: -15 to 150oC and 0 to 99 % RH

# Lighting Instruments

**Lux meter**


- Used for illumination level measurement.
- Can be used to measure the instantaneous value or record the variation in lux level over a period.

# Chemical Instruments

**Conductivity and PH meter**


- To analyse water quality

**Flue gas analyser**

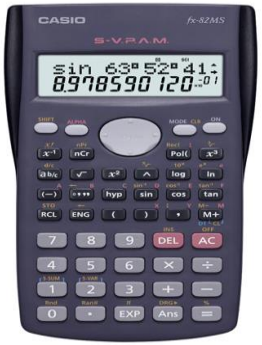
- Measure Oxygen (O2) and Carbon dioxide (CO2) levels in the flue gas
- Other flue gas parameters such as Carbon monoxide (CO), Nitrogen Dioxide (NO2), Temperature and Humidity can also be measured

# Other Accessories

**Notepad or Tablet**

- To quickly record data and observations on site

**Calculator**




- To do calculation

**Measuring Tape**


- To measure diameter or length of duct

# Stages of Energy Audit


**Preliminary Data Collected Before Site Visit**

- Monthly Energy Consumption Detail
  - Monthly electricity bill
  - Monthly diesel or any other fuel consumption
- List of equipment's or appliances
- Other relevant information like total build-up area or annual production

# Steps Followed During Plant / Facility Visit

**Step-1 :** Identify the energy intensive instruments or appliances

- Calculate Energy Consumption By Instruments or Appliances

**Step-2 :** Identify energy saving opportunities

**Step-3 :** Calculate annual energy saving (kWh/Year)

**Step-4 :** Calculate annual cost saving (EC$/Year)

**Step-5 :** Calculate investment require (EC$)

**Step-6 :** Calculate payback period.

# Energy Consumption By Equipment's

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

**Energy Consumption Per Month (kWh/Month)**

| Date | Name | Quantity | Rated Input Power (W) | Operating Hour Per Day | Energy Consumption Per Day (kWh/Day) |
|---|---|---|---|---|---|
| 1 Jan 2022 | | | | | |
| 2 Jan 2022 | | | | | |
| 3 Jan 2022 | | | | | |
| - | | | | | |
| - | | | | | |
| 31 Jan 2022 | | | | | |
| **Total Energy Consumption Per Month (kWh/Month)** | | | | | |

**Above step need to be followed for all the equipment's or appliances present within the facility**

# Energy Consumption By Equipment's

**Energy Consumption Per Month By Lamp (kWh/Month)**

| Date | Name | Quantity | Rated Input Power (W) | Operating Hour Per Day | Energy Consumption Per Day (kWh/Day) |
|---|---|---|---|---|---|
| 1 Jan 2022 | Lamp | 10 | 28 | 12 | **3.3** |
| 2 Jan 2022 | Lamp | 10 | 28 | 12 | |
| 3 Jan 2022 | Lamp | 10 | 28 | 8 | |
| - | | | | | |
| - | | | | | |
| 31 Jan 2022 | Lamp | 10 | 28 | 10 | |
| **Total Energy Consumption Per Month By Lamp (kWh/Month)** | | | | | |

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

# Energy Consumption By Equipment's

**Energy Consumption Per Month By Lamp (kWh/Month)**

| Date | Name | Quantity | Rated Input Power (W) | Operating Hour Per Day | Energy Consumption Per Day (kWh/Day) |
|---|---|---|---|---|---|
| 1 Jan 2022 | Lamp | 10 | 28 | 12 | **3.3** |
| 2 Jan 2022 | Lamp | 10 | 28 | 12 | **3.3** |
| 3 Jan 2022 | Lamp | 10 | 28 | 8 | **2.2** |
| - | | | | | |
| - | | | | | |
| 31 Jan 2022 | Lamp | 10 | 28 | 10 | **2.8** |
| **Total Energy Consumption Per Month By Lamp (kWh/Month)** | | | | | **78** |

# Energy Consumption By Equipment's

**Energy Consumption Per Year (kWh/Year)**

| Date | Energy Consumption Per Month By Lamp (kWh/Month) |
|---|---|
| January | 78 |
| February | 62 |
| March | 79 |
| April | 84 |
| May | 65 |
| June | 84 |
| July | 71 |
| August | 76 |
| September | 72 |
| October | 83 |
| November | 81 |
| December | 79 |
| **Energy Consumption Per Year (kWh/Year)** | **914** |

# Energy Consumption By Equipment's

To simplify the process to calculate monthly or yearly energy consumption by different equipment's following information were collected from facility manager:

- Operating days in a month
- Operating days in a year

| | | | | |
|---|---|---|---|---|
| **Energy Consumption Per Month (kWh/Month)** | **=** | **Energy Consumption Per Day (kWh/Day)** | **x** | **Operating Days in a Month** |
| **Energy Consumption Per Year (kWh/Year)** | **=** | **Energy Consumption Per Day (kWh/Day)** | **x** | **Operating Days in a Year** |

| | | | | |
|---|---|---|---|---|
| **Monthly Cost of Utilizing (ECD)** | **=** | **Energy Consumption Per Month (kWh/Month)** | **x** | **Per Unit Electricity Cost (ECD/kWh)** |

# 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 | |

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

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

# 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 | **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 | | | |

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

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

**Number of Days in a month : 30**

# 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 | |
| Computer (150W) | 6 | 6 | | | |
| Printer (120W) | 2 | 3 | | | |
| Ceiling Fan (75W) | 10 | 12 | | | |

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

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

**Number of Days in a month : 30**

# 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<br>C = b - a | Quantity of fuel required to fill tank (fuel required to cover distance) (d) | Fuel Efficiency<br>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 | |

# Thank You