microRenewables HANDBOOK

ENERGY MANAGEMENT

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CREST

FRIEDRICH EBERT STIFTUNG

What is Energy Management?

Energy management is a cost-effective and proactive solution to track, optimize and save energy and in the process mitigate climate change. Energy management can include the following:

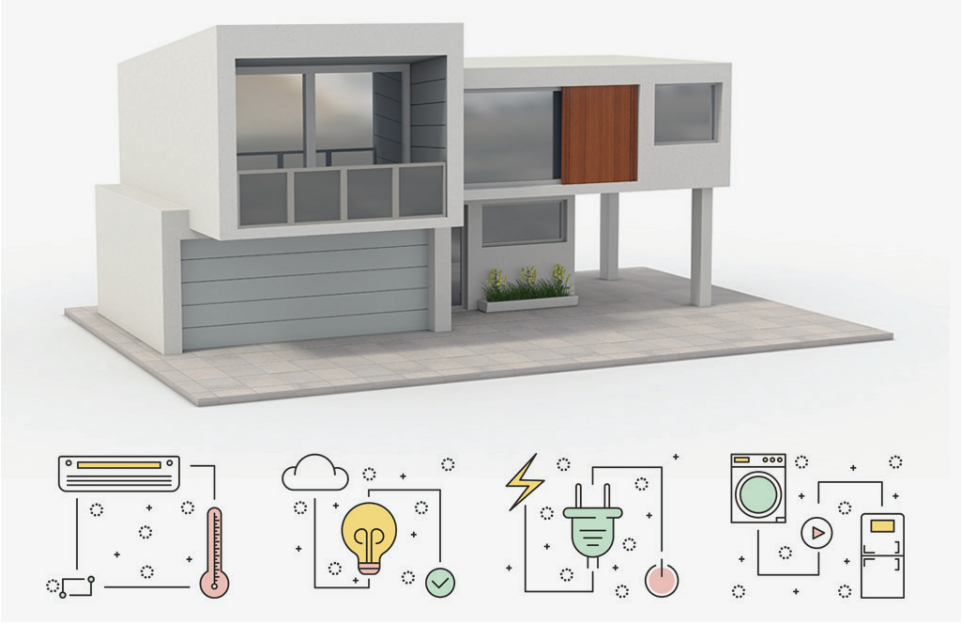
a. Monitoring the quantity and pattern of energy use;

b. Quantifying reduction of energy consumption; and

c. Implementing measures to decrease energy requirements without sacrificing productive applications and services.

Managing energy consumption will first and foremost require a fundamental change in mindset; it may start from simple actions such as turning off appliances, using energy-saving devices and appliances such as LED bulbs for lighting or highly efficient variable frequency motors (known as inverter motors) for air conditioning and refrigeration.

Energy management also involves looking at the big picture such as making investments in retrofitting building envelope and cooling systems, financial modelling and planning to estimate future operational cost reduction targets, and/or tapping accredited Energy Service Companies (ESCOs) to facilitate your energy audits and planning.



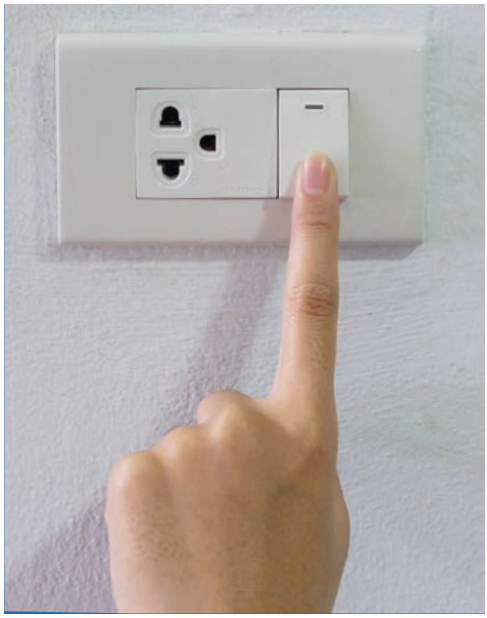
Concept of Energy Management

There are two general concepts of Energy Management:

Energy Conservation: Focuses largely on behaviors and actions that result in a reduction in energy use. For example, by switching the lights off inside an empty room or unplugging appliances that are not in use, a consumer saves energy from being wasted, and makes it available to carry out other necessary services or productive tasks.

Energy Efficiency: Primarily relates to the goal of reducing the amount of energy needed to provide the same level of services and output. Simply put, energy efficiency aims to eliminate energy waste. It also refers to the various measures (technical and non-technical) applied to processes and activities to reduce energy consumption.

To illustrate, replacing a 40 watt (W) incandescent bulb with a 6W LED lamp that provides the same level of illumination will result in energy savings of 34 watt-hour (Wh) and consequently, a reduction on the energy bill. The replacement or upgrade of technology may incur some initial costs for the consumer, but these costs may be comparatively lower versus investments required to increase generation capacity.

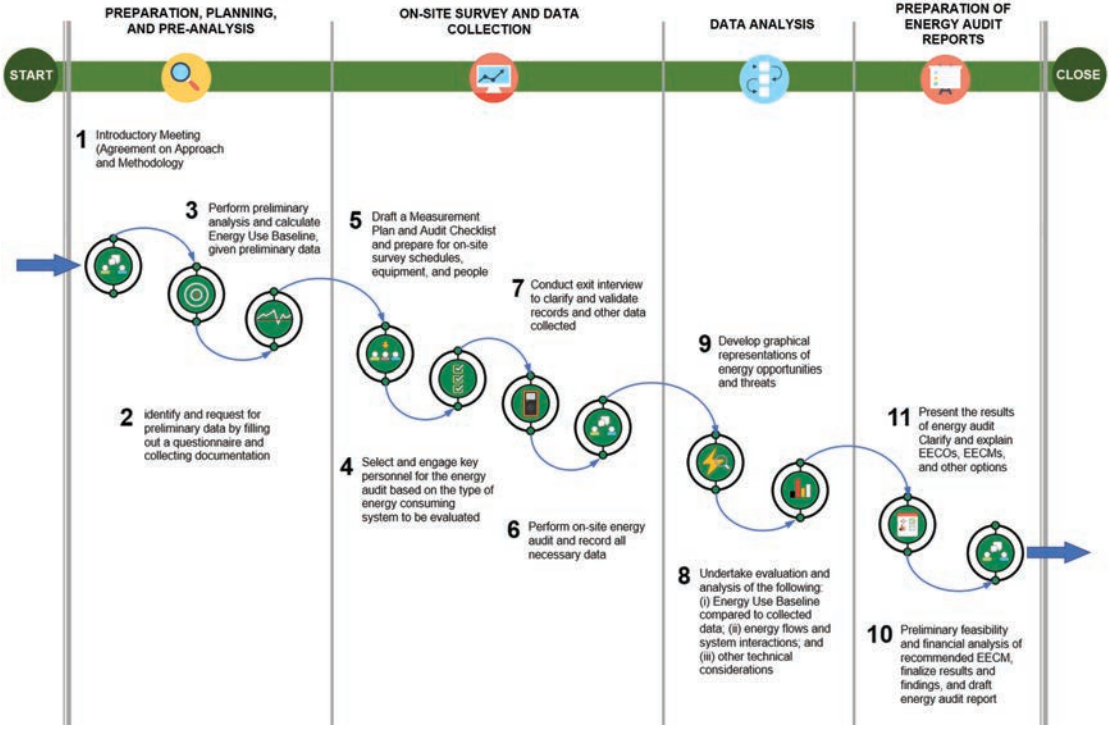


Why carry out an Energy Audit?

To improve the management of energy utilization in households and businesses, the economics of the overall energy consumption must be well understood. This is to ensure that the owner will recover the target returns for investing time and money in implementing energy efficiency and conservation efforts.

The benefits might reflect on energy savings, more productive applications, or lower operational costs. Unfortunately, most people do not have a good handle on the specifics of how and where energy and other resources are being used in households and businesses. Energy audit eliminates the guesswork and provides a systematic analysis of the energy consumed.

It is important to conduct an energy audit to be able to establish an energy management program. It also



Various steps of Energy Audit

facilitates the following outcomes:

a. Better understanding of the current level of energy utilization (in part or as a whole) for households or business organizations;
b. Identified behavioral change opportunities and/or technical opportunities by evaluating the operation of energy using components or systems;
c. Potential and viability of installing renewable energy supply technologies;
d. Compliance with legal and regulatory requirements, particularly the Energy Efficiency and Conservation Act; and
e. Clear financial information regarding energy savings opportunities in order to integrate these into household or organizational decision-making.

Defining the Energy Audit

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) defines three (3) levels for energy audits, based on the level of detail and the physical extent or scope of the audit.[1] Such that, as the complexity of the audit increases, the scope of work (including the thoroughness of the site assessment, amount of data collected, and the analysis and details provided for the final energy audit report) increases proportionally (Figure 3).

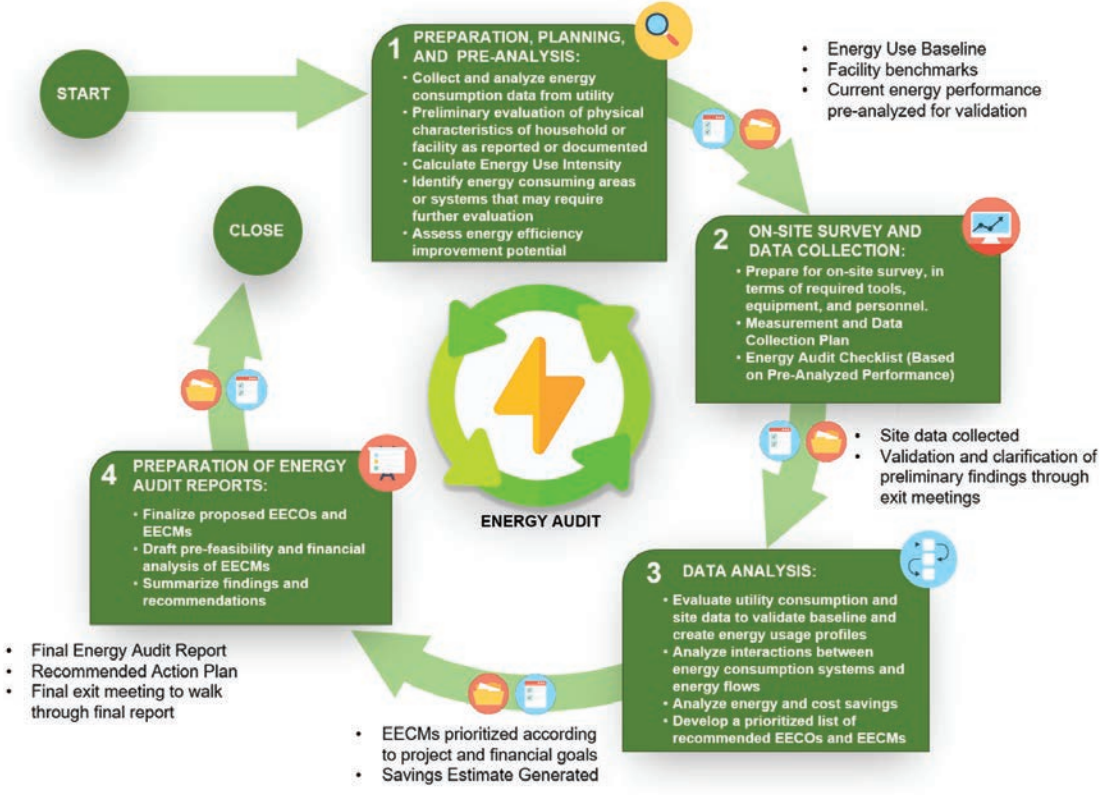
a. **Level I: Site Assessment or Preliminary Audits (Walk-Through Energy Audit).** Identifies no-cost and low-cost energy saving opportunities, and a general view of potential capital improvements. Activities include benchmarking of energy consumption, assessment of energy utility bills, site inspection of the household or building envelopes, systems and equipment, and specific operating data.

b. **Level II: Energy Survey and Engineering Analysis Audits (Detailed Energy Audit).** Identifies no-cost and low-cost opportunities, and also provides Energy Efficiency and Conservation Opportunities (EECOs) and/or Energy Efficiency and Conservation Measure (EECM) recommendations in line with available financial plans of the household or organization and potential capital-intensive energy savings opportunities. Level II Energy Audits build on the activities done in a Level I Energy Audit and goes further to include an in-depth analysis of energy

1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE). 2004. Procedures for Commercial Building Energy Audits. Quoted in Baechler, Michael, Strecker, Cincy, and Shafer, Jennifer. 2011. A Guide to Energy Audits. Richland, Washington: US Department of Energy and Pacific Northwest National Laboratory.

costs, energy usage and building characteristics, and a more refined survey of how energy has been used within the household or organization.

c. **Level III: Detailed Analysis of Capital-Intensive Modification Audits (Investment Grade Energy Audit).** Provide solid recommendations and financial analysis for major capital investments. In addition to Level I and Level II activities, Level III Energy Audits include intensive monitoring of processes and systems and equipment, collection of operating data, and a rigorous engineering analysis of interactions and energy flows.



Stages of Energy Audit

Walk-Through Energy Audit (Level I)

For smaller facilities, micro/small-scale business establishments, or households with no or little financial resources, a walk-through energy audit can already yield significant results and give the household owner or building manager a general idea of step-by-step activities that will eventually develop into a comprehensive energy management program.

Step 1: Set the goals and parameters of the energy audit. Secure organization or family members' support in adopting energy management practices. Some key questions: What do we want to achieve with the energy audit? How much time and resources do we need to spend? Is the walk-through audit for the whole building or specific floors only?

Step 2: Study available data. Building layout, monthly electrical bills, equipment purchase records etc can help you establish patterns of energy use. Some useful sources of information are as follows: monthly electrical bill for the past year, building floor plans and electrical plans, list of electrical equipment and devices used and average usage of hours per day for each equipment.

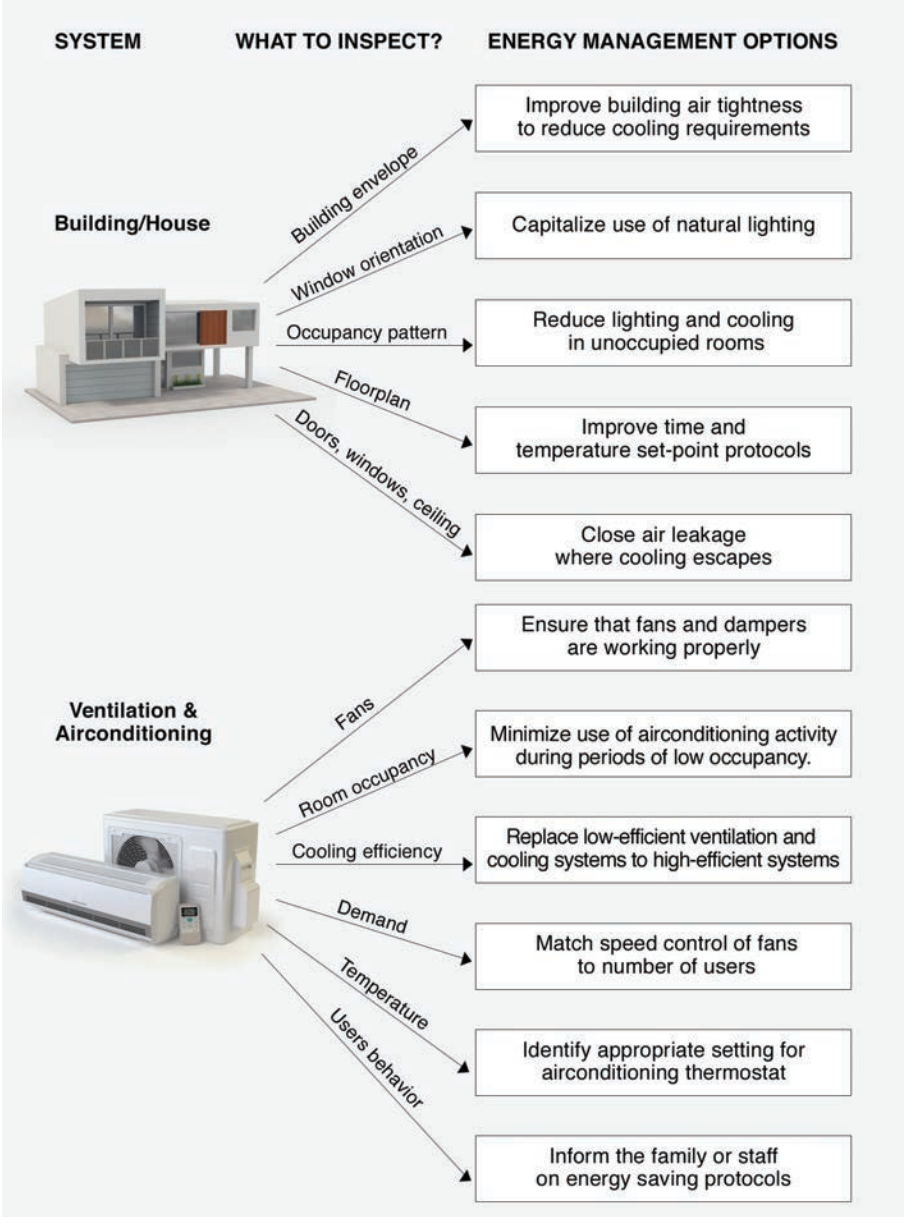
Step 3: Perform a Preliminary Data Analysis. Establish your electricity pattern from your monthly bills and correlate the data with your available appliances and devices. The data that you accumulated can serve as your Energy Use Baseline and it will be helpful to monitor the progress of your program.

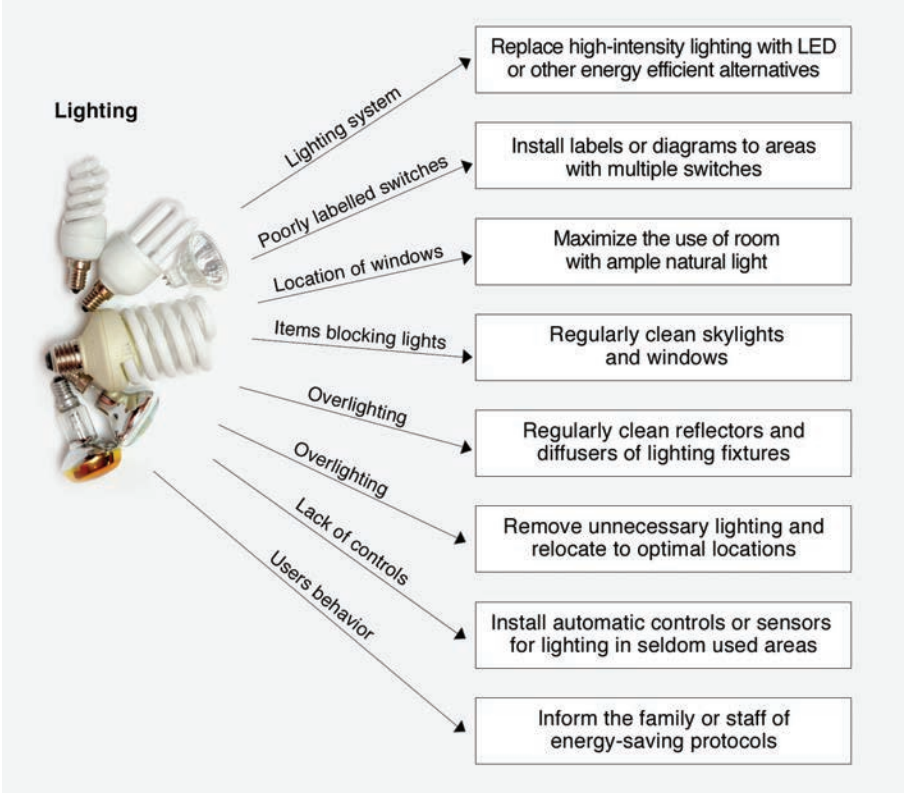
Step 4: Identify who will conduct the Energy Audit. Identify the family member or business personnel who will conduct the walk-through energy audit. The same person can be asked to help implement or monitor the energy management program.

Step 5: Prepare an Energy Audit Plan. Develop a checklist for the energy audit depending on the results of your preliminary data analysis. To ensure the smooth conduct of the on-site survey, the following tasks should be prepared

- Ensure that the organization or facility has been notified and able to provide approval on the schedule and conduct of the energy audit.
- Safety should be a priority. Ensure that the energy audit personnel wears appropriate clothing and proper personal protection equipment.
- Check that the necessary measuring equipment and instrumentation are operating properly (correctly calibrated, fully charged status, memory cards inserted, sensors and probes complete) to ensure that no mistakes and inaccuracies will hamper the audit.

Step 6: Conduct the walk-through audit. Some common energy consuming systems that may be observed in residential, commercial, and industrial sectors.





Step 7: Conduct an exit interview to validate the data collected. Conduct an interview with the building manager or operator to validate the information that you gathered during the walk-through audit.

Step 8: Design your Energy Management Plan. Analyze information gathered from preliminary data review and on-site walk-through energy audit. Design a simple management plan including recommendations. Present it to the family members and business personnel for approval and adoption.

Practical Tips and Tricks to Reduce Energy Consumption

Here are some practical tips to reduce your energy consumption at home or in your business establishment.

Air Conditioners

1. Ensure that the cooling capacity of the air conditioner matches the required cooling load for the space or room. Basing the capacity primarily on the floor area alone, a room or space with a floor area of 18 m² will require a 1.0HP air conditioning unit.
2. Understand the different operating modes for the air conditioners installed in the space or room and how such operating modes affect cooling performance and electric power consumption. Air conditioning units from different brands may feature different modes or have different names for the same operating modes.

Cooling Mode

Default operating mode for any air conditioner. The thermostat setting on the air conditioner dictates the amount of energy consumption resulting from the periodic cycling of the compressor in order to maintain the room temperature. Available technical studies recommend setting the air conditioner thermostat to the 25°C mark as a way of ensuring energy efficient operation while providing adequate comfort for occupants.

Cooling: High | Power Saving: Moderate

Fan Mode

Operating the air conditioner in Fan Mode switches OFF the compressor and in effect, the cooling functionality of the appliance. In this mode, the air conditioner will only provide ventilation and air circulation at a low amount of energy consumption.

Cooling: Minimal | Power Saving: Very High

Power Saving or Energy Saver Mode

This is a built-in air conditioner operating mode included as one of the energy conservation features of the appliance. Different manufacturers implement the Energy Saver Mode in a variety of ways: (i) Some program the air conditioner to automatically adjust the temperature a few degrees higher than the thermostat setting selected by the user. When the air conditioner reaches the set temperature,

the compressor switches OFF, but the fan continues operating. The adjusted temperature setting means that the compressor will run for shorter durations, reducing energy consumption; (ii) Manufacturers may also implement the operating mode by switching both the compressor and fan OFF when the thermostat reaches the temperature set by the user; and (iii) Other manufacturers may also switch both the compressor and fan OFF when the thermostat reaches the temperature set by the user and a timer to switch both the compressor and the fan ON.

Cooling: Moderate | Power Saving: Very High

Quick Cool or Turbo Mode

The operating mode runs the air conditioner at maximum capacity until the thermostat cools down to 16°C or 17°C and as a consequence, consumes the highest amount of energy.

Cooling: Very High | Power Saving: Low

Dry or High Humidity Mode

The Dry or High Humidity Mode removes the extra humidity or moisture in the space or room by cycling the compressor ON and OFF for short periods of time, while continuously running the fan at low speed. The compressor run-time will be adjusted so that when the internal humidity sensor of the air conditioner detects a low enough humidity level, the compressor will be turned OFF. The operating mode will be useful for temperate areas with high humidity or during the monsoon season in tropical locations.

Cooling: Low | Power Saving: Moderate

Sleep or Night Mode

The operating mode has been designed to keep the room temperature comfortable and reduce energy consumption during sleeping hours. Turning the operating mode ON will increase the temperature by 0.5°C to 1°C every hour to prevent overcooling (people normally require less cooling while asleep).

Cooling: Moderate | Power Saving: High

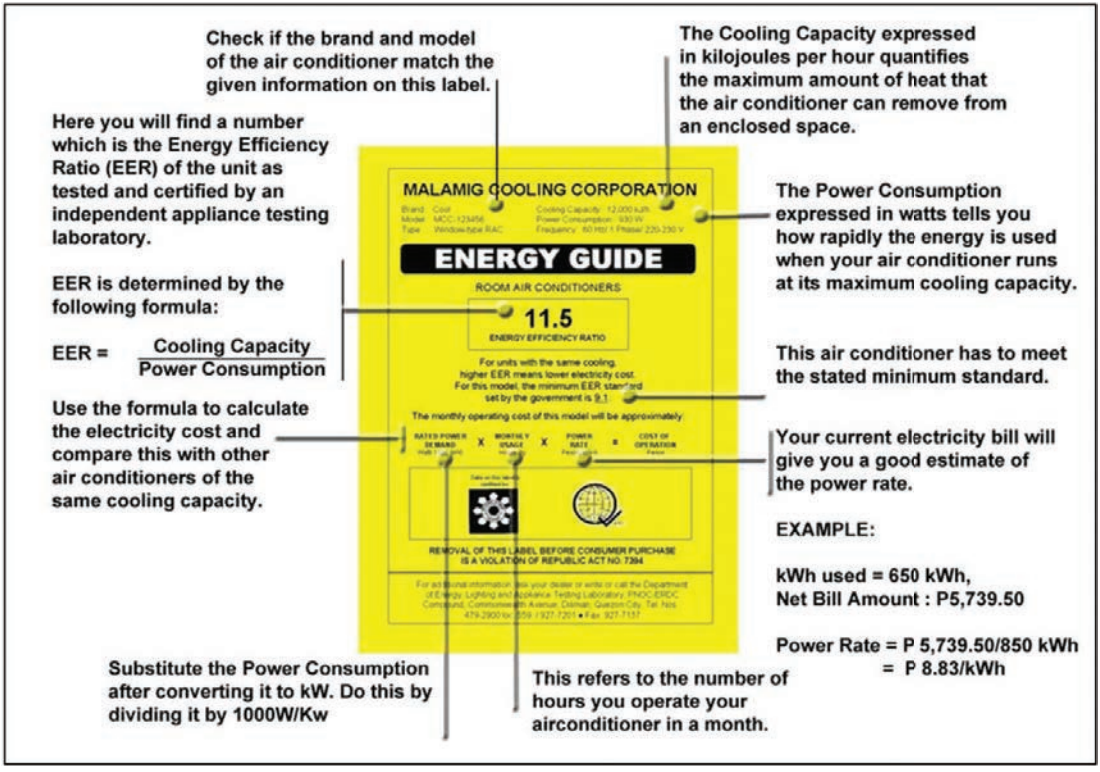
3. Follow prescribed maintenance schedules and clean the air conditioner filters. Clogged air filter reduces airflow and forces the air handler to work harder in pushing air through the appliance for cooling and ventilation. As a consequence, the cooling efficiency decreases and energy consumption increases – approximately resulting to a 30 percent increase or additional PHP330.00 to PHP350.00 per month (based on the MERALCO rate for 2Q 2020) for a 1.0HP aircon unit.

4. Consider upgrading to highly efficient variable frequency motors

for air conditioning and refrigeration (more popularly known as inverter air conditioners or refrigerators). Based on MERALCO Power Lab tests, inverter based cooling technologies can generate savings ranging from 25 percent to 62 percent. For a 1.0HP unit, the equivalent monetary amount can be around PHP504.00 per month.

5. Reduce the amount of floor area to be cooled by the air conditioner and the potential heat gains from windows and doors.

6. Always compare and select air conditioner units based on the computed Energy Efficiency Ratio (EER). High values of the EER (for the same cooling capacity) usually corresponds to potentially lower the operating costs. The label below presents a sample of the energy label for air conditioning units.



EER Label for Air Conditioning Units under the Philippine Energy Standards and Labelling Program

Electric Fans

1. Use the appropriate fan speed to ensure both thermal and noise comfort of occupants within the room or space. Setting the fan speed to high will not only increase energy consumption, but may also distract or annoy people due to the noise or excessive air flow created by the fan. MERALCO Power Lab tests found that a fan with a 16" diameter operating daily at low speed setting for 9 hours, can save as much as PHP32.40 per month compared to a fan operating at the highest speed setting.
2. Follow prescribed maintenance schedules and clean electric fan parts. Accumulated dust reduces airflow and forces the motor to work harder in pushing air through the fan blades and increases energy consumption. Occasionally open the motor housing for cleaning and lubrication to lessen the chance of the fan overheating and consuming more energy.

Audio-Visual Equipment

1. Watch together, instead of watching different programs on different television sets and multiplying the energy consumption. The MERALCO Power Lab estimated the operating cost for a 32" LED television at PHP0.38 per hour. Using the television for 8 hours daily would generate a cost amounting to PHP91.20 per month. Use the energy saving operating mode for televisions installed with this function.
2. Always unplug unused appliances to eliminate costs associated with the consumption of stand-by power. The 32" LED television mentioned above and plugged in consuming stand-by power may result to additional costs to the electric bill ranging from PHP5.00 to PHP10.00 per month or around PHP10.00 to PHP15.00 per month for older models on stand-by power. The use of an electric power strip for the television and other appliances may help lessen the inconvenience of unplugging.
3. Consider upgrading to more energy efficient models, such as LED televisions, that can save up to 77 percent of energy costs per month with a better viewing experience. Select the appropriate size when purchasing a new television. The larger television size, the higher the required operating wattage, resulting to a higher consumption of energy and associated costs.

$$\text{Recommended Television Size} = \frac{\text{Viewing Distance (in inches)}}{2}$$

Kitchen Devices and Appliances

Induction Heat Cookers

Based on MERALCO Power Lab tests, induction cookers perform more efficiently than liquefied petroleum gas (LPG) and conventional electric (coil-type) stoves. Induction cookers can cook food faster with precise time and temperature, create less ambient heat to save on space cooling costs, and have a higher degree of safety compared to LPG stoves. Operating costs range from PHP12.00 to PHP13.50 per hour. Using the induction cooker for a total of 4.5 hours daily will result to an average cost of around PHP380.00 per month.

Gas Ovens and Microwaves/ Oven Toasters

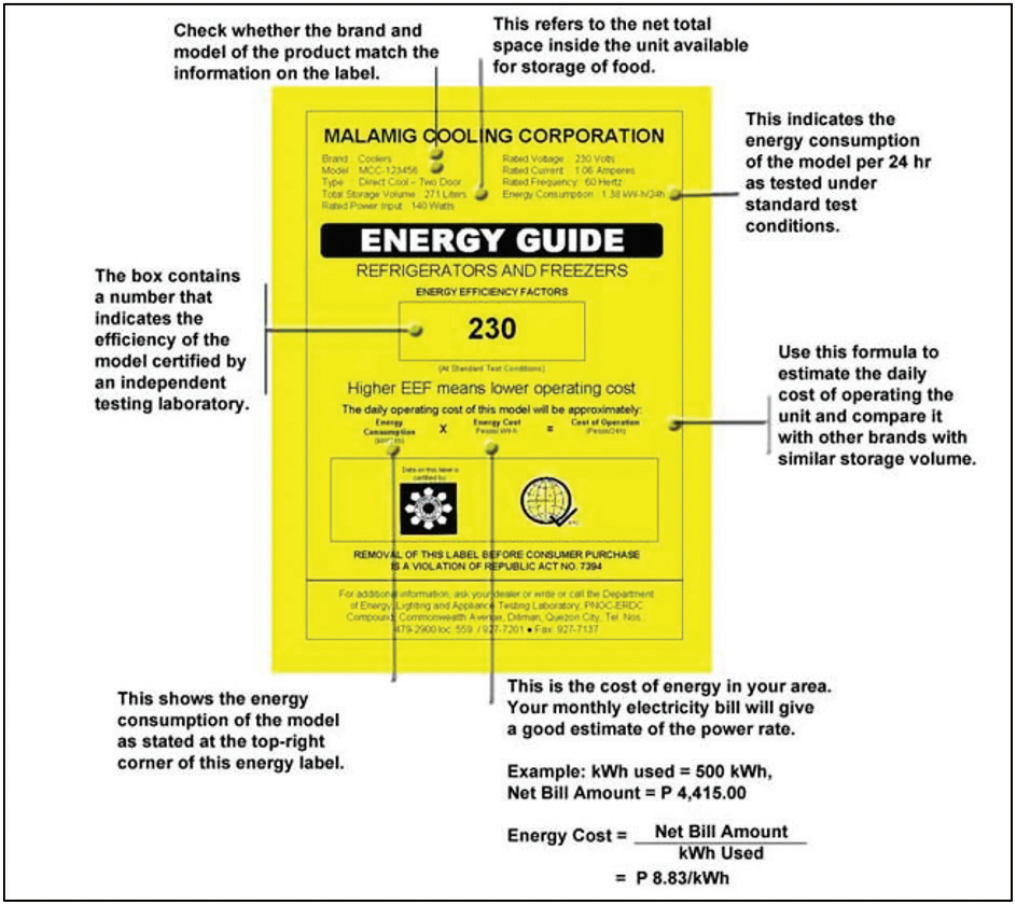
1. Use a microwave over conventional full-size gas ovens, particularly for cooking small portions of food or warming leftovers. The microwave consumes 35 percent less energy compared to cooking with gas. However, the cost of electricity will be higher than the cost of LPG.

2. Utilize the most appropriately-sized pan to maximize the space inside a full-sized gas oven. Smaller pans will be cheaper and more energy-efficient to heat up. To further lessen the costs, use glass pans (applicable for both microwave and gas ovens) to facilitate the retention of heat and enable the use of lower cooking temperatures.

3. Turn the gas oven off even before the recommended cooking time has been completed (up to 15 minutes, depending on the type of food). The residual heat in the oven will continue to cook the food until finished. Keep preheating to a minimum.

Refrigerators

1. Always compare and select refrigerator units based on the computed Energy Efficiency Factor (EEF). High values of the EEF (for the same cooling capacity) usually corresponds to potentially lower the operating costs. Figure 12 presents a sample of the energy label for refrigerator units. In addition, make sure to purchase an appropriately sized unit based on the number of family members or users of the refrigerator unit. 7ft³ to 10ft³ refrigerator units will generally have enough capacity for two (2) people. Add an extra cubic foot of capacity for each additional person or user.



EEF Label for Refrigerator Units under the Philippine Energy Standards and Labelling Program

2. Provide proper air circulation and placement based on the recommendation and instructions of manufacturers. Allow for a 1.5" to 2" clearance on all sides of the refrigerator to ensure proper airflow to prevent overworking the motor and efficiently reduce heat from the condenser coils. Do not position the refrigerator near heat-producing appliances or expose it to direct sunlight.

3. Keep the refrigerator full, but not overloaded, to allow for the proper circulation of cold air. Overfilling the refrigerator hinders airflow, effectively reducing efficiency and increasing energy consumption. The internal temperature of the refrigerator should be between 2°C to 3°C and -18°C for the freezer.

4. Always mind the door and other seals/gaskets. Repeated opening of doors increases the heat gain inside the unit reducing the operating efficiency and increasing energy consumption. In addition, air infiltration and leakages will require additional energy to maintain the internal temperature. The gaskets and seals may be tested using the paper test. The test involves closing the door on a piece of paper and attempting to manually pull out the paper. If the paper can be pulled out easily, the gaskets and seals must be repaired or replaced.

5. Consider upgrading to highly efficient variable frequency motors for air conditioning and refrigeration (more popularly known as inverter air conditioners or refrigerators). Based on MERALCO Power Lab tests, inverter based cooling technologies can generate savings of up to 50 percent.

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NOW OPEN!

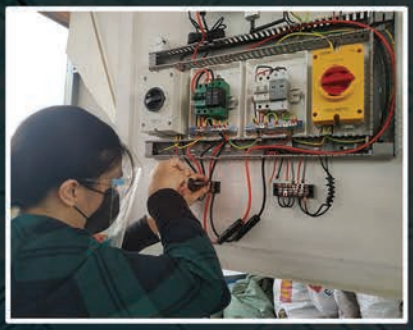
CREST

microRenewables Learning Center

Do you want to expand your knowledge and skills on RE systems?

Visit our center and learn about different renewable energy and small-scale climate systems. The facility provides a venue for professionals, advocates and enthusiasts to learn practical applications for various microrenewable such as solar photovoltaic (PV) rooftop and wind technology.

The facility also has a regenerative urban garden system that combines an organic garden with rainwater harvesting, soil management, and composting.

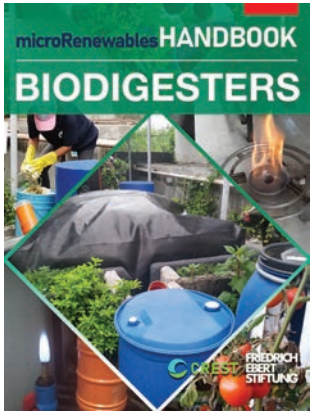
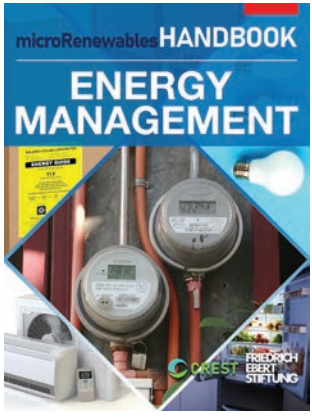
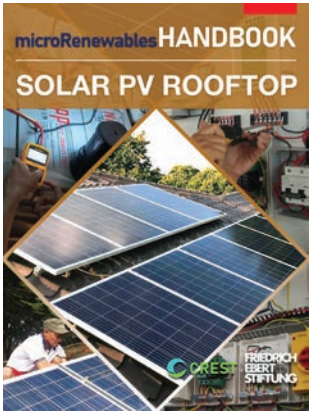


The CREST's microRenewables Learning Center is located in **69 Bansalangin Street, Project 7, Quezon City**.
To know the training schedules and/or arrange visits, please contact **crestphilippines@gmail.com**

Go microRenewables!

Renewable energy is one of the fastest growing global industries. In the Philippines, solar PV rooftop has already achieved grid parity, and it is now the cheapest electricity source. Electricity produced from other renewable energy sources are also already cost-competitive with those produced from conventional fossil-fuel power facilities such as coal and oil.

Current and future innovations on renewable energy are already shifting to decentralized, small-scale systems. CREST sees the renewable energy industry today in a similar stage as the computer industry, when microcomputers were starting to be used by techies and increasingly by businesses. When these products reached a certain market volume, the economy of scale began to take effect, resulting in a virtuous cycle of steady price reductions and continuing market growth.

CREST releases this handbook to encourage all to adopt sustainable energy and climate systems in your own homes and business establishments. These learning products will be useful to interested local government officials, teachers and students, technical professionals, energy advocates, and even to individuals that have no deep technical background.

The adoption of sustainable practices in homes and workplace will result to healthier and safe environment for families, co-workers and fellow members of our community.