Guidelines on No-Cost and Low-Cost Measures for Efficient Use of Electricity in Buildings

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INTRODUCTION

These guidelines are prepared by the Energy Commission with the intention to provide guidelines and assistance to owners or occupants of a building in undertaking energy saving measures that require:-

- No-Cost measures, which can be implemented immediately without spending any money. They require only sometime, attention, creativity, discipline and persistence.

- Low-Cost measures, which require spending of small amounts of money, and

- Some planning for their implementation.

From experience, such measures can achieve at least 5 percent of energy savings and in some cases it can be much more.

These measures do not address or involve projects which require heavy investments. However, in many cases, it can result in significant savings. They can in fact , create the efficiency culture and behaviour change to the people as well as an organisation and prepare the way for more investments in energy saving measures.

Typical electricity distribution in Malaysian buildings as shown in figure 1 , consist of air-conditioning load (usually with the highest percentage), lighting, office equipment and others.

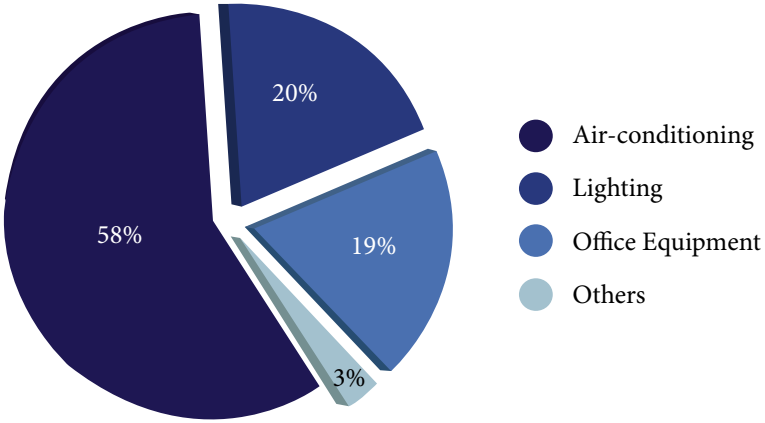


Figure 1: Typical electricity usage in office buindings in Malaysia

INITIAL MANAGEMENT INITIATIVES

i. Formulate a simple energy management policy, with targets and have it available to all staff, workers and occupants;
ii. Appoint a specific person with responsibilities on energy management activities. Assign an energy management team with representatives from various departments/sections;
iii. Have a suggestion box for possible energy saving measures;
iv. Provide simple incentives for good energy saving practices;
v. Include energy efficiency in specifications and procurement for new equipment;
vi. Keep records of energy consumption within the facility. Trend consumption figures to track variations or excessive uses and the reasons for it;
vii. Publicise energy saving successes to motivate the staff towards greater commitment;
viii. Reinvest a portion of the savings in more saving measures.

ENERGY AUDIT

Before embarking on any energy saving measures, it is important that an energy audit is carried out in t he facility concerned. An energy audit is an inspection, survey and analysis of electrical energy usage in a building, process or system which is done to conserve energy by reducing the amount of energy in to the system without negatively affect ing the output. Energy audits have to be accurate to a certain degree and it s findings credible enough to be used as the baseline value prior to retrofitting for energy efficiency.

When an energy audit is done in an occupied building, opportunities to reducing energy consumption should be identified without compromising on human comfort, health and safety which are the primary object ives of a building.

Industrial energy audits usually will show that cooling energy, compressed air energy, lighting and production equipment use the most electrical energy.

Beyond simply identifying the sources of energy use, an energy audit seeks to prioritise the energy utilisation according to the greatest to least cost effective opportunities for energy savings.

In an industrial energy audit, cooling energy, compressed air energy, lighting, and production equipment are usually those that use the most electrical energy. In specialised plants, scrubbers, vacuum systems and clean rooms are also large electrical energy consumers.

There are three commonly used methods in energy auditing described below;

a) *Benchmarking/Baseline*
Establishing baseline consumption or benchmarking mainly consists of comparing the measured consumption with reference consumption of other similar buildings or generated by simulation tools to identify excessive or unacceptable running costs. A benchmark can be as simple as kWh if the building has a constant load, for example, a naturally ventilated school building.

As mentioned before, benchmarking is also necessary to identify buildings presenting interesting energy saving potential. An important issue in benchmarking is the use of performance indices to characterise the building.

These indices can be;

- Comfort indices, comparing the actual comfort conditions to the comfort requirements;

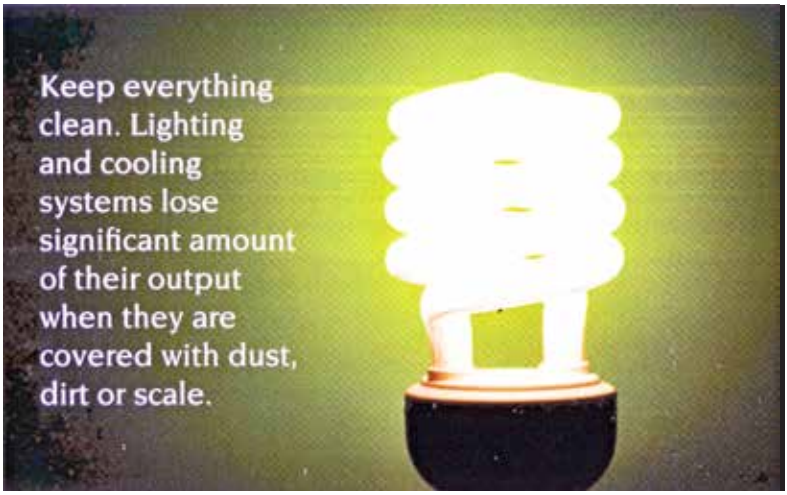
- Energy indices, consisting of energy demands divided by air con ditioned area, allowing comparison with reference values of the indices coming from regulation or similar buildings;

- Specific energy index such as chiller system kW/ton or compressed air system kW/cfm. In this case, it should be system

kW that is taken in to account, for example chiller, pumps and cooling tower energy should be lumped as the total plant kW and not just the chiller. For compressed air, its pressure should be used as the reference when using kW/cfm simply because lower pressure means lower energy and tracking the change in pressure help s track the savings.

b) *Walk-through, or Preliminary Audit*
The preliminary audit is the simplest and quickest type of audit. It involves minimal interviews with site-operating personnel, a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and to identify any glaring areas of energy waste or inefficiency.

Typically, only major problem areas will be covered during this type of audit. Corrective measures are briefly described, and quick estimates of implementation cost, potential ope rating cost savings, and simple payback periods are provided. A list of energy conservation measures (ECMs) requiring further consideration is also provided.



c) *General Audit*
The general audit expands on the preliminary audit described above by collecting more detailed information about facility operation and by performing a more detailed evaluation of energy conservation and efficiency measures. Utility bills are collected for a 6 to 12 month period to allow the auditor to evaluate the facility's energy demand rate structures and energy usage profiles. In-depth interviews with facility ope rating personnel are conducted to provide a better understanding of major energy consuming systems and to gain insight in to short and longer term energy consumption patterns.

This type of audit will be able to identify all energy-conservation measures appropriate for the facility, given its operating parameters. A detailed financial analysis is performed for each measure based on detailed implementation of cost estimates, site-specific operating cost savings, and the customer's investment criteria. Sufficient detail is provided to justify project implementation.

OPERATION & MAINTENANCE

Operation and maintenance is the area in which the greatest energy and economic saving are likely to be gained at little cost. Some common procedures that offer immediate savings at little or no cost include:

- Turn off lights, computer monitors, and other items when they are not in use. Most modern equipment is engineered to withstand frequent on-off cycles. The economic benefits of turning equipment off are greater than the benefits of extending the machinery's life by leaving it on.

- Keep everything clean . Lighting and cooling systems lose

significant amounts of their output when they are covered with dust, dirt or scale.

- Actively manage indoor temperatures by opening and closing windows and windows covering. Also, ensure the thermostat is properly calibrated.

- Understand system requirements - i.e. for example, a compressed air plant could be delivering 8 bar of compressed air when the actual requirement may be just 5 bar. Due to misinformation and standard practice, pressure reduction was never considered.

Utility bills are not fixed costs and should be actively managed. Graphing your utility costs is a good way to monitor energy use.

BEMS & CONTROL SYSTEM

A building energy management system (BEMS) is a sophisticated method to monitor and control the building's energy needs. Next toenergy management, the system can control and monitor a large variety of other aspects of the build ing such as heating, ventilation and air conditioning, lighting or security measures. BEMS technology can be applied in all type of buildings; however they have become increasingly popular in commercial buildings.

Commissioning is a key stage in the implementation of the BEMS. Commissioning is the quality control process that begins with the early stages of design. In other words, it is essential to consider the BEMS technology and its required functions in the earliest stages of design to optimize the operation's potential and consequently the energy savings of the technology.

It is more practical to incorporate a BEMS in to the design of the building compared to retrofit a BEMS into an existing building. The commissioning process ensures clear design intent. Proper commission procedures can result in significant energy savings in the buildings operation. Several common functional capabilities of a BEMS include:-

- Optimisation of building and plant operations;
- Provision of energy management information;
- Remote monitoring and control of services and functions of one or several buildings;
- Possibility of automatic control of services and functions i.e. automatic switch-on, switch-off of appliances;

Building Energy Management System used to control, manage and monitor the energy consumption in buildings

- Monitoring of building status and environmental conditions.

One main characteristic of BEMS is that it is capable to provide a real-time and extensive data on energy consumption to the facility manager. This information can be further analysed and used to increase energy efficiency of the overall system.

Additionally, the BEMS itself improves energy efficiency by streamlining the operation of the machinery it monitors and controls.

AIR-CONDITIONING AND MECHANICAL VENTILATION (ACMV) SYSTEM

As indicated in Figure 1, air-conditioning system contributes to the highest amount of electrical energy used in an office building which consumes more that 50% of the total electricity consumption. Building owners and building operators can refer to these following measures to save energy on air-conditioning systems:

a) **Indoor Design Conditions** of an air-conditioned space shall be designed and maintained as follows;

i.	Recommended design dry bulb temperature	24°C - 26°C
ii.	Minimum dry bulb temperature	23°C
iii.	Recommended design relative humidity	60%
iv.	Recommended relative humidity	55%- 65%
v.	Recommended air movement	0.15-0.50m/s

b) **System and Equipment Sizing** - ACMV systems and equipment shall be sized to provide no more than the space and system loads calculated in accordance with design requirement as above, consistent with avail able equipment capacity.

c) **Separate Air Distribution System** - Zones which are expected to operate non-simultaneously for more than 750 hours per year shall be served by separate air distribution systems. As an alternative, off-hour controls shall be provided.

Zones with special process temperature and/or humidity requirements i.e. clean rooms, operation theatres and etc shall be served by separate air distribution systems from those serving zones requiring only comfort cooling, or shall include supplementary provisions so that the primary system may be specifically controlled for comfort purposes only.

d) **Temperature Controls**
System control - Each Air-conditioning system shall include at least one temperature control device.

Zone control - The supply of cooling energy to each zone shall be controlled by individual thermostatic controls responding to temperature within the lone.

Thermostats - Where used to control comfort cooling, thermostats shall be capable of being set, locally or remotely, by adjustment or selection of sensors, between 2°C and 26°C.

Off-hour Control-Air-conditioning system shall be equipped with automatic controls capable of accomplishing a reduction of energy use through equipment shutdown during periods of non-use or alternative use of the spaces served by the system.

Outdoor air supply and exhaust systems shall be provided with motorised or gravity dampers or other means of automatic volume shut-off or reduction during period of non-use or alternate use of the spaces served by the system.

Other general measures;

- Air dampers need to be maintained properly to respond to temperature controls.
- Filters have to be regularly cleaned to prevent clogging which increase energy use.
- Install variable air volume (VAV) air hand ling systems with Variable Speed Drives (VSD).
- Install interior or exterior shading devices.
- Prevent leakages by ensuring doors are closed shut, reducing gap between doors and window frames.
- Setting temperature to 24 degree Celsius.
- Optimise operating hours of the air-conditioning.
- Ensure that extraction fans have self closing shutters - to prevent ingress of hot outside air.

- Improve piping insulation to prevent air leakage.
- Provide training to key maintenance personnel for proper operation and maintenance for energy saving.

It has been estimated that a properly maintained HVAC system will use about 15 - 20% less energy than a system which is not properly maintained.

OFFICE EQUIPMENT

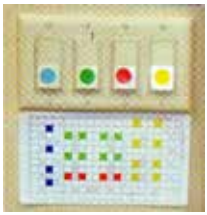
Office equipment and commonly used electrical appliances are generally controlled by occupants. Like manually controlled lighting. these loads are normally turned on by occupants. but are often left on longer than necessary.

The best no-cost measure that can be taken to reduce overall electrical consumption is to switch off all computers, printers and associated equipment when not in use. Leaving computer equipment switched on for long periods when they are not in use wastes electricity.

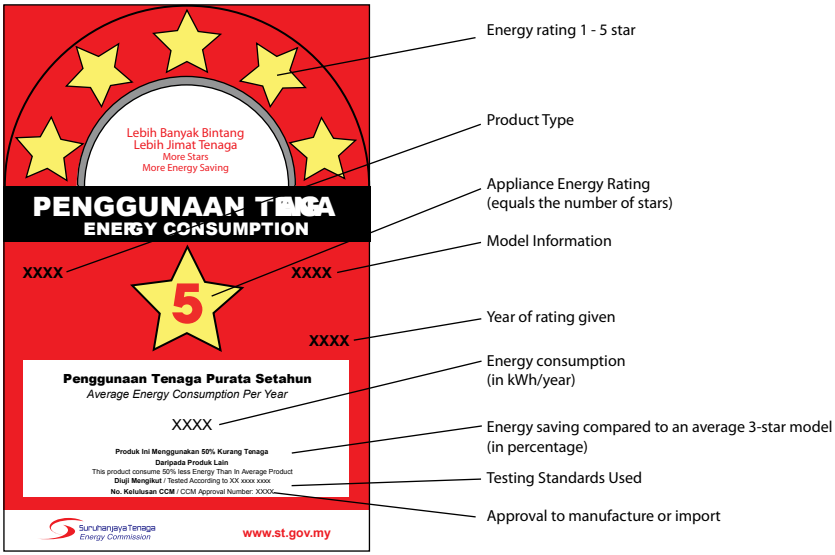
Also, the heat given out by computer equipment may encourage the use of electrical fans and may add to higher usage of air conditioning.

A proper plan to curb wastage of electricity through office equipment should include the following:-

- Use efficient appliance preferably 4 or 5 star rating or energy star-label.
- Identify equipment which can be switched off when not in use.
- Utilise the power management feature on computer and monitor to help save electricity.
- Use green and red labels to indicate which equipment can be switched off and which must stay switched on.



- Make appropriate staff aware that green-coded equipment must be switched off when not in use.
- Also, encourage staff to switch off photocopiers or switch to a stand by mode d ur ing long periods when they are not in use.
- Switch off / Unplug appliance to avoid 'vampire' loads. Many appliances such as TV, DVD player, computer and etc, continue to use small amount of power when they are switched off. Over long period, the electricity consumption is quite significant.



Energy Efficiency Labelling for Electrica/Appliances

LIGHTING SYSTEM

On average, lighting represents about 22% of a building's annual energy consumption. Areas to be considered for savings:-

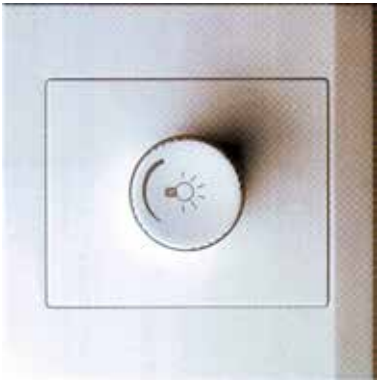
Options of high efficient light sources and fittings

- Use of longer life time lamps.
- Use of efficient lamps, such as compact fluorescent, T5 fluorescent or LED lighting as they have high efficacy (Lumens/Watt).
- Consideration of reflect ion efficiency of fittings.
- Lamps used for a long period of time such as emergency or exit lightings, traffic lights, etc shall be of high efficient lamps.

b) Reduction or Optimisation of Illumination

- Install individual lighting switch in areas near windows or daylight sources.

- Adequacy of illumination according to standards/requirements.
- De-Iamping area with over brightness.
- Reduction of whole or part of illumination.
- Install more switches according to occupancy requirement.
- Label switches for easy identification of lights to be switched on/off.
- Install lighting control
  - selection switch.
  - Manual, automatic or programmable dimmer .
  - Occupancy/movement sensor.
  - Energy management system.
- Review places needing illumination and the levels of illumination required.



c) Improvement of Maintenance Rate

- Ensure fixtures are clean and free of dust.
- Periodical cleaning of lamps to ensure maximum efficiency. Check if diffusers are discoloured and replace them if needed.
- Frequent cleaning of reflector fittings to maintain available light output.
- Selection of appropriate lighting fittings for ease of maintenance.
- Lighting fittings should be placed at suitable location for ease of maintenance.

- Frequent cleaning of windows or roof lightings for maximising natural lighting.
- Keep good maintenance record.

d) Reduction of Lighting Time of Use

- Install lighting control
  - Manual, automatic or programme able timing control.
  - Occupancy/movement sensor.
  - Energy management system.
  - Photoelectric switch for outdoor/compound/street lighting.

e) Retrofit to Energy Efficient Lighting System

- Incandescent lamp with a Minimum Energy Performance Standards (MEPS) efficacy value less than 20 lumens/watt to be replaced for general lighting.
- Replace magnetic ballast to electronic ballast or low loss ballast (less than 6 watt) .
- Replace with Compact Fluorescent Lighting (CFL)/LED/T5 Fluorescent/T8 Fluorescent when lamp breaks down/damage.
- Use high efficient reflector fittings.

f) Lighting Zone Control for Energy Savings

- Open office space separated by partition or walls shall be provided with at least one operated on-off lighting switch for each enclosed area.
- Provide different switch for different task, work activities or group of task.
- Total number of switches shall be at least one switch for each 1 kW of connected load .
- Change to more efficient lighting in areas where lights are frequently used or switched on for long periods of time.
- Use separate circuit or provide individual switch in area where daylight can be made use.
- Areas of infrequent use of lighting need to be equipped with on/off control switch.

- In area of low occupancy such as M&E rooms, store rooms, toilets, meeting rooms and etc, an automatic control system equipped with sensors shall be placed to reduce energy consumption.
- Areas such as open parking lots and street lightings shall be dimmed to 50% after midnight in view of low occupancy or traffic.
- For street lighting, separate circuit of alternate lighting pole with different switching time zone can be designed to switch off half of the load after midnight.
- For hotel or motel room s, a master switch at the door shall be used to turn off all power and lighting load except for emergency lighting, whenever the occupants leave the room.

g) Good Design and Housekeeping

- Maximise the utilisation of day lighting.
- Switch off lights when not used .
- Where group of switches are installed at a particular location, labelling shall be provided for ease of switching on/off.
- Paint interior walls with light color to avoid absorption of light .
- Bulbs should be re laced when they first begin to dim, before they completely burn out.
- Any install at ion should follow manufacturer's recommendation to avoid wattage limit that increase energy consumption.
- All excessive and unnecessary lighting equipment, wiring etc shall be removed .
- Task or area lighting may be used in the case where only a small area is needed for high lighting levels.
- Where possible, use natural lighting by using transparent material and proper insulation for heat removals.
- Any street light with damaged sensor or automatic control shall be immediately identified and repaired.

- An intensive awareness program for employees shall be conducted regularly.
- Safety guard must be tasked to ensure lights are switched off after office hours i f it is not in use.

ELEVATORS AND ESCALATORS SYSTEM

- Buy elevator/escalator which specify energy efficient features.
- Choose elevator with flexible programming for wide-use operation.
- Reduce number of stop of elevator by creating zone of floors.
- During off-peak period, switch off or put some of the elevator in standby mode to reduce electricity consumption.
- Correct and comprehensive maintenance. Moving parts should be sufficiently lubricated and worn parts should be replaced .
- Use stairs for short distance travel.
- For escalators, it should be equip with motion detector system.

IT ROOM

- Virtualisation of server by reducing a number of physical servers into single or few servers.
- Air flow management through hot aisle/cold aisle containment concept.
- Centralised light ing with LED.
- Use of more energy efficient IT equipment such as server, Uninterruptible Power Supply (UPS) and Power Distribution Unit (PDU).
- ACMV temperature & humidity adjustment.
- Install blanking panels to improve rack air flow.

AWARENESS PROGRAMME

The success of an energy efficiency program or initiative depends on people as much as or even more than technology. To maximise the energy savings potential of your building, an effort has to be made to raise the awareness of everyone involved, including owners, managers, executives, operations staff, tenants and suppliers through an energy efficiency awareness program. There are a number of stages to consider when com ing up with an energy efficiency awareness program. They include:

Stage 1: *Commit*
The overall success of such a campaign depends on the co-operation and involvement of everyone within an organisation including senior and middle management. This commitment is essential to driving an energy awareness campaign and showing staff that they are serious about making the campaign a success.

Stage 2: *Identify*
The identify stage is where you find out the level of energy awareness that employees currently have, what will encourage them to change behaviour and how they will get involved. It is also the stage where you will identify your message and audience.

Stage 3: *Plan*
Once you have assessed awareness and motivation, identify yor audience and your messages; Then it is time to start planning your program.

Stage 4: *Take Action*
If y u have planned your activities thoroughly, taking action should be fairly straightforward; however it still takes time, effort and commitment.

Stage 5: *Review*
Reviewing and evaluating your awareness campaign is an extremely important step. You and your team will obviously have a 'feel' for the response the campaign is getting and whether or not it is working. However it is important to objectively review and see if objectives and targets are being met.

ENERGY EFFICIENT APPLIANCES {MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)}

For residential buildings, the use of energy efficient appliances will help to further reduce the energy consumption. Minimum Energy Performance Standards (MEPS) regulations for 5 types of domestic electrical appliances, namely Refrigerator, Air-Conditioning, Television, Domestic Fan and Lightings have been in force since May 2013. Refrigerator, Air-Conditioning, Television and Domestic Fan must meet the requirement of a minimum of 2 star rating for it to be available in the Malaysian market, whereas lightings have to meet a minimum efficacy value in terms of lumens/watts for it to be available in the Malaysian market. For incandescent lighting, a minimum of 20 lumens/watt must be met before it can be sold in the market.

ENQUIRIES AND CLARIFICATION

For enquiries, clarifications and more information on Energy Efficiency, plea se refer to the contact information below:-

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ENERGY SAVING TIPS

- Switch off lights and electrical appliances when not in use
- Replace inefficient incandescent lighting with energy efficient lighting (LED, CFL)
- Purchase and use energy efficient electrical appliances with 4 or 5 Star MEPS Rating
- Clean light bulbs and air-conditioner filters regularly
- Adjust air-conditioner thermostat's setting to 24-26°C
- Track your electricity consumption every month
- Conduct energy audit to identify potential energy savings

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