Understanding Energy Efficiency and Energy Saving Devices

by Ir. Dr Mohamed Fuad bin Faisal

1. WHAT IS ELECTRICAL ENERGY?

Electricity is the flow of electrical power or charge. It is both a basic part of nature and one of our most widely used forms of energy. Electricity is actually a secondary energy source, also referred to as an energy carrier. That means that we get electricity from the conversion of other sources of energy, such as coal, nuclear or solar energy. These are considered primary sources of energy. The energy sources we use to make electricity can be renewable or non-renewable, however, electricity itself is neither renewable nor non-renewable.

Before electricity became available over 60 years ago, houses in Malaysia were lit using kerosene lamps, food was cooked with wood-burning or coal-burning stoves and clothes were hand washed. There were no electrical lighting, rice cookers or washing machines. Despite its great importance in our daily lives, few of us probably stop to think what life would be like without electricity. Like air and water, we tend to take electricity for granted. We use electricity to carry out many tasks for us every day, from lighting, heating and cooling our homes to powering our television sets and computers.

In Peninsular Malaysia, electrical power is partially generated, transmitted and distributed by Tenaga Nasional Bhd (TNB). The latter constructs power plants, transmission networks, underground cables, overhead lines and substations to ensure electrical power is delivered to customers.

2. UNDERSTANDING ENERGY COST

At the end of every month, the amount of electrical energy consumed by a customer is recorded by an energy meter. An electricity or energy meter is a device that measures the amount of electrical energy consumed by a residential home, business, industry or an electrically powered device. Electricity meters are typically calibrated in billing units, the most common one being the kilowatt-hour (kWh). Periodic readings of an electricity meters establish the billing cycles and energy consumed during a cycle. The term kWh refers to the amount of energy consumed by a customer. The cost of energy consumption is then determined based on the existing energy tariff. This cost is also termed as energy cost and is applicable to all categories of customers.

Electrical energy (kWh) =
Electrical power (kW) x duration (hours) (1)

Energy cost (RM) = Electrical energy (kWh) x Cost per unit (2)

Example:

Electrical energy consumed	100kWh
Cost per unit	RM0.23/kWh
Energy cost	100kWh x RM0.23/kWh=RM23.00

There are also other costs, i.e. demand cost and power factor surcharges, that will not be discussed in this article. It is important to note that this definition of energy is based on kWh and is only applicable in Malaysia and some parts of the world. Some countries define energy based on the total apparent energy or kVAh. The equation that shows the relationship between all the electrical power components is shown in Equation (3).

$$kVA = \sqrt{(kW^2 + kVar^2)} \quad (3)$$

Note: kVA = Apparent Power, kW = Active or True Power and kVar = Reactive Power

Figure 1: A TNB substation

Figure 2: An example of an energy meter

3. UNDERSTANDING ENERGY EFFICIENCY

Efficient energy use, sometimes simply called energy efficiency, is the goal of efforts to reduce the amount of energy required to provide the same products and services. For example, installing fluorescent lights or natural skylights reduces the amount of

Figure 3: Incandescent lamp

Figure 4: Fluorescent lamp

energy required to attain the same level of illumination compared to using traditional incandescent light bulbs. The reason for this is because compact fluorescent lights use less energy compared to incandescent lights. Improvement in energy efficiency is most often achieved by enhancing the awareness of the users, improvement in maintenance procedures and adopting more efficient technology.

There are various motivations to improve energy efficiency. Reducing energy use reduces energy costs and may result in cost savings to consumers if the energy savings offset any additional costs of implementing an energy efficient technology. Reducing energy use is also seen as a key solution to the problem of reducing emissions. According to one international study, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases [1].

Figure 5: Energy efficiency labels for household products

Figure 6: Sample ads to remind users to switch off the lights when not in use

Look around your house. There are simple things you can do to save money on your electricity bill. Choosing energy efficient products is one of the smartest ways for consumers to reduce energy use and help prevent greenhouse gas emissions. A household that buys energy efficient equipment instead of standard new equipment can substantially reduce carbon dioxide emissions over the lifetime of the products.

Energy efficient products also save money. When we receive our monthly electricity bill, many of us think there is little that we can do to reduce our monthly costs besides adjusting our air conditioners. However, this is not true! The products you select can significantly affect that monthly bill. You can reduce your energy bill by about 10% to 20% when you purchase energy efficient products. Common product labels for energy efficiencies are shown in Figure 5.

Lastly, the most simple action plan to achieve energy efficiency and energy savings is simply to switch off all electrical appliances whenever they are not needed. Some equipment still consumes electricity whilst in sleep or standby mode, for example, computers, television decoders, DVD players, etc.

4. DISCUSSION ON ENERGY SAVING DEVICES

Recently, many products defined as Energy Saving Devices (ESD) have been made available to homeowners in Malaysia. Many of the advertisements for such devices can be found posted at various rest areas (R&R) along the highways and selected shopping complexes. An example is shown in Figure 7. Two sample units of ESD are shown in Figure 8.

Figure 7: Example of a misleading advertisement on an energy saving device

a) Brand X b) Brand Y

Figure 8: Two brands of ESDs

These ESDs are marketed under various brand names. They are simple to use into the power socket inserted into the power socket and, according to the advertisements, can help reduce one's monthly electricity bill. However, do these devices actually work?

Overall, there are two basic designs for ESD, neither of which has proven to provide cost savings when used under normal conditions.

4.1 ESD Type A (application of a capacitor unit)

The first type of ESD is designed to correct the lagging power factor that gets introduced when an inductive load, i.e. a motor, is placed on the power supply (See Figure 9). In Figure 9, the current lags the voltage. The power factor is calculated based on Equation 4. The ESD will then provide reactive power as a means of correcting that lagging power factor.

$$Power\_Factor = \cos\phi = \frac{kW}{\sqrt{(kW^2 + kVar^2)}} \quad (4)$$

Unfortunately, many of us assume that Power (kilowatt) = Volts x Amps. That is not true when you are dealing with alternating current (AC), where Power (kilowatt) = Volts x Amps x Power Factor.

The capacitance provided by the ESD actually increases the power factor, even though the current goes down. So, the number of kilowatts being used remains almost unchanged. Figure 10 shows the power triangle which depicts the relationship of the power components in Equation 3. Adding a capacitor will reduce the reactive power (VAR) and improve the power factor. However, the true power or watts remains the same. Therefore, the net savings in RM (based on kWh) will be negligible.

The ESDs shown in Figure 8 are classified as ESD Type A. Examples of tests carried out on these devices are shown in Figure 11.

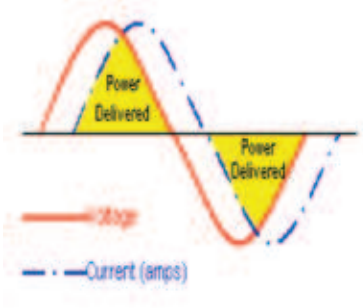


Figure 9: Current lags voltage

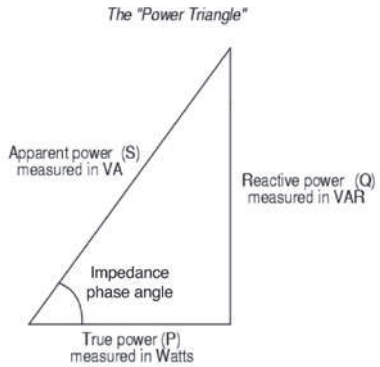


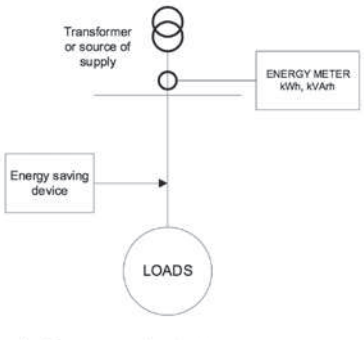
Figure 10: Power triangle

4.2 ESD Type B (based on voltage minimisation technique)

The second type of ESD operates by switching the incoming power on and off very quickly, thus reducing the average effective voltage (i.e. it decreases the effective height of the sine wave (See Figure 9). So, instead of the standard 230 volts being supplied from the power outlet, fewer volts actually arrive at the equipment terminals. While less power is truly being consumed during a fixed time interval, the appliance is not receiving the amount of power it was designed and intended to receive.

a) Capacitance test for 3-phase ESD

b) Current injection test



c) Energy saving test

d) Capacitance test for 1-phase ESD

Figure 11: Sample tests for ESDs

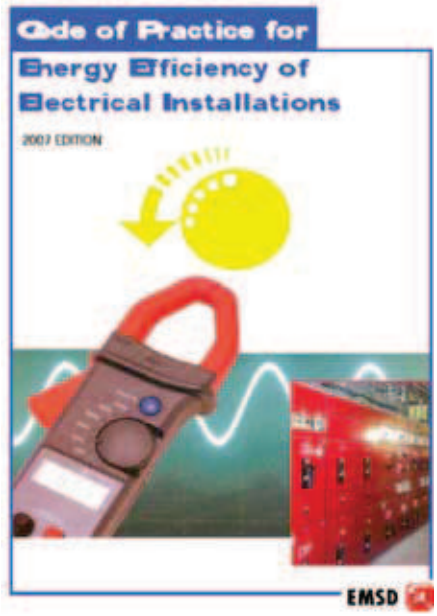
To compensate for the fact that it has been "short-changed", the appliance must often simply run longer to perform its intended task. A good example is to imagine a window fan that is suddenly being forced to run at medium speed instead of high speed; it simply will not cool the room as effectively. So once again, the net savings for motors running at the normal load is negligible. Minimal savings may occur for some appliances if their motors are being greatly underutilised, such as a refrigerator that is opened only once a week. Lamps would also be slightly dim when this type of ESD is applied.

The testing performed on these ESD has revealed that all of these devices do not promote energy (kWh) savings. Conceptually, the principles behind these devices make sense, but the reality of a controlled test environment has shown that they are generally not worth the investment.

5. A PRACTICAL GUIDE ON ENERGY EFFICIENCY

There are several good guidelines on implementing practical energy efficiency programmes. For commercial and industrial customers, it is recommended that they refer to the Code of Practice for Energy Efficiency of Electrical Installations developed in Hong Kong.

(Continued on page 16)



This guideline aims to set out the minimum requirements on energy efficiency of electrical installations. It forms part of a set of comprehensive Building Energy Codes that address the energy efficiency requirements in building services installations. Designers are encouraged to adopt a proactive approach to exceed these minimum requirements.

6. CONCLUSION

The intention of this article is to provide basic information related to energy efficiency and ESDs. One of the main reasons why there is still a demand for ESDs is because most consumers have an insufficient working knowledge of electricity. Some ESDs with a simple voltage reduction technique can save energy partially, but have limited application since there is usually a reduction in output such as lower lighting levels or less shaft horsepower. These devices typically chop the voltage sine wave to achieve a voltage reduction. Other devices only reduce the reactive power but not watts. Since customers pay according to watts or kilowatt-hours consumed, there may be little or no savings to gain. Reducing reactive power also helps to improve the power factor but does reduce kWh, therefore it does not minimise one's energy cost. ■

REFERENCE:

[1] Sophie Hebden (22-6-2006). "Invest in clean technology says IEA report". Scidev.net.

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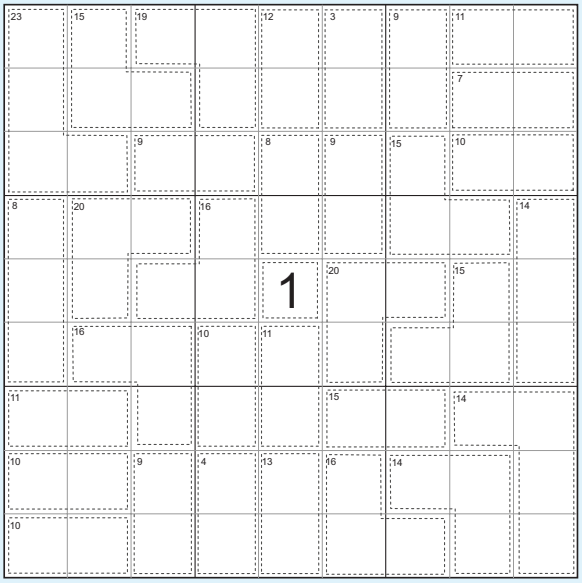

1SUDOKU Centerpiece "1"

by Mr. Lim Teck Guan

Fill in the remaining 80 squares with single digits 1-9 such that there is no repeat of the digit in every Row, Column and Block. The number at the top left hand corner of the dotted cage indicates the total for the digits that the cage encompasses.

For tips on solving, visit www.1sudoku.com.my

(*Solution is on page 59 of this issue.*)