FUNDAMENTAL ENERGY EFFICIENCY & CONSERVATION

Hamrin Abu Hasan
Razimah Abdul Rahim

DEQ30052 FUNDAMENTAL OF ENERGY EFFICIENCY AND CONSERVATION VOLUME 1

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data (after eisbn is received)

Cataloguing Information (to be informed)

PUBLISHED BY:

Politeknik Port Dickson

KM14, Jalan Pantai, 71050 Si Rusa

Port Dickson, Negeri Sembilan

AUGUST 2021

ACKNOWLEDGEMENT

PATRON
Mohamad Isa Bin Azhari
Director, Politeknik Port Dickson

ADVISORS
Dr. Nor Haniza Binti Mohamad
Deputy Director (Academic), Politeknik Port Dickson
Munirah Binti Md Nujid
Head of Electrical Engineering Department, Politeknik Port Dickson

EDITOR
Amrah Binti Mat Safri
Head of Electrical Engineering (Energy Efficiency) Programme, Politeknik Port Dickson

FACILITATORS
Nin Hayati Binti Mohd Yusof
PELJ
(Azilah Binti Asri)

WRITERS
Hamrin Bin Abu Hasan
Razimah binti Abdul Rahim

We would like to convey our utmost gratitude to the Department of Polytechnic and Community College Education particularly the E-learning and Instructional Division (BIPD) for funding our e-book project.

We hereby declare that this module is our original work. To the best of our knowledge it contains no materials previously written or published by another person. However, if there is any, due acknowledgement and credit are mentioned accordingly in the e- book.

TABLE OF CONTENTS

TOPIC 1: THE INTRODUCTION OF ENERGY EFFICIENCY & CONSERVATION

- The global and national commitment related to energy efficiency
- The trend of energy efficiency and conservation in Malaysia
- The greenhouse effect
- An energy efficiency and conservation

START

❖ The global and national commitment related to energy efficiency:

1. Sustainable Development Goals (SDG)

- All United Nations Member States accepted the Sustainable Development Goals (SDGs), often known as the Global Goals, in 2015. They are a call to action to end poverty, injustice, and climate change, to protect the environment, and to ensure that all people live in peace and prosperity by 2030.

- The SDGs aim to ensure that development must balance social, economic, and environmental sustainability for long-term success..

- The seventeen of SDGs goals are shown in Figure 1(a):

Figure 1(a): Sustainable Development Goals

2. SDG 7-Affordable and clean energy

- Energy system environmental implications include emissions from fuel burning, regional, and global levels. The precise effects are governed by elements such as primary energy source, conversion technology, device size and position, and others. Energy is the principal driver of climate change, accounting for roughly 60% of global greenhouse gas emissions.
- Energy is also a significant contributor to human health issues, mainly due to air pollution caused by fuel combustion. CO2 emissions have risen by over 46% globally since 1990.

The targets are:

i. ensure that everybody has access to affordable, secure, clean, and modern energy.
ii. Increase the proportion of renewable energy in the global energy mix significantly.
iii. twice the global rate of increase in energy efficiency

3. Conference of Parties (COP 21)

The Paris Agreement is a legally binding agreement aimed at mitigating the effects of climate change. The 21st Conference of the Parties (COP 21) was held in Paris from November 30 to December 12, 2015. A global agreement has been reached to keep global warming below 2 degrees Celsius, if not much lower. This agreement was agreed during the COP21 Conference of Parties in Paris, which took place from the 21st to the 25th of December 2015 in the French capital.

- Malaysia has vowed to lower its carbon emission intensity per Gross Domestic Product (GDP) by 35% by 2030, or 45% with developed-country support. The Paris Agreement ratified this Nationally Determined Contribution in order to mitigate the negative effects of climate change.

4. National Energy Efficiency Action Plan (NEEAP)

- Malaysia's government has unveiled the National Energy Efficiency Action Plan (NEEAP) for the 2016-2025 implementation period, which includes four major thrusts:
    1. Implementation of EE Plan,
    2. Strengthen Institutional Framework
    3. Capacity Development and Training, Establishment of Sustainable Funding Mechanism
    4. Promotion of Private Sector Investment in Energy Efficiency Initiatives

The four thrusts mentioned in Figure 1(b) will help to remove potential barriers and ensure that energy users in the targeted industries are motivated to embrace and adjust energy efficiency as a way of life in order to take full advantage of energy efficiency.

The National Energy Efficiency Action Plan includes ten unique energy efficiency programmes targeting three industries that will be introduced over ten years. The programmes can be divided into five categories based on their design. i.e.

- ✓ Initiative 1: Promotion of 5-Star Rated Appliances;
- ✓ Initiative 2: Minimum Energy Performance Standards (MEPS);
- ✓ Initiative 3: Energy Audits and Energy Management in Buildings and Industries;
- ✓ Initiative 4: Promotion of co-generation
- ✓ Initiative 5: Energy Efficient Building Design

Figure 1(b): National Energy Efficiency Action Plan

The trend of energy efficiency and conservation in Malaysia

Energy scenario in Malaysia

- As of December 31, 2018, Malaysia had a total installed capacity of 33,991 MW. Natural gas accounted for 43.7 percent of the total, with coal (31.4 percent), hydro (major and minor) (18.1 percent), diesel/MFO (2.5 percent), solar power (2.3 percent), biomass (1.6 percent), biogas (0.2 percent), and others accounting for the remainder (0.2 percent).
- Peninsular Malaysia accounted for 79.4 %of total installed power, with Sarawak accounting for 15.0 % and Sabah accounting for 5.6 %. Peninsular Malaysia's maximum demand was 18,338 megawatts on August 15, 2018, an increase of 3.1 %from 17,790 megawatts in 2017.
- Sabah's peak demand climbed by 1.8 percent (938 MW to 955 MW), while Sarawak's peak demand increased by 0.4 percent (3,489 MW to 3,504 MW). Peak demand refers to the time of day when energy use is at its peak.
- Malaysia has three types of power plants: hydro, thermal, and self-generation. The overall energy intake into power plants (excluding self-generation) was 38,723 ktoe, representing a 3.2 percent increase over the previous year. Coal continues to account for 52.9 percent of power plant fuel, followed by natural gas at 29.8 percent, hydropower at 16.1 percent, renewable energy at 0.7 percent, and oil at 0.5 percent. Total RE rose by 49.9 percent in 2018 compared to 2017, showing that more aggressive actions are being taken to fulfil the government's objective of a 20 percent renewable energy capacity mix by 2025.

- In 2018, the total electricity production (excluding self-generation) was 163,415 GWh, up 5.1 % from the previous year's figure of 155,456 GWh. With 47.3 % of the generation mix, coal remained the most common fuel used to produce electricity. Natural gas came in second with 35.7 %, led by hydropower (16.1%), renewables (0.6%), and oil (0.3%). In 2018, the total electricity usage reached 152,866 GWh, up 4.3 % from the previous year. Peninsular Malaysia used 78.9% of all electricity, followed by Sarawak (17.4%) and Sabah (3.7%).
- The Primary production by fuel type has been shown in Figure 1 (c) and (d)

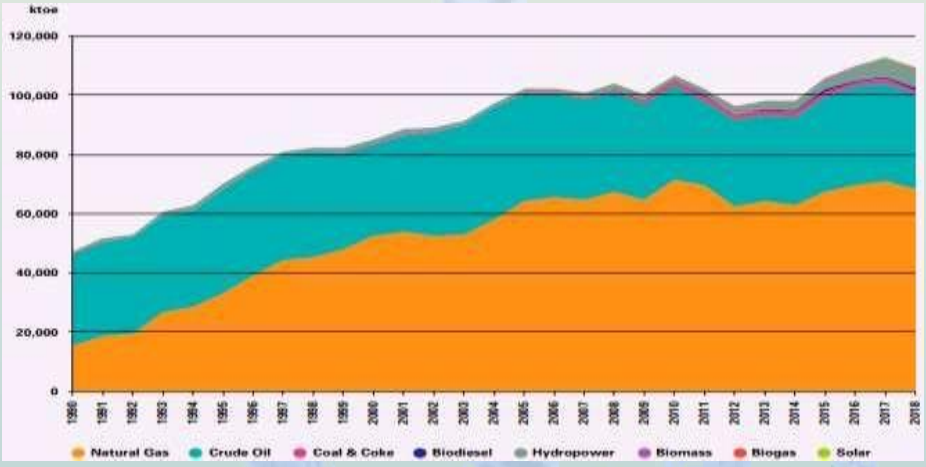
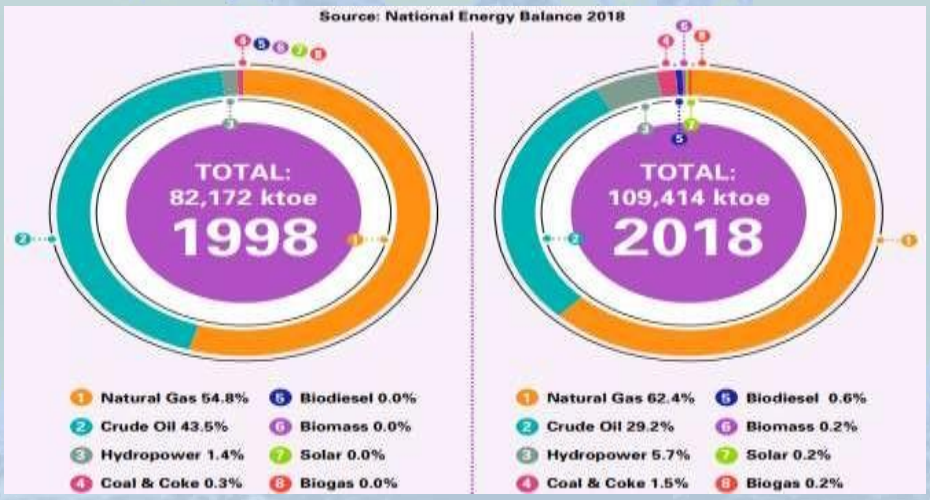


Figure 1 (c) & 1 (d) Primary Production by Fuel Type
Source: National Energy Balance 2018



- In 2018, the industrial sector accounted for nearly half of Malaysia's total power consumption, accounting for 49.8 percent or 76,096 GWh. The industrial sector consumed 29.0 percent of total electricity, while the residential sector consumed 20.5 percent. Agriculture and transportation accounted for 0.4 percent and 0.3 percent of total electricity consumption, respectively. The power supply sector is vertically integrated, with a utility corporation responsible for all electricity generation, transmission, and distribution in a given area.
- The major utility firms are Tenaga Nasional Berhad (TNB), Sarawak Electricity Supply Company (SESCO), and Sabah Electricity Limited (SESB), which serve Peninsular Malaysia, Sarawak, and Sabah, respectively. Each company was founded under British authority before to the country's independence, and it is continuing doing so today. SESB has been owned by TNB since 1998. In all three countries, independent power producers (IPPs) operate, supplying a share of the electricity to energy firms for transmission to end customers.

Energy needs for Malaysia's growing economy

- Energy has long been regarded as a critical component of human development and economic growth. Rising human health and living standards necessitate the provision of adequate and affordable energy. Since energy is used as an input in most production processes, it should be regarded as an essential factor in economic growth.
- Energy consumption rises in lockstep with economic development and growth. As a result, energy needs should be addressed adequately and cost-effectively. In 2018, total energy usage was predicted to be 64,658 ktoe, a 3.5 percent increase over the previous year. With the exception of transportation, residential, and industrial, all sectors increased in 2018.
- Energy consumption in the transportation sector fell 2.0 % to 23,555 ktoe, while consumption in the residential and industrial sectors fell to 7,773 ktoe. Agriculture (including fisheries) grew at the fastest rate of 51.5 %, led by the industry sector, which rose by 9.1 % to 19,046 ktoe.

- Transportation sector continues to lead with 36.4%, followed by manufacturing industry with 29.5%. All fuel forms increased in 2018, except for petroleum products, which fell 1.3%. Due to increased demand for natural gas for heating, natural gas consumption increased by 12.0% in 2018.

- Electricity consumption climbed by 4.3 percent to 13,153 ktoe. Coal and coke final energy consumption increased by 0.2 percent in 2018, as cement demand remained strong due to increased construction activity. Cement producers consumed the majority of coal and coke (88.2%), while iron and steel manufacturers consumed the remaining 11.8 percent.
- Malaysia's ultimate energy consumption per capita climbed by 2.3 percent, reaching 2.0 toe per user. In 2018, per capita electricity consumption climbed by 3.2 percent to 4,721 kWh.
  Final energy intensity declined 1.2 percent in 2018 to 47.44 toe/RM Million, suggesting improved performance. The absolute electricity intensity was 0.112 GWh/RM Million, a 0.4 percent decrease from the previous year. As a result of our GDP growth rate outpacing our energy and electricity consumption growth rates, Malaysia's energy and electricity elasticity in 2018 was less than 1.0..

- Malaysia is energy self-sufficient due to numerous energy sources such as oil, gas, hydropower, and biomass. In truth, Malaysia is still considered as one of the world's major energy exporters. Following a good performance in 2017, Malaysia's economic growth was predicted to stabilise in 2018. The economy, on the other hand, was confronted with a number of external and domestic issues. Supply interruptions in the commodity industries affected Malaysia's economic performance, resulting in a slower-than-expected slowing of growth. Malaysia's economy expanded by 4.8 percent in 2018.
- The final energy by sector has been shown in Figure 1(e) and (f).

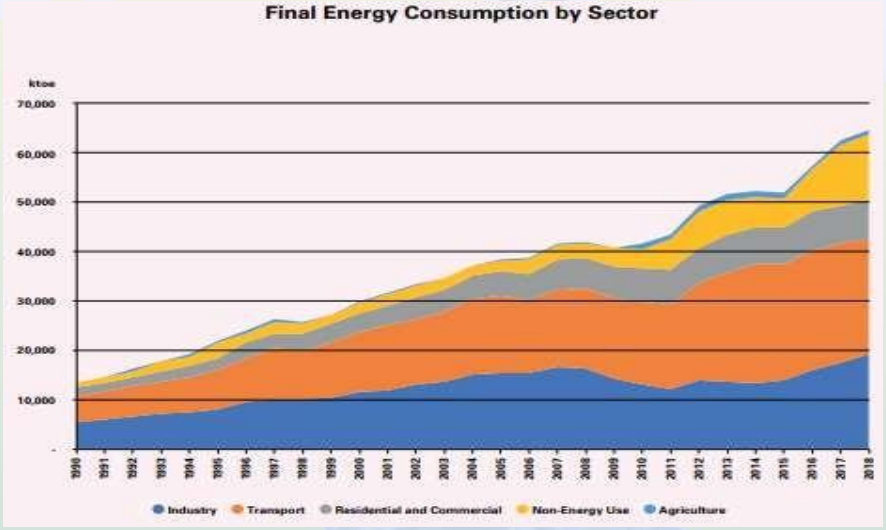
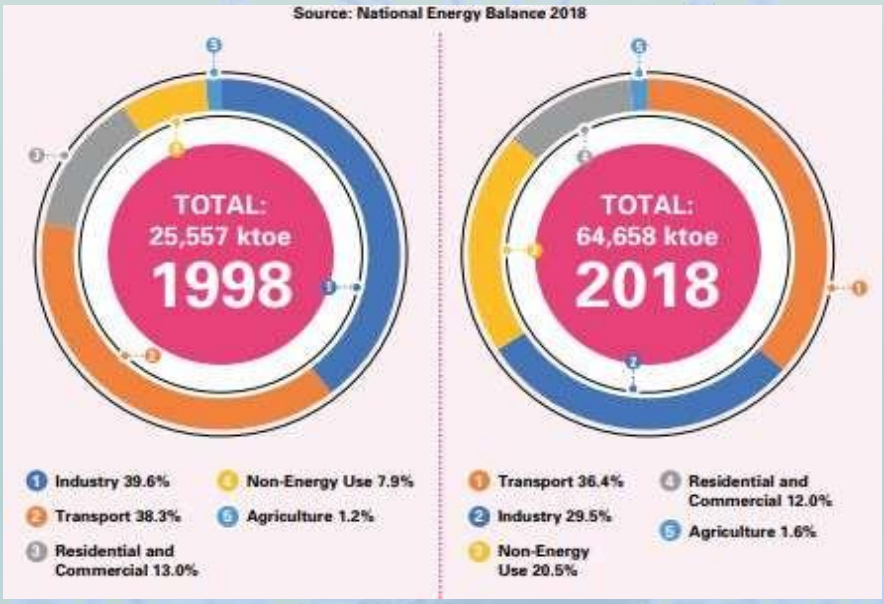


Figure 1 (e) & 1 (f) Final Energy Consumption by Sector
Source: National Energy Balance 2018



National energy-related policy objective

National Petroleum Policy (1975)	Efficient utilization of petroleum resources
	Ensuring the nation exercises majority control in the management and operation of the industry
National Depletion Policy (1980)	To prolong the life span of the nation's oil and gas reserves
Four-fuel Policy (1981)	Aimed at ensuring reliability and security of supply through diversification of fuel (oil, gas, hydro and coal)
Five-fuel Policy (2001)	To encourage the utilization of renewable resources such as biomass, solar, mini hydro etc
	Efficient utilization of energy
National Renewable Energy (RE) Policy + Action Plan	To prolong the life span of the nation's oil and gas reserves

Figure 1 (g): Energy Policy Objective

National Green Technology Policy

ENERGY
Seekto attain energy independence & promote efficient utilization

ENVIRONMENT
Conserve and minimize impact on the environment

ECONOMY
Enhance the national economic development through the use of technology

SOCIAL
Improve the quality of life for all

POLICY STATEMENT

Green Technology shall be a drive to accelerate the national economy and promote sustainable development

Figure 1 (h): National Green Technology Policy

The Greenhouse Effect

1. Greenhouse effect related to energy

- The energy that travels to Earth from the Sun will have difficulty returning to space. Some of this energy is consumed and emitted by greenhouse gases as a result of the greenhouse effect. The Earth mainly receives the Sun's energy in visible light and wavelengths close to it. At the Earth's surface, about 50% of the energy from the Sun is consumed.
- The Earth's surface emits energy in the infrared spectrum. Greenhouse gases absorb most of the infrared radiation emitted by the surface in the atmosphere, which then passes the heat to other atmospheric gases through molecular collisions.

2. How the greenhouse effect works

- The Earth's surface emits infrared energy, which is transferred to other atmospheric gases via molecular collisions. Greenhouse gases absorb the majority of the infrared light released by the surface and transmit it on to other parts of the climate system.
- The greenhouse effect is the name given to this phenomenon. The greenhouse effect was discovered in 1827 by Joseph Fourier, a French mathematician and scientist. John Tyndall conducted the first experiments on it in 1858, and Svante Arrhenius reported it quantitatively for the first time in 1896.
- Figure 1 depicts the greenhouse effect (i).

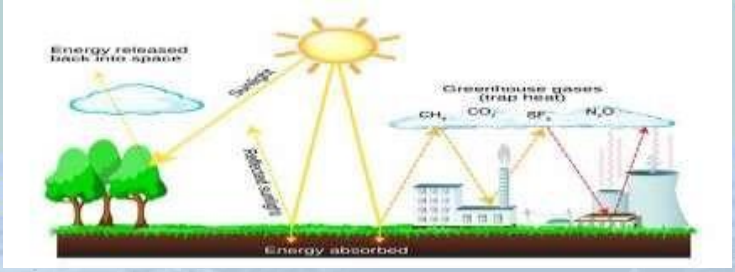


Figure 1(i): Greenhouse Effect

3. The different types of greenhouse gases

The term "greenhouse gas" refers to a variety of gases that are released into the atmosphere. Carbon dioxide, water vapour, methane, and nitrous oxide are the main ones..

- These gas molecules all contain three or more atoms. Because the atoms are bound together loosely enough, they vibrate as they absorb heat.
- The radiation is finally released by the vibrating molecules, and it is most likely absorbed by another greenhouse gas molecule. This technique keeps heat near the Earth's surface. The majority of atmospheric gases are nitrogen and oxygen, both of which cannot absorb heat and hence contribute to the greenhouse effect.

4.Water vapour (H2O) is the most powerful greenhouse gas, and its concentration is mostly regulated by air temperature. The air may contain more moisture or water vapour when the temperature rises. As the air becomes saturated, excess moisture condenses as cloud droplets (or retains as much moisture as the air can at that temperature). If the droplets are large enough, they will fall as precipitation.

5.CO2 (carbon dioxide) is another important greenhouse gas. It has a lengthy lifetime in the Earth's atmosphere. Carbon dioxide absorbs a lot of energy due to its wavelength of 15 m (micrometres). Because of this, carbon dioxide is a strong absorber of wavelengths in the infrared radiation section of the spectrum. The four major processes that continually move carbon dioxide into and out of the atmosphere are photosynthesis, respiration, organic decomposition or decay, and combustion, or the burning of organic material.

6.Methane (CH4) absorbs infrared radiation 30 times better than carbon dioxide. Methane, on the other hand, is present in lower concentrations than carbon dioxide and contributes only a modest net quantity to the greenhouse effect. In addition, methane is a relatively short-lived gas in the atmosphere. Bacteria degrade organic plant and animal matter in wetlands (such as marshes, mudflats, and flooded rice fields), sewage treatment plants, landfills, and cattle and termite guts, creating methane. Scientists are concerned about rising methane levels in locations where permafrost in the Arctic and the Alps is thawing and leaking methane as temperatures rise.

7. Halocarbons are composed of carbon, chlorine, fluorine, and hydrogen. They contain anthropogenic gases such as chlorofluorocarbons (CFCs), which are commonly found in refrigerators and air conditioners. CFC gases have the largest halocarbon concentrations in the atmosphere and can absorb more infrared radiation than any other greenhouse gas. One molecule of CFC gas is equivalent to 10,000 molecules of carbon dioxide.

8. Nitrous oxide (N_2O) is produced as a byproduct of agricultural, land use, industrial, fossil fuel and solid waste combustion, and wastewater treatment. Nitrate (NO3-) and ammonia (NH4+) fertilisers are utilised. Bacteria turn a small portion of these nitrate and ammonia to nitrous oxide. Nitrous oxide is also produced by internal combustion engines.

9. Ozone (O3) is a minor greenhouse gas as well (the lowest layer of the atmosphere). In the troposphere, it is generated by a variety of pollutants, mostly hydrocarbons and nitrogen oxide molecules.

The greenhouse effect on the environment

- **Global Warming**

Global warming is the steady heating of the Earth's surface, oceans, and atmosphere. It is caused by human activities, specifically the combustion of fossil fuels. Over the previous century, the average global temperature has risen by about 1.4 degrees Fahrenheit (0.8 degrees Celsius).

Figure 1 (j): Global Warming

- **Sea Level Rise**

If global warming occurs, sea level will rise due to two independent factors. Warmer temperatures, for example, cause sea level to increase due to the thermal expansion of seawater. Second, meltwater from Greenland and Antarctica's glaciers and ice sheets will enter the ocean. Between 1990 and 2100, the average sea level is anticipated to rise by 0.09 to 0.88 m..

Figure 1 (k): Sea Level Rise

Potential Impact on Human Life

a) Economic Impact

Within 100 kilometres of the ocean, more than half of the world's population resides. The majority of this population lives in seaport communities. A considerable rise in sea level, for example, would have a severe economic impact on low-lying coastal towns and islands, increasing beach erosion rates along coasts and displacing fresh groundwater for a significant distance inland.

b) Agricultural Impact

Scientists have shown that plants grow faster when CO2 levels are higher. Global warming can affect global precipitation patterns and change soil moisture content across continents.

c) Effects on Aquatic systems

The destruction of coastal wetlands has the potential to have a large influence on fish populations, particularly shellfish. Estuaries with higher salinity may have fewer freshwater species while having more marine species. The actual degree of the impact on marine ecosystems, however, remains uncertain.

d) Effects on Hydrological Cycle

The amount of precipitation on the planet is anticipated to increase. However, it is unknown how regional rainfall patterns would change. Rainfall varies by country, with some receiving more than others. Furthermore, greater temperatures are more likely to enhance evaporation. As a result of these improvements, many water treatment systems will most certainly face new challenges..

Carbon footprint concept

A carbon footprint is the sum of greenhouse gases emitted into the atmosphere due to human activity. It's generally measured in tonnes of CO2 released per year, but can include other greenhouse gases like methane and nitrous oxide.

Carbon Footprint

A carbon footprint is the amount of greenhouse gases produced by a particular human activity

Figure 1 (l): Carbon Footprint Concept

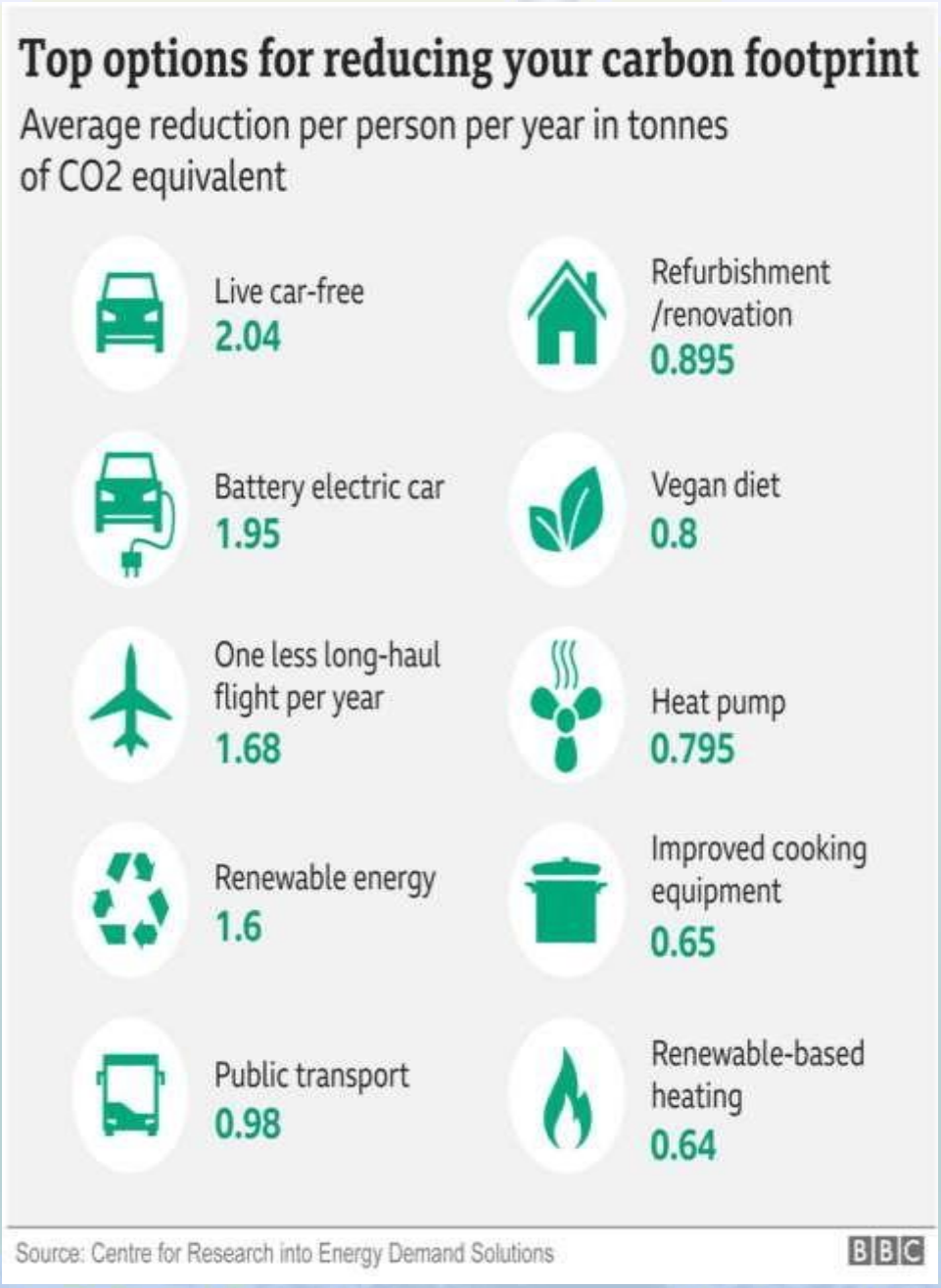


Figure 1 (m): Option for Reducing Carbon Footprint

Energy efficiency and conservation

The concept of the energy pyramid

The Energy Pyramid and its sustainable flow method will keep you from overspending and overproducing energy. The energy pyramid tells us to begin with the 'low hanging fruit,' such as energy conservation as a voluntary measure, and then progress to the next step, which involves replacing obsolete or less efficient equipment with super energy-efficient equipment. Following the Energy Pyramid guarantees long-term savings and results in electricity bills being reduced by 25-65%, regardless of tariff. The energy pyramid has been shown in Figure 1(n).

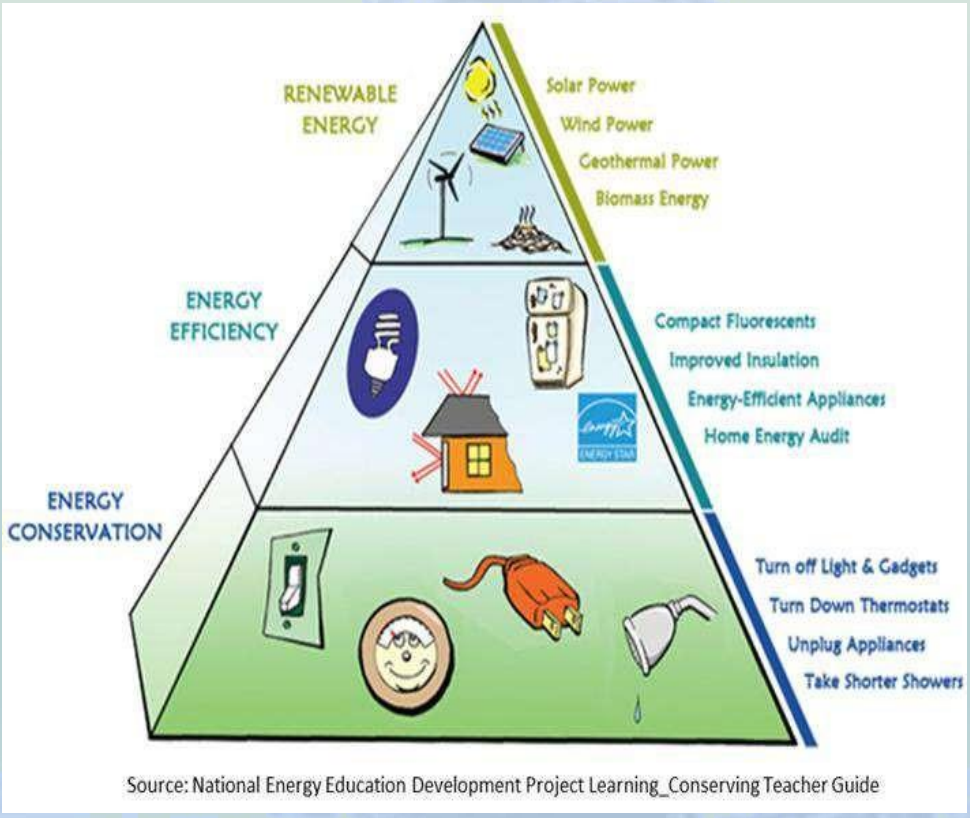


Figure 1 (n): The Concept of The Energy Pyramid

FIRST STAGE: ENERGY CONSERVATION

It is primarily based on behavioural and operational practices—best return on investment.

- To use ***Real-Time Energy Monitoring System*** to identify wastage and control the usage
- No Cost Implementation
- Low Cost Implementation
- With Investment ROI within 10 – 24 months

SECOND STAGE: ENERGY EFFICIENCY

Purchasing and installing efficient equipment and processes.

- Continuous saving strategy by identifying the inefficiency in the operating system and reducing further energy cost
  - Medium Cost Implementation
  - High Cost Implementation
  - With / Without Investment by Energy Performance Contracting (EPC)

THIRD STAGE: RENEWAL ENERGY

When the system is modified to use efficiency, less renewable energy is needed.

- Develop long term plan for renewable energy-Solar (Off/On Grid) by eliminating the electricity energy usage.

The concept of Energy Efficiency and Energy Conservation

- The use of technology that utilises less energy to complete the same function is referred to as energy efficiency. Energy conservation entails consuming less energy by altering one's thoughts and behaviour. Energy-efficient technology includes smart home hubs, energy- saving light bulbs, and smart thermostats..
- Energy efficiency is not the same as energy conservation. The purpose of both Energy Efficiency and Energy Conservation is the same: to save energy. They both have the same effect: they help you save money. Both can save energy on their own, but when combined, they can save twice as much energy and money.

Energy Efficiency

"Using less energy to provide the same service"

Examples

- A compact fluorescent light bulb is an example of energy efficiency because it consumes less energy to create the same amount of light as an incandescent light bulb.
- When an appliance, such as a refrigerator or washing machine, or office equipment, such as a computer or printer, is replaced with a more energy-efficient model, the new equipment performs the same function but consumes less energy.
- Use Energy Efficient Appliances

Energy Conservation

"Any behavior that results in the use of less energy"

Examples

- Switch off appliances when not in use.
- Lower the room temperature.
- Energy conservation is demonstrated by the decision to replace an incandescent light bulb with a compact fluorescent.

The importance of energy efficiency and energy conservation

- Financial savings – Buildings that run more efficiently consume less energy and have lower running costs.
- Reduced carbon footprint –Buildings create fewer greenhouse emissions because they use less energy and perform better in terms of environmental performance.
- Environmental legislation - Companies that operate in energy-efficient facilities will find it easier to comply with ever-increasing environmental standards. That means increased output.
- Sustainable credentials – Organizations that are environmentally conscious get a reputation for functioning ethically. This will result in higher profitability.
- Increased security - Reduced energy demand helps to ensure energy security. This means that future generations will be better off.

Tutorial

1. Describe Sustainable Development Goals (SDG).
2. Describe Conference of Parties (COP 21).
3. Malaysia's government launched the National Energy Efficiency Action Plan (NEEAP) with four major thrusts for the implementation period of 2016-2025. List the the four major thrusts.
1. List the17 Sustainable Development Goals.
5. List eleven Malaysia Energy Policies.
6. List five greenhouse effect related to energy.
7. Explain carbon footprint concept.
8. Explain the impacts of carbon footprint on environment.
9. Explain the importance of energy efficiency and energy conservation.
10. Draw the energy pyramid diagram.
11. Explain how energy conservation and energy efficiency must work together to achieve clean energy goals.
12. Discuss three examples related to the question above.

Tutorial Answer

1. The Sustainable Development Goals (SDGs) are the roadmap for achieving a better and more sustainable future for all, with each goal and objective being met by 2030.

2. **Conference of Parties (COP21)**

The 21st Conference of the Parties (COP 21) was held in Paris from November 30 to December 12, 2015. The Paris Agreement is a legally binding agreement aimed at mitigating the effects of climate change.

- A global agreement has been reached to hold global warming below 2 degrees Celsius and to limit it to well below that level.
- Malaysia has pledged to reduce its carbon emission intensity per Gross Domestic Product (GDP) by 35 per cent by 2030, or 45 per cent with developed-country support. To combat the detrimental effects of climate change, the Paris Agreement ratified this Nationally Determined Contribution.

3. The Malaysian government has launched the National Energy Efficiency Action Plan (NEEAP) for the 2016-2025 implementation period, which has four strategic thrusts:

i. Implementation of EE Plan,
ii. Strengthen Institutional Framework
iii. Capacity Development and Training, Establishment of Sustainable Funding Mechanism
iv. Promotion of Private Sector Investment in Energy Efficiency Initiatives

4. **List of 17 SDG:**

i. No poverty
ii. Zero hunger
iii. Good health & well being
iv. Quality education
v. Gender equality
vi. Clean water & sanitation
vii. Affordable and clean energy
viii. Decent work & economy growth
ix. Industry information & infrastructure
x. Reduced inequalities
xi. Sustainable cities community
xii. Responsible consumption & production
xiii. Climate action
xiv. Life below water
xv. Life on land
xvi. Peace, justice & strong institution
xvii. Partnership for goals

5. 11 Malaysia Energy Policies.

i. Petroleum Development Act
ii. National Petroleum Policy
iii. National Energy Policy
iv. National Depletion Policy
v. Four-Fuel Diversification Policy
vi. Five-Fuel Diversification Policy
vii. National Biofuel Policy
viii. National Green Technology Policy
ix. National Renewable Policy
x. New Energy Policy (10th Malaysia Plan)
xi. New Energy Policy (11th Malaysia Policy)

6. **List five greenhouse effect related to energy**

i. Energy industries: Public electricity
ii. Transport: Road transportation
iii. Emissions from fugitive oil and gas operations
iv. Construction and manufacturing industries
v. Manufacturing of solid fuels and other energy businesses are examples of energy industry (natural gas transformation)
vi. Other sectors: Commercial
vii. Energy industries: Petroleum refining
viii. Other sectors: Agriculture, forestry and fishery

7. **Carbon footprint concept**:

A carbon footprint is the sum of greenhouse gases emitted into the atmosphere due to human activity. It's generally measured in tonnes of CO_2 released per year, but can include other greenhouse gases like methane and nitrous oxide as well as CO_2-equivalent gases.

8. **Carbon footprint is formed from carbon dioxide (CO_2) released into atmosphere in a certain time frame. An increase in the amount of carbon dioxide will give an impact on the environment such as:**

i. Temperature will get warmer
ii. Glaciers will melt, ice sheets in Artic will melt (Polar Bears hunt on ice sheets)
iii. Sea levels will rise
iv. More droughts in dry areas and more rain and snow in wet areas
v. More violent weather around the world.
vi. More killer storm
vii. Spread of disease

9. Explain the importance of energy efficiency and energy conservation

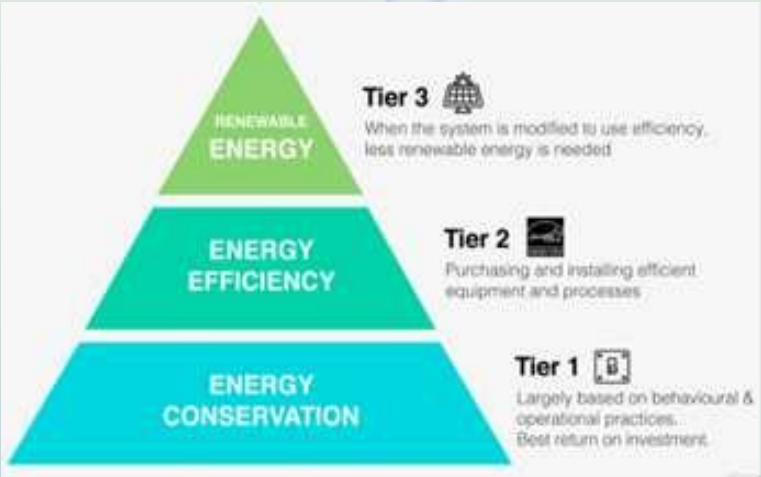
i. To save fossil fuels

ii. To conserve the environment

iii. To improve the foreign reserves of our country

iv. To save money on the energy not "wasted".

10. Draw the energy pyramid diagram.



11. **Explain how energy conservation and energy efficiency must work together to achieve clean energy goals.**

Any behaviour that leads in the use of less energy is considered energy conservation. Energy efficiency entails employing technology that uses less energy to do the same purpose.

12. Discuss two examples related to the question above.

- **Example 1:**
  An example of energy efficiency is a compact fluorescent light bulb that consumes less energy to provide the same amount of light as an incandescent light bulb. Energy conservation is demonstrated by the decision to replace an incandescent light bulb with a compact fluorescent.
- **Example 2:**
  Energy conservation is demonstrated by replacing older model appliances, such as a refrigerator or washing machine, with new energy-efficient models. Modern appliances consume substantially less energy than earlier models, demonstrating energy efficiency.

END OF TOPIC 1

TOPIC 2: THE COST OF ELECTRICITY

- Electric power utilities categories
- Electricity tariff
- Calculating electricity cost

START

INTRODUCTION

- In accordance with the Energy Supply Act 1990, the Ministry of Energy, Green Technology, and Water (KeTTHA) controls the electricity rates imposed by utilities to final consumers in Peninsular Malaysia and Sabah.
- Among the principles used to determine tariff rates are:
  - the tariff should be based on the cost of supply
  - offer sufficient revenue for the expansion of the power sector
  - competitiveness of industries and services,
  - Consumer affordability and the government's social and economic goals

ELECTRICPOWER UTILITIES

Fixed Cost/Tariff

The 'fixed' portion of this tariff refers to the price a client pays per kilowatt hour (or kWh —the unit of energy measurement). At the start of the customer's contract period, a price per unit is established, and this price remains constant until the contract expires.

What are the advantages of a fixed energy tariff?

Because of price is fixed, you will not have to pay more if the wholesale price of energy rises. Furthermore, due of the energy industry's vigorous competition, fixed-rate tariffs are frequently the less expensive option..

Variable Cost/tariffs

A variable tariff, often known as a 'standard' tariff, is the default pricing of your supplier. The cost per unit of energy (kWh) is not fixed, unlike a fixed tariff. Depending on the wholesale market price, it can rise or fall.

What are the advantages?

This is the one for you if you wish to be flexible and do not want to be bound by a contract. You have the option of switching to a new supplier at any time. This plan also allows you to take advantage of wholesale market discounts.

ENERGY PRICING STRUCTURE

- Changes in fuel prices have a direct impact on the cost of power.
  - ✓ Gas prices are fixed according to a precise formula, with a 6-month review..
  - ✓ The market price determines the price of coal.
  - The cost of electricity is included in the cost of
  - ✓ Generation 70%
  - ✓ Delivery 10%
  - ✓ Distribution 20%

Figure 2(a): Cost of Electricity

COST COMPONENT IN ELECTRICITY TARIFF TNB FY2013 (HISTORICAL)

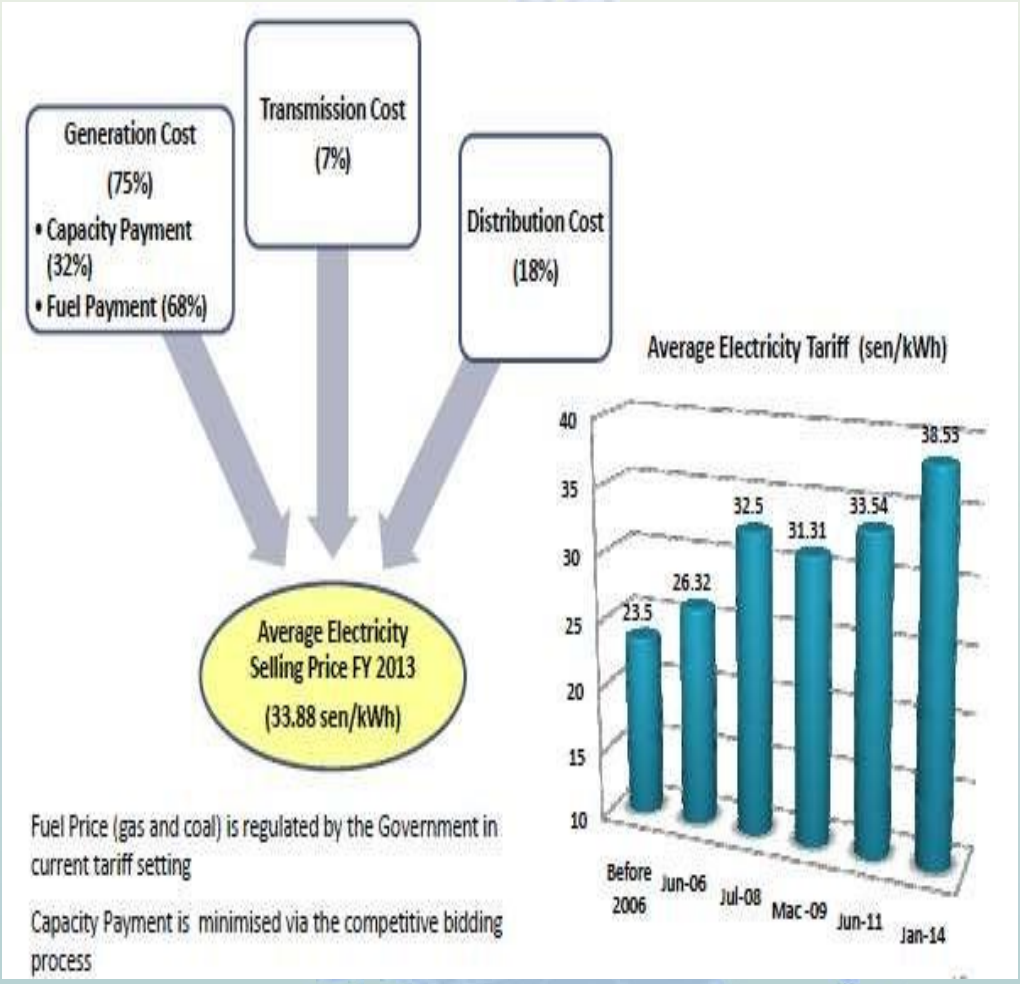


Figure 2(b): Cost of Electricity & Average Electricity Tariff

ELECTRICITY TARIFF

Principle Tariff Rate

❖In accordance with the Power Supply Act 1990, regulates the electricity tariffs imposed by utilities to final users in Peninsular Malaysia and Sabah.

❖ Among the principles used to determine tariff rates are:

–the tariff should be based on the cost of supply

–offer sufficient revenue for the expansion of the power sector

–competitiveness of industries and services,

–Consumer affordability and the government's social and economic goals

Guidelines of Electricity Tariff Rate

❖ The electricity tariff rate is determined by the rules listed below:

- The amount of energy consumed (kWh)
- The maximum demand at which energy is consumed (kW)
- Peak / off-Peak period
- The power factor of the load
- The connected load

❖ Prior to that, the last review was carried out in 1st June 2011

❖ Effective 1st January 2014, the electricity tariff was reviewed

Incentive Base Rate (IBR)

- A strategy or methodology for determining electricity tariffs that focuses on efficiency gains and an organised process in tariff assessment.
- An efficient approach that is widely employed around the world, often known as performance-based regulation.
- In the tariff computation, only the most efficient cost of electricity supply will be considered.
- Identifying key performance indicators (KPIs) for the utility
- Induction of incentives or penalties for operational performance
- Consumers and utilities will share efficiency gains.

Moves Toward Better Regulation

Suruhanjaya Tenaga (ST) is using Incentive-based Regulation (IBR) to reinforce the following:

- The economic regulatory framework for regulating TNB;
- The tariff setting mechanism and principles for tariff design;
- Incentive mechanisms to promote efficiency and service standards
- The process of tariff review; and
- The creation of regulatory accounts and its annual review process.

Figure 2(c): ST Moving Towards IBR

Imbalance Cost Pass-Through (ICPT)

- Comprises of two components:

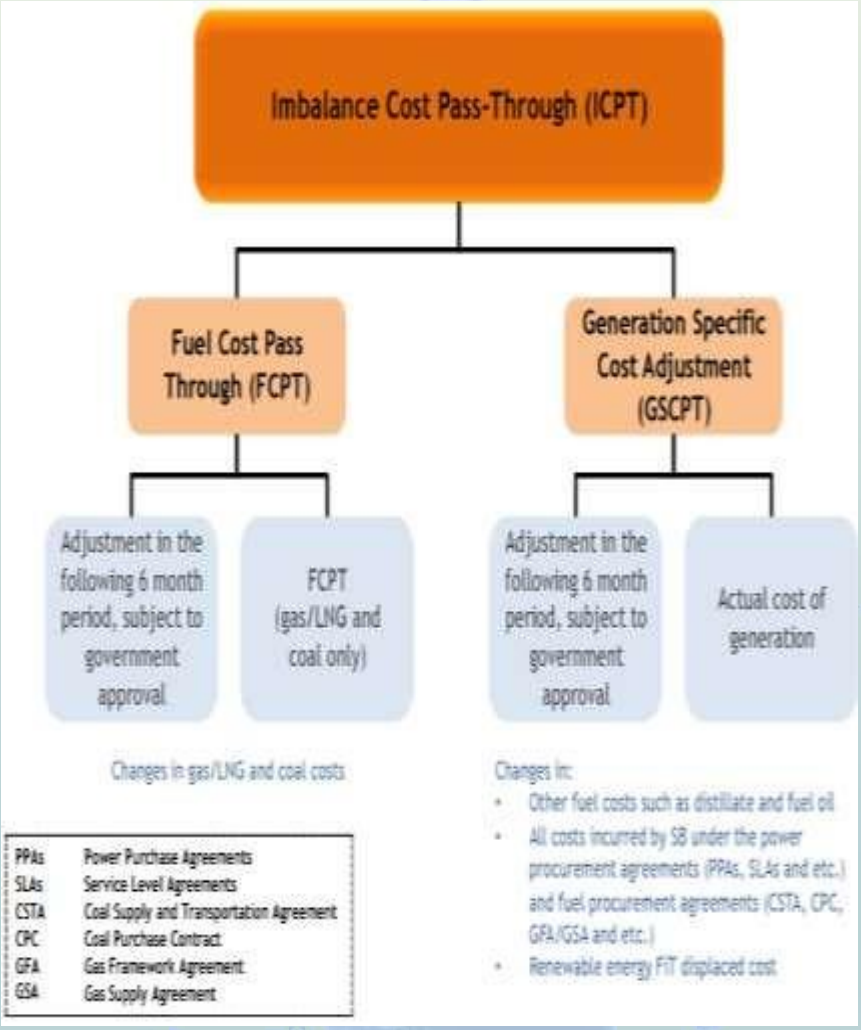


Figure 2(d): Imbalance Cost Pass-Through (ICPT)

Typical Rate Structure

The electrical power utility categorises their customers based on their power sectors:Domestic

- Commercial
- Industrial
- Mining
- Street lighting
- Agriculture
- Top-up and Standby services

Definition

"COMMERCIAL SUPPLY"

means the supply of energy from the Company's supply lines to all commercial premises, including office blocks, shops, godowns, restaurants, schools, hotels, boarding houses, farms, estates, ports, broadcasting and telecommunication installations, cinemas and entertainment venues, military and government installations, and hospitals, as well as any supply used in construction or building activities, but excluding private dwellings and industrial premises.

"INDUSTRIAL SUPPLY"

means the supply of energy to industrial operations such as manufacturing, quarrying, mining, shipbuilding business, and consumers who use energy for the purpose of pumping water, in whose premises electric motors and plants are used in connection therewith, and the total wattage of lamps and air-conditionings installed for office use shall not exceed 20% of the total wattage of all electric equipment installed.

"DOMESTIC SUPPLY"

means the provision of energy to premises used solely for private living purposes, provided that no commercial activity takes place in such premises.

"CO-GENERATOR"

A generator that uses a single primary energy source to generate two different types of useful energy for its own use at a rate of greater than 70% efficiency. The following services are available to co-generators:

- Top-up supply: The additional supply required by a Co-generator that does not create enough power for its own consumption.
- TNB provides a standby supply to a co-generator in the event that the co-generator does not generate energy due to a plant breakdown or a planned stoppage for maintenance.

"PEAK PERIOD"

indicates the time between 0800 and 2200 hours (Monday to Sunday)

"OFF-PEAK PERIOD"

indicates the time between 2200 and 0800 hours (Monday to Sunday)

"MAXIMUM DEMAND"

the highest number of kilowatt-hours supplied in any thirty-minute period during the month.

"MONTH"

is the time between two consecutive metre readings; metres are generally read at thirty-day intervals.

"CONNECTED LOAD CHARGE (CLC)"

CLC is a risk-mitigation mechanism that discourages customers from over-declaring their load requirements. Overdeclaration will result in overplanting, resource loss, and an increase in reserve margin. Without CLC, other users must pay for the unwarranted higher cost of power due to wastage, which is unfair to those who declare properly. Other utilities that do not have a CLC penalty recover their demand component or fix cost by applying a contract capacity fee in their tariff rate based on customer disclosure.

"PUBLIC LIGHTING SUPPLY"

the supply of energy to any local authority for the purpose of street lighting and other general lighting.

Energy Pricing & Cost

- Tariff A – Domestic
- Tariff B– LV Commercial
- Tariff C1 - Medium Voltage General Commercial
- Tariff C2 – Medium Voltage Peak/ Off-Peak Commercial
- Tariff D – LV Industrial
- Tariff E1 – MV General Industrial
- Tariff E2 – MV Peak/ Off-Peak Industrial
- Tariff E3 – HV Peak/ Off-Peak Industrial
- Tariff F1 – LV Mining
- Tariff F2 – MV General Mining
- Tariff F3 – MV Peak/Off-Peak Mining
- Tariff H1 – LV Specific Agriculture
- Tariff H2 – MV General Specific Agriculture
- Tariff H3 – MV Peak/Off-Peak Agriculture

Rate Structure-Domestic

Electricity Tariff for Domestic Customer

- Increasing rates by band
- Structure of increasing rates to promote Energy Efficiency (EE)
- The rate for higher band group will reflect cost of service
- Lower rate for life line band rate (first 200kWh) to protect lower income.

Tariff A	
Band (kWh)	Rate (sen/kWh)
0-200	21.8
201-300	33.4
301-600	51.6
601-900	54.6
901 and above	57.1

Figure 2(e): Tariff for Domestic Customer

Rate Structure-LV Commercial

Electricity Tariff for Commercial Customer

- Majority of commercial customers are taking supply at low voltage level.
- The applicable tariff is Tariff B

Tariff B – Low Voltage Commercial Tariff	Unit	B
For the first 200 kWh (1-200kWh) per month	sen/kWh	43.5
For the next kWh (201 onwards) per month	sen/kWh	50.9
The minimum monthly charge is RM7.20		

Figure 2(f): Tariff for Commercial Customer

Rate Structure-LV Commercial

Electricity Tariff for Commercial Customer (continue)

For companies taking supply at medium voltage (such as 11kV or 33kV)

Tariff C1 - Medium Voltage General Commercial Tariff	Unit	C1
For each kilowatt of maximum demand per month	RM/kW	30.30
For all kWh	sen/kWh	36.5
The minimum monthly charge is RM600.00		

Normally applicable for 24 hours operation

Tariff C2 - Medium Voltage Peak/Off-Peak Commercial Tariff	Unit	C2
For each kilowatt of maximum demand per month during the peak period	RM/kW	45.1
For all kWh during the peak period	sen/kWh	36.5
For all kWh during the off-peak period	sen/kWh	22.4
The minimum monthly charge is RM600.00		

Hilton
HOTELS & RESORTS

Figure 2(g): Tariff for Commercial Customer

Rate Structure-LV Industrial

Electricity Tariff for Industrial Customer

- Majority of industrial customers are taking supply at low voltage level.
- The applicable tariff is Tariff D

Tariff D – Low Voltage Industrial Tariff	Unit	D
For the first 200 kWh (1-200kWh) per month	sen/kWh	38.0
For the next kWh (201 onwards) per month	sen/kWh	44.1
Tariff DS – Special Industrial Tariff (for customers who qualify only)		
For all kWh	sen/kWh	42.7
The minimum monthly charge is RM7.20		

SMECORP MALAYSIA

Figure 2(h): Tariff for Industrial Customer

BACKGROUND OF SPECIAL INDUSTRIAL TARIFF (SIT)

- Introduced in 1996 as part of TNB's new tariff
- Open to 5 identified industries with electricity consumption being 5% or more of their total operating cost
- The industries were:-
  - Ice factories
  - Iron and Steel industries
  - Glass industries
  - Industrial gas industries
  - Cement industries
- On 29 March 1996, the SIT was introduced to all industries (Tariff D, E1, E2 and E3 only) with electricity consumption being 5% or more of their total operating costs

Figure 2(i):Tariff for Special Industrial Tariff (SIT)

Rate Structures – MV Commercial

Electricity Tariff for Industrial Customer

Applicable for manufacturing companies taking supply at medium voltage (such as 11kV or 33kV)

Tariff E1 - Medium Voltage General Industrial Tariff	Unit	E1	E1s
For each kilowatt of maximum demand per month	RM/kW	29.60	23.70
For all kWh	sen/kWh	33.70	33.60
The minimum monthly charge is RM600.00			

Normally applicable for those who operate 24 hours

Tariff E2 - Medium Voltage Peak/Off-Peak Industrial Tariff	Unit	E2	E2s
For each kilowatt of maximum demand per month during the peak period	RM/kW	37.00	32.90
For all kWh during the peak period	sen/kWh	35.50	33.60
For all kWh during the off-peak period	sen/kWh	21.90	19.10
The minimum monthly charge is RM600.00			

Figure 2(j): Tariff for Medium Voltage Customer

Rate Structures – MV Commercial

Electricity Tariff for Industrial Customer

In general, applicable for manufacturing companies taking supply at 132kV or 275kV

High Voltage Peak/Off-Peak Industrial Tariff	Unit	E3	E3s (SIT)
For each kilowatt of maximum demand per month during the peak period	RM/kW	35.50	29.00
For all kWh during the peak period	sen/kWh	33.70	31.70
For all kWh during the off-peak period	sen/kWh	20.20	17.50
The minimum monthly charge is RM600.00			

Figure 2(k): Tariff for Medium Voltage Industrial Customer

Tariff Based On Energy

- The cost of electricity is determined by the amount of energy (kWh) utilised every month.
- If the consumer consumes no electricity, he must pay a minimum service charge because keeping him connected to the line costs money.
- As use rises, so does the cost per kWh, usually on a sliding scale.
- Domestic clients just pay for the amount of energy (kWh) consumed..

Tariff Based On Power Factor

- Power factor is the ratio of the active power Pto the apparent power S.
- **Power Factor = P/S = cos θ** where; θ is the angle between V & I
- Power factor is a measurement of how efficiently electrical power is used.
- For the same amount of useable power delivered, a load with a low power factor uses more current than a load with a high power factor in an electric power system.
- Higher currents cause more energy to be lost (I2R) in the distribution system and necessitate larger wires and other equipment.
- Many alternating current equipment, such as induction motors and transformers, absorb reactive power to generate magnetic fields.
- A low power factor raises the cost of supplying electrical energy.

- In practice, the rate structure is set up to automatically increase billing whenever the power factor falls below a certain threshold.
- In order to qualify for the minimum rate, most electrical utilities require that their industrial clients have a power factor of 90% or higher.
- When PF is too low, it is usually in the customer's best interest to raise it rather than pay the higher monthly bill.
- This is typically accomplished by putting capacitors near the plant's service entrance, on the load side of the metering equipment.
- This capacitors may provide some or all of the reactive power needed by the facility.
- Industrial capacitors for power factor correction are available in single-phase and three-phase configurations with ratings ranging from 5kVAr to 200kVAr.

TNB PF SURCHARGE

- TNB requires all industrial and LPC to keep their power factor at or above 0.85. Failure to maintain the required PF will result in the imposition of a PENALTY. The penalty is built into the TARIFF framework.
- Except for TARIFFs A and G, consumers must use their best efforts to achieve the highest possible PF in the operation of any of their electrical systems.

(1) Below 0.85 and up to 0.75 (0.85>PF0.75) lagging, an extra charge of 1.5 percent of the bill for that month will be charged to the bill for that month for each 0.01 unit below 0.85 and up to 0.75 lagging PF.

(2) Below 0.75 (0.75>PF) lagging, in addition to the fee due under (1) above, an additional charge of 3% of the bill for that month will be added to the bill for that month for each 0.01 unit below 0.75 lagging PF.

Power Factor Correction

- Power factor correction is economically possible when the reduction in annual electricity costs exceeds the amortised cost of installing the necessary capacitors. In some circumstances, the client has no choice but to adhere to the utility company's minimum power factor.
- Installing capacitors at the service entry to the industrial or commercial company can improve the power factor. If the power factor of a single device or equipment is especially low, it may be beneficial to correct it.

Metering Methodology For Large Power Consumer (LPC)

- Definition of Large Power Consumer:
  - TNB Commercial Circular No.91 stated that a large power consumer is one who is supplied via CT metering and includes domestic, commercial, industrial and mining customers taking LV, MV and HV.
- LPC Billing components:
  - kWh unit consumption
  - kW maximum demand charges and satisfying initial MD declaration
  - kVarh units for calculation of the monthly average power factor

Know Your Bill

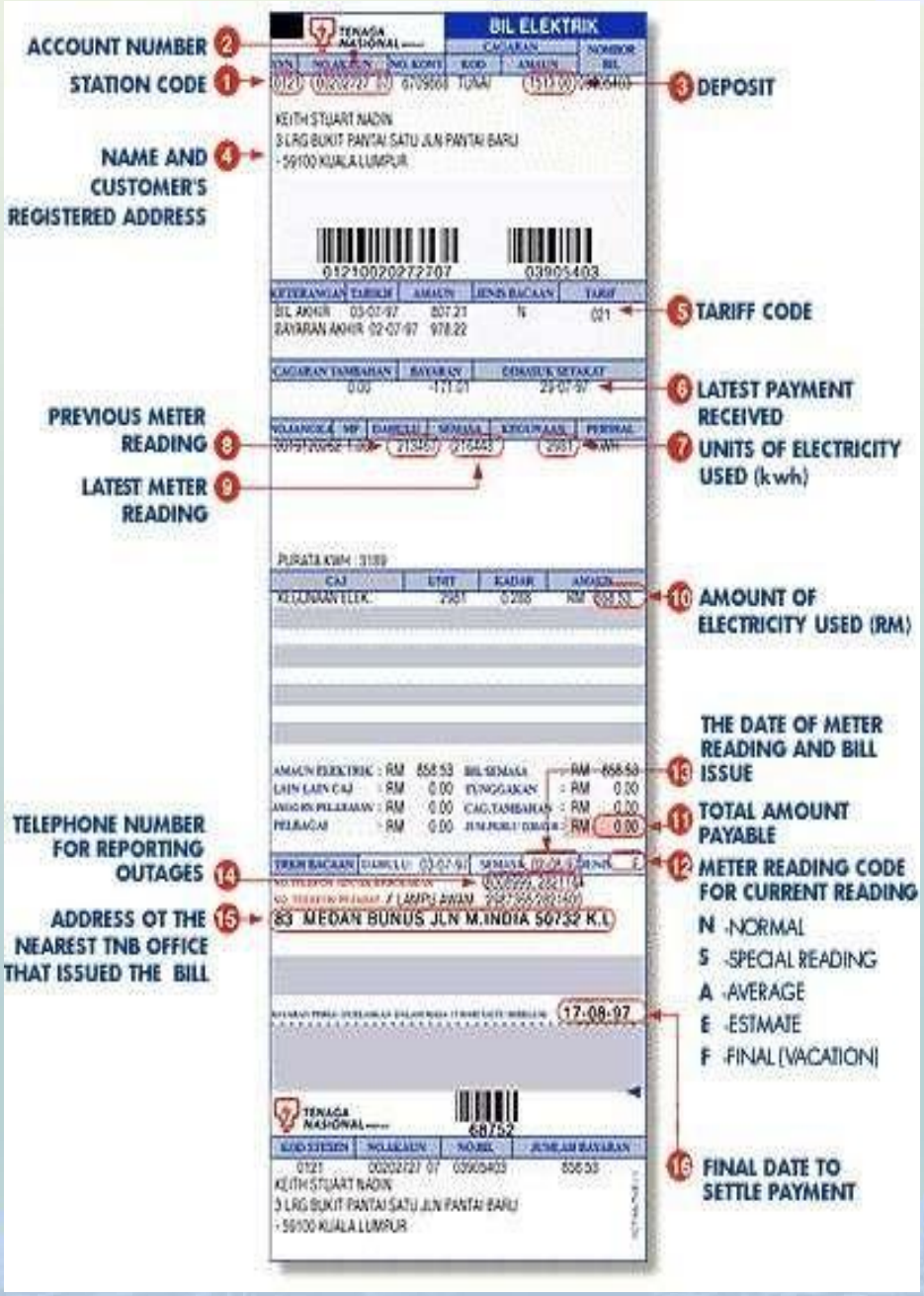


Figure 2(I): Know Your Electricity Bill

CALCULATING ELECTRICITY COST

Formula

Energy = Appliance power x Duration		
(kWh)	(kW)	(h)

1 kW Air-conditioner will consume 1 kWh of energy in 1 hour

40 W Florescent light will consume 0.4 kWh in 10 hour

Example 1

During the month of June, a typical homeowner uses 530 kWh. Use the household rate to compute the electricity bill.

Solution:

First 200 kWh @21.8 cents/kWh = RM 43.60

Next 100 kWh @33.4 cents/kWh = RM 33.40

Next 230 kWh @51.60 cents/kWh = RM 118.68

Total bill for the month = RM 195.68

This represents an average cost of RM 195.68/530 = 36.92 cents/kWh

Example 2

During the month of June, a homeowner uses 330kWh. Use the household rate to compute the electricity bill.

Solution:

First 200 kWh @21.8 cents/kWh = RM 43.60

Next 100 kWh @33.4 cents/kWh = RM 33.40

Next 30 kWh @51.60 cents/kWh = RM 15.48

Total bill for the month = RM 92.48

This represents an average cost of RM 92.48/330 = 28.02 cents/kWh

Example 3

At a power factor of 65 percent, a plant draws an apparent power of 300kVA (lagging). Calculate the kVAR of the capacitor bank required at the service entry to get the overall power factor to:

a) Unity (PF = 1)
b) 85% lagging

Solution:

a) Unity power factor

Apparent power absorbed by the plant is

$S = 300kVA$ $PF = 65\% = 0.65$ $\theta = \cos^{-1}0.65 = 49.5^{o}$ Active power absorbed by the plant is

$P = S\cos\theta = 300 \times 0.65 = 195$ kW

Reactive power absorbed by the factory is

$Q = S\sin\theta = 300 \sin 49.5^{o} = 228$ kVAr

To raise the power factor to unity, we have to supply all the reactive power absorbed by the load (228kVAr).

The three-phase capacitors rating is 228kVAr.

b) 85% lagging

$PF = 85\% = 0.85$ $\theta = \cos^{-1}0.85 = 31.78^{\circ}$

The new reactive power supplied by the line is

$Q_{new} = PTan\theta = 195\ Tan\ 31.78^{\circ} = 121kVAr$

Because the load still draws 228kVAr but the line now supply only 121kVAr, the difference must come from the capacitors.

The rating of these units is $Q = 228 - 121 = 107kVAr$

Example 4

During the month of June, a homeowner uses 950 kWh. Use the household rate to compute the electricity bill.

Solution:

First 200 kWh @21.8 cents/kWh = RM 43.60

Next 100 kWh @33.4 cents/kWh = RM 33.40

Next 300 kWh @51.60 cents/kWh = RM 154.80

Next 300 kWh @54.60 cents/kWh = RM 163.80

Next 50 kWh @57.10 cents/kWh = RM 28.55

Total bill for the month = RM 424.15

This represents an average cost of RM 424.15/950 = 44.64 cents/kWh

Example 5

Calculate the electricity bill of the month for the list of appliances below:

Qty	Type	Power (kW)	Duration (hours)
2	Fan	60	4
6	Fluorescent lamp	38	5
1	Refrigerator	700	24

Solution:

Calculate energy (kWh):

2 x 60 x 4 = 480 W = 0.48 kWh

6 x 38 x 5 = 1140 W = 1.14 kWh

1 x 700 x 24 = 16800 W = 16.8 kWh

Total kWh /day

= 0.48+1.14+16.8 =18.42 kWh

Total Energy consumption in 1 month

= 18.42 kWh x 30 days = 552.6 kWh

Electricity bill:

For the first 200 kWh (1 - 200 kWh)

200 kWh x RM 0.2180 = RM 43.60

For the next 100 kWh (201 - 300 kWh)

100 kWh x RM 0.3340 = RM 33.40

For the next 300 kWh (301 - 600 kWh)

252.6 kWh x RM 0.5160 = RM 130.34

Total bill = RM 43.60 + RM 33.40 + 130.34

= **RM 207.34**

Example 6

Calculate total annual energy consumption and electricity bills of a vacuum cleaner and radio alarm. Assume the vacuum cleaner is used two hours once a week and a radio alarm is on all the time. The capacity for both appliances are 2000 watts and 10 watts respectively.

Solution:

Annual energy consumption:

Radio alarm: 10 x 24 x 365

= 87.6 kWh

Vacuum cleaner: 2000 x 2 x 52

= 208 kWh

Total annual energy consumption

= 87.6 + 208

= 295.6 kWh

First 200 kWh @21.8 cents/kWh = RM 43.60

Next 95.6 kWh @33.4 cents/kWh = RM31.93

Total bill for the annual = RM75.53

This represents an average cost annual of RM 75.53/295.6

= 25.55 cents/kWh

Example 7

At an 83 percent power factor, a paper mill consumes 28 million kilowatt-hours of energy every month. The peak demand is 43000kW, according to the demand metre. Calculate the monthly bill using the following huge power rate schedules::

TARIFF CATEGORY	UNIT	RATES
2. **Tariff E1 - Medium Voltage General Industrial Tariff**		
For each kilowatt of maximum demand per month	RM/kW	25.3
For all kWh	sen/kWh	28.8
The minimum monthly charge is RM600.00		

Solution:

Usage: 28,000,000 x RM0.288 = RM8,064,000.00

Maximum demand: 43,000 x RM25.3 = RM1,087,900.00

Power Factor Penalty:

Power Factor = 0.83

(a) 0.85 -0.83 => 1.5% x 2 = 3.0%

Penalty = 3.0% x RM 8,064,000 = RM 241,920.00

Total Bill = RM8,064,000.00 + RM1,087,900.00 + RM241,920.00 = RM 9,393,820.00

Example 8

A LPC called KODUK has a monthly PFat 0.6 lagging, and its monthly consumption (electricity bill) is RM4,800.00. What will be its monthly PF PENALTY?

Solution:

- Based on the tariff,

(1) 0.85 -0.75 = 1.5% x 10 units lagging = 15%

(2) 0.75- 0.60 = 3% x 15 units lagging = 45%

Total extra levied = 60%

Penalty charge = 60% x RM4,800 = RM2,880

Total monthly bill = RM4,800 + RM2,880 = RM7,680

Example 9

Billing for LPC

A small industry that operates 24 hours a day, seven days a week utilises 560,000 kWh and 555,427 kVarh each month. The peak demand is 1200 kW. Calculate the electricity bill using the following tariff:

	TARIFF CATEGORY	UNIT	RATES
2.	**Tariff E1 - Medium Voltage General Industrial Tariff**		
	For each kilowatt of maximum demand per month	RM/kW	25.3
	For all kWh	sen/ kWh	28.8
	The minimum monthly charge is RM600.00		

Solution:

Usage: 560,000 x RM 0.288 = RM 161,280.00

Maximum demand: 1,200 x RM 25.3 = RM 30,360.00

Power Factor Penalty:

Power Factor = 0.71

(a) 0.85 -0.75 => 1.5% x 10 = 15.0%

(b) 0.75 -0.71=> 3.0% x 4 = 12.0%

Penalty = 27.0% x RM 161,280 = RM 43,545.60

Total Bill = RM 161,280.00 + RM 30,360.00 + RM 43,545.60 = RM 235,185.60

END OF TOPIC 2

TOPIC 3: STANDARDS IN ENERGY EFFICIENCY

- Important of Standards in Energy Efficiency Practices
- Management Standards
- Technical Standard MS 1525:2014

START

Important Of Standards In Energy Efficiency Practices

The important of standards in energy efficiency

- To create a standard for more efficient energy consumption.
- To establish aims and objectives in order to meet that standard.
- To collect data in order to better understand and make decisions about energy use.To quantify the findings obtained.
- To assess the standard's effectiveness.
- Constantly improving energy efficiency.

International Organization for Standardization

Figure 3(a): International Standard Organization

- Non-governmental organisation (NGO) founded in 1947 and headquartered in Geneva, Switzerland.
- It is made up of approximately 160 national standards institutes from countries all over the world.
- The world's leading developer of voluntary International Standards, with a focus on global and commercial relevance.

MANAGEMENT STANDARDS

MS ISO50001:2018

What is IS050001?

ISO 50001:2018, issued in August 2018, is the most recent standard for creating a strong Energy Management System (EnMS).It creates a global framework for industrial facilities or entire enterprises to manage all aspects of energy, including purchase and use.

Objectives of ISO 50001

- To help businesses make better use of their existing energy-consuming assets.
- To encourage best practises in energy management and to reinforce excellent energy management behaviours.
- To establish a framework for encouraging energy efficiency throughout the supply chain.
- To aid in the improvement of energy management for initiatives aimed at reducing greenhouse gas emissions.

- How does ISO 50001 work?
  - Determines which requirements must be met.
  - It does not specify how you will meet the requirements.
  - Every energy management system is one-of-a-kind.
  - Allows for adaptability.
  - Allows management to maintain control.

Benefits to an Organization for implementing an Energy management System

- Identifies and manages risks associated with your future energy supply.
- Measures and monitors energy consumption to determine where energy efficiency might be improved.

- Improves overall performance, resulting in lower energy use and costs.
- Reduces carbon emissions while meeting government targets.
- Utilizes existing management systems.
- makes use of existing continuous improvement procedures
- Creates a baseline of energy consumption.
- Actively manages energy consumption and expenditures.
- Reduces emissions without affecting operations.
- Continuous improvement in energy consumption.

ISO 50001 Approach is Based on the Plan-Do-Check-Act (PDCA) cycle

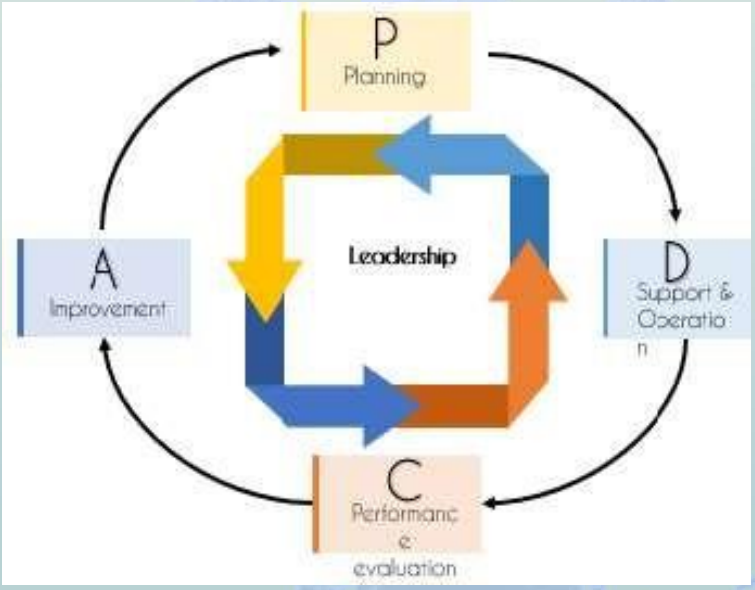


Figure 3(b): Scope of the Energy Management System

- An energy management system assists enterprises in better managing their energy consumption, resulting in increased productivity. It entails creating and implementing an energy policy, establishing attainable targets for energy consumption, and creating action plans to meet those targets and track progress. This could include installing new energy- efficient technologies, decreasing energy waste, or enhancing present processes to save money on energy.
- ISO 50001 provides enterprises with a well-known framework for creating an efficient energy management system. It follows the "Plan-Do-Check-Act" method for continuous improvement, as do other ISO management system standards.

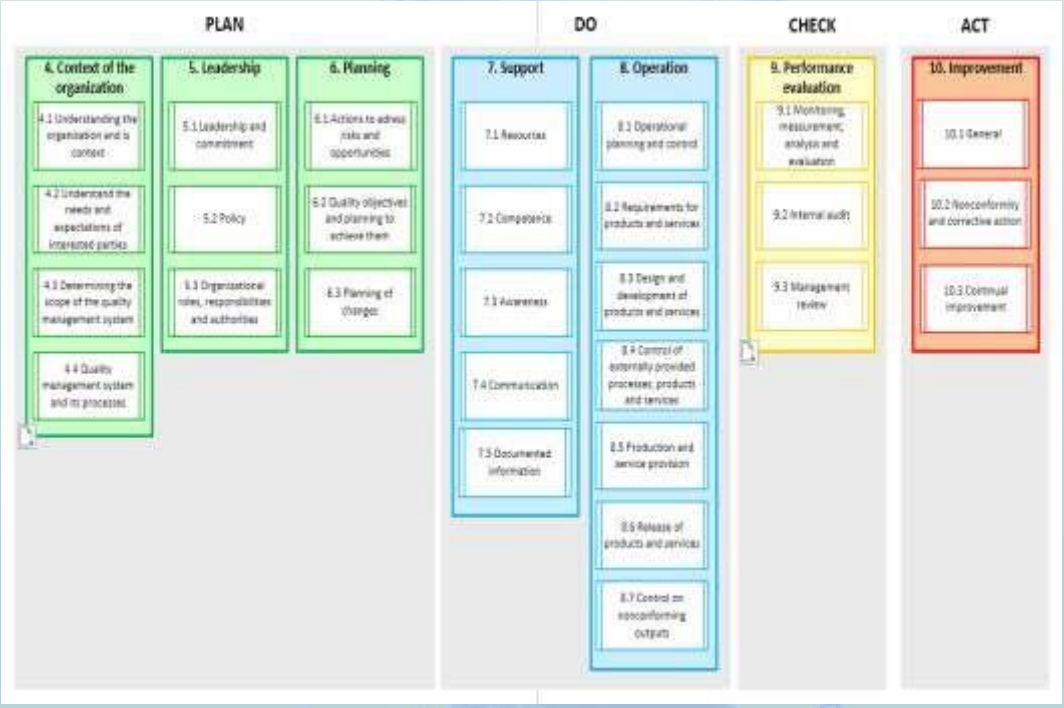


Figure 3(c): Plan-Do-Check-Act Process

ISO 50001:2018 is Based on the ISO High-Level Structure for Management System Standards

1. Scope
2. Normative References
3. Term & Definitions
4. Context of the Organization
5. Leadership
6. Planning
7. Support
8. Operation
9. Performance Evaluation
10. Improvement

Energy Management System Strategic Plan

Figure 3 (d): Energy Management System Strategic Plan

Basic Concept of Energy Planning Process

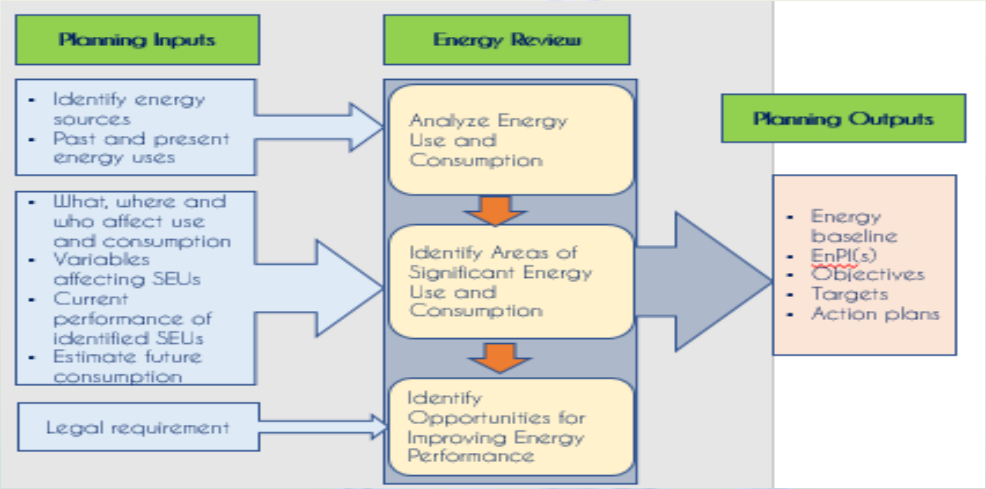


Figure 3 (e): Basic Concept of Energy Planning Process

Becoming ISO 50001 Certified

- The certification organisation assesses the EnMS for compliance with the ISO 50001 standard.
- The ISO 50001 audit is a compliance inspection.
- Certification indicates that the organisation has a documented EnMS that has been completely implemented and meets ISO 50001 criteria.

Audit Findings

i. Major Non-conformity

ii. Minor Non-conformity

iii. Observation

ISO 50001:2018 Certification Transition Timeline

Figure 3 (f): ISO50001:2018 Certification Transition Timeline

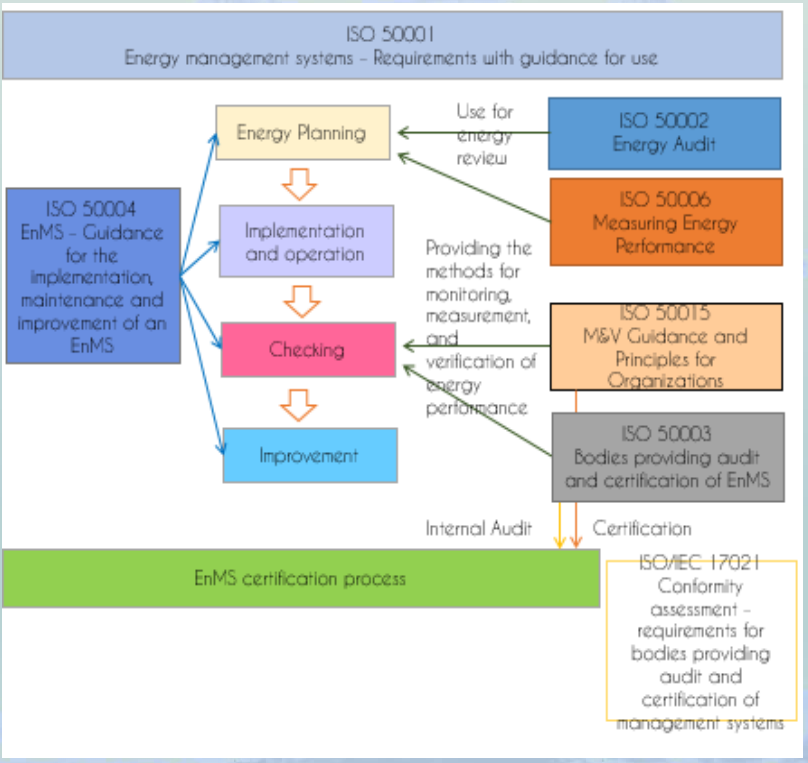


Figure 3 (g): Energy Management System Certification Process

ISO 50002:2014

- The process requirements for conducting an energy audit in relation to energy performance are specified in ISO 50002:2014. It applies to all types of companies and organisations, as well as all types of energy and energy use. ISO 50002:2014 defines the concepts of conducting energy audits, as well as the requirements for common processes during energy audits and energy audit deliverables.
- ISO 50002:2014 does not address the standards for selecting and evaluating the competence of bodies offering energy auditing services, nor does it discuss the auditing of an organization's energy management system, which is covered in ISO 50003. ISO 50002:2014 also includes useful information on how to use it.

ISO50003:2015

Organizations that provide EnMS auditing and certification:

- Specifies the competence, consistency, and impartiality requirements for organisations offering auditing and certification of energy management systems (EnMS).
- It addresses the auditing method, competency requirements for individuals involved in the certification process for energy management systems, audit duration, and multi-site sampling to assure the effectiveness of EnMS auditing.
- This document is intended to be used in conjunction with ISO/IEC 17021.

ISO50004:2014

- Provides practical instructions and examples for establishing, implementing, maintaining, and improving an energy management system (EnMS) using ISO 50001's systematic methodology..

ISO50006:2015

- Provides companies with information on how to construct, use, and maintain energy performance indicators (EnPIs) and energy baselines (EnBs) as part of the energy performance measurement process.

ISO50015:2015

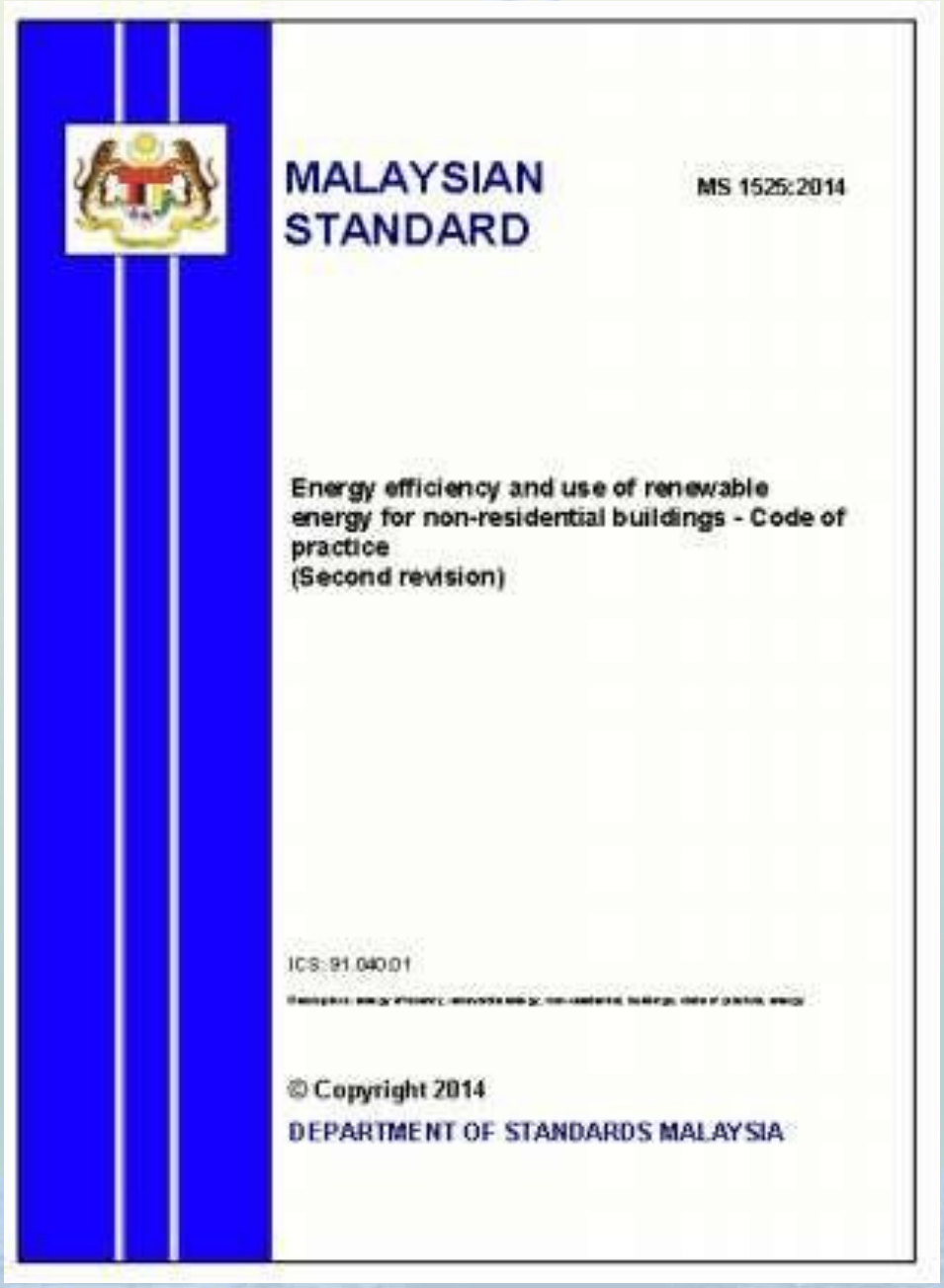
- Provides a set of measurement and verification principles and procedures, boosting the credibility of energy performance.

ISO50047:2016

- Energysavings– Energysavingsin organisationsarecalculated.
- ISO50047:2016 specifies methodologies for calculating energy savings in enterprises. It can be utilised by any organisation, regardlessofwhetherit hasan energymanagementsystem, suchasISO50001.

- In the context of energy savings, ISO 50047:2016 addresses the following topics:
    - defining the goal of calculating energy savings;
    - establishing limits /boundaries;
    - Accounting for energy, including source and delivered energy, aswell asthe use of common energy units;
    - deciding on a method for calculating energy savings;
    - creating a baseline for energy;
    - Energy consumption should be normalised;
    - calculating energy savings;
    - reports, and other issues.

MS 1525:2014 Technical Standard



MALAYSIAN STANDARD

MS 1525:2014

Energy efficiency and use of renewable energy for non-residential buildings - Code of practice
(Second revision)

ICS: 91.040.01

DEPARTMENT OF STANDARDS MALAYSIA

- Energy efficiency and use of renewable energy for nonresidential buildings – Code of practice (Second revision) – MS1525: 2014
- MS1525 primarily deals with building energy efficiency
- The Malaysian Standard covers new and existing buildings such as offices, hotels, shopping complexes and department stores as well as those portions of factory and industrial buildings that are used primarily for human occupancy

MS1525 – Overall Content

Energy efficiency and use of renewable energy for non-residential buildings - Code of practice (Second revision)

- First Edition – 2001
- Second Edition – 2007
- Third Edition – 2014
- Section 1 – Scope
- Section 2 – Normative reference
- Section 3 – Terms and definitions
- Section 4 – Architectural and passive design strategy
- Section 5 – Building envelope
- Section 6 – Lighting design
- Section 7 – Electric power and distribution
- Section 8 – Air conditioning and mechanical ventilation (ACMV) System
- Section 9 – Energy management control system
- Section 19 – Building energy simulation method (an alternative compliance method)

Tutorial

1. List five important of standards in energy efficiency.
2. Describe the benefits of an energy management system.
3. Explain the goals of an ISO 50001 Energy Management System.
4. Explain the process of ISO 50001 certification.
5. Define an energy audit.
6. Why one needs to carry out an energy audit.
7. Explain how does an energy audit work.
8. Explain what is the most important content of ISO50003:2015.
9. Describe the main function of an ISO50004:2014.
10. Explain the goals of an ISO50015:2015.
11. Describes the approaches for the determination of energy savings in ISO50047:2016.
12. Explain the purpose of technical Standard MS 1525:2014.

Tutorial Answer

1. List five an importance of standards in energy efficiency.

- to create a standard for more efficient energy use
- To establish aims and objectives in order to meet that standard
- To collect data in order to better understand and make decisions about energy consumption
- To assess the standard's efficacy by measuring the results produced
- Constantly improving energy efficiency

2. Describe the benefits of an energy management system.

- Profitability: Increases your competitive advantage by lowering your energy costs.
- Positive energy balance: Reduces CO2 emissions while increasing energy efficiency.
- Improved branding: Documents energy awareness and performance improvement measures to convey to your customers the importance you have on sustainability and energy efficiency.
- Employee awareness: Makes your employees aware of the need of boosting energy efficiency.

3. Explain the goals of an ISO 50001 Energy Management System

- Identifying cost-cutting opportunities
- lowering CO2 emissions
- Energy flow transparency throughout the business
- Process optimization
- Energy usage, efficiency, and performance improvements
- Implementation and verification of compliance with your energy policy
- External third-party verification of your energy policy and energy management system (EnMS) in accordance with ISO 50001.
- Possibility of becoming certified by an approved certifying authority.

4. Explain the process of ISO 50001 certification

Preliminary audit (optional).

- The auditors undertake a preliminary evaluation to discover which ISO 50001 standard requirements, if any, have already been implemented by the organisation and which, if any, have possible vulnerabilities or have yet to be addressed.

Certification audit.

- The certification procedure is divided into two stages: The audit team verifies, among other things, whether EnMS meets the ISO 50001 requirements in the initial part of the procedure. The audit team verifies the deployment and efficacy of EnMS in the second stage of the procedure.

Certificate issuance.

- The certificate will be issued once the organisation has successfully proved adherence to the ISO 50001 standard, as well as the installation and efficacy of EnMS to accomplish the desired outcomes.

Surveillance audits.

During annual surveillance audits, auditors examine the continuous improvement of EnMS processes and determine if the organization's adherence to the standard has been maintained.

Recertification.

- It will be able to sustain the continuous improvement of EnMS and energy performance by recertifying before the conclusion of the three-year certification cycle. The organisation will also be able to present partners and consumers with third-party recorded documentation confirming the organization's commitment to improved energy performance.

5. Define an energy audit?

- An energy audit is a survey, inspection, and analysis of energy flows to identify energy savings potential in a structure, process, or system in order to lower the amount of energy input into the system without negatively affecting the output (s).

6. Why one needs to carry out an energy audit.

- There are numerous reasons to do an energy audit, including::
  - i. Improving energy efficiency and reducing the environmental effect of the organization's activities.
  - ii. To discover potential for behavioural change by reviewing current operations and maintenance methods.
  - iii. To find technological opportunities, significant process energy-using components or utilities such as boilers, refrigeration plants, ventilation systems, building performance, and fleet efficiency must be evaluated.
  - iv. To give clear financial information on energy-saving opportunities so that these things can be prioritised for the organization's decision-making process.
  - v. to acquire a better grasp of a portion or the entirety of the organization's energy consumption patterns
  - vi. Identifying the possible use of renewable energy supply methods
  - vii. To meet regulatory criteria such as the Energy Efficiency Directive, the Industrial Emissions Directive, and the Environmental Protection Agency's waste licence requirements. To meet corporate social responsibility objectives.
  - viii. To meet the expectations of customers and shareholders.
  - ix. To provide input into a strategic strategy targeted at reducing the organization's carbon footprint..
  - x. Contribute to the ISO 50001 certification process for a structured energy management system.

7. Explain how does an energy audit work.

- The energy auditing procedure is divided into two stages:

❑ **Phase 1: Preparation and analysis**

- Step 1: An introductory meeting will be held to agree on a strategy.
- Step 2: Confirm the scope and gather preliminary data
- Step 3: Determine important employees and plan a site visit.
- Step 4: Create an energy usage baseline and a measurement plan.
- Step 5: Create an audit checklist.

❑ **Phase 2:** Site Visit & Reporting.

- Step 6: Conduct a site audit and document your observations.
- Step 7: Conduct an onsite analysis of current energy practises and usage.
- Step 8: Create a graphical representation of the energy opportunities and dangers.
- Step 9: Create a final report that includes contextualised graphic information.

8. Explain isthe most important content of ISO 50003:2015.

- ISO 50003 provides certifying body requirements for audits and certification of energy management systems (EnMS). This standard will also have an impact on organisations obtaining or maintaining ISO 50001 certification, either directly or indirectly.
- The following are the standard impacting organisations' most salient points:
  - The audit duration calculation requirements have changed. Significant energy usage (SEUs) and EnMS-effective employees are now taken into account.
  - The organisation will be divided into eight technical areas, and auditors must demonstrate abilities in the technical area corresponding to each examined organisation.
  - Requirements for auditing processes have been updated. This means that in the future, organisations will be expected to explicitly demonstrate an improvement in energy performance in order to be certified or continue certification of the EnMS.

9. Describe the main function of an ISO50004:2014.

- Provides practical instructions and examples for establishing, implementing, maintaining, and improving an energy management system (EnMS) using ISO 50001's systematic methodology.

10. Explain the goals of an ISO50015:2015.

- Provides a set of measurement and verification principles and procedures, boosting the credibility of energy performance.

11. Describes the approaches for the determination of energy savings in ISO50047:2016.

.

- Methods for calculating energy savings in companies. It can be utilised by any organisation, regardless of whether it has an energy management system, such as ISO 50001.

12. Explain the purpose of technical Standard MS 1525:2014.

- This code of practice provides recommendations on energy efficiency, including the use of renewable energy in new and existing non-residential buildings. The standard aids architects and engineers in the design of structures, lighting and electrical systems, air conditioning and mechanical ventilation systems, and energy management systems.

END OF TOPIC 3

REFERENCES

1. http://www.un.org/sustainabledevelopment/news/communications-material/
2. https://www.st.gov.my/
3. https://www.st.gov.my/en/contents/files/download/116/Malaysia_Energy_Statistics_Handbook_20201.pdf
4. https://www.tnb.com.my/
5. https://www.tnb.com.my/assets/files/Tariff_booklet.pdf
6. https://www.tnb.com.my/assets/files/Tariff_Rate_Final_01.Jan.2014.pdf
7. https://www.sarawakenergy.com/
8. https://www.sesb.com.my/
9. https://www.unido.org/sites/default/files/2009-02/Module12_0.pdf
10. https://www.iso.org/iso-50001-energy-management.html
11. MS1525 2014 Energy efficiency and use of renewable energy for non-residential buildings - Code of practice
12. http://www.seda.gov.my/pdfdownload/malaysian-standards-ms-1525-2019-energy-efficiency-and-use-of-renewable-energy-for-non-residential-buildings/
13. https://epdf.pub/queue/transmission-and-distribution-electrical-engineering.html
14. https://www.greenbuildingindex.org/how-gbi-works/gbi-certified-buildings/
15. https://www.ovoenergy.com/guides/energy-guides/energy-tariffs-explained