BMM4753 RENEWABLE ENERGY RESOURCES

Chapter 1. Introduction to Energy Resources

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1.1 Introduction

Energy are extracted from the nature in the form of raw primary energy, processed and transformed to intermediate and finally useable energy forms. The conversion processes are accompanied with pollution problems as a major portion of energy is transformed to electrical energy in power plants particularly the coal fired, which emit solid particles, SO_x, NO_x, CO, CO_2, waste heat and chemicals into the environment and harm the ecological balance.

The widespread use of petroleum began during the 20th century, with the advent of modern and bulk transportation and big industries. Energy utilization got further enhanced with the invention of electricity and development of electrical power stations, consuming either fossil fuels or potential energy of water. Access to cheap energy is essential to function in modern economy and energy security. However, the uneven distribution of energy supplies among countries has led to significant vulnerabilities. The world's annual energy consumption rate is increasing at a rate of 2-4% and the thermal power plants are emitting solid, liquid and gaseous pollution in the environment, causing greenhouse effect and global warming.

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1.2 Terminology

Energy is adopted from Greek language, *en* means 'in' and *ergon* means 'work'; *en-ergo* means 'inwork' or 'work content' ; exist in numerous forms such as thermal, mechanical, kinetic, potential, electric, magnetic, chemical, and nuclear.

Primary energy is the energy in raw fuel in nature in such as wood, coal and petroleum and not subjected to any transformation process.

Secondary energy refers to the more convenient forms of energy which are transformed from other, primary energy sources through energy conversion process such as electricity.

Heat energy is an intrinsic energy of all combustible substances, the kinetic energy of molecules, can cause gases to expand, drive engines and raise the temperature of water.

Work is the transfer of energy to or from a body of matter due to external forces acting on them.

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1.2 Terminology

Chemical energy is converted into *thermal energy* by chemical reactions in combustion, into *electrical energy* in fuel cells, storage batteries etc.

Kinetic energy is the energy a system possesses as a result of its motion relative to some reference

Electrical energy arises out of the arrangement of movement of electrons to produce heat, magnetic field and electromagnetic radiations, highly versatile, can easily be converted to other forms for utilization.

Potential energy is energy a system possesses as a result of its elevation in a gravitational field

Alternative energy refers to source of usable energy to replace fuel sources without the undesired consequences of the fuels to be replaced.

Renewable energy refers to energy from naturally replenishable resources such as sunlight, wind, rain, tides, and geothermal heat.

1.2 Terminology

Power is the *rate* at which energy is converted from one form to another, or transferred from one place to another.

watt (W) is defined as one joule per second.

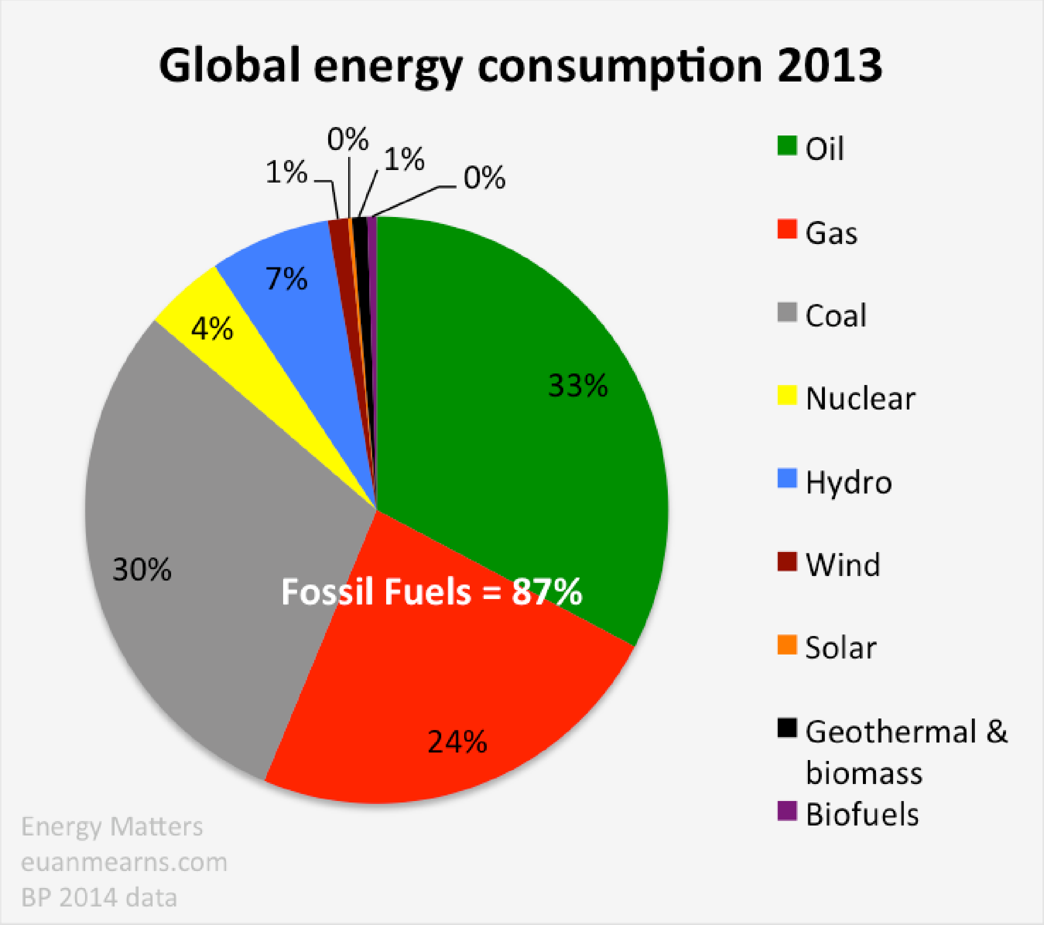
kilowatt is 1000 watts, i.e. 1000 joules per second, and there are 3600 seconds in an hour, so 1 kWh = 3600 x 1000 = 3.6 x 10^6 Joules (3.6 MJ).

kilowatt-hour (kWh) is a measure energy of power used for a given time period. If the power of an electric heater is 1 kW, and it runs for an hour, we say that it has consumed one kWh of energy.

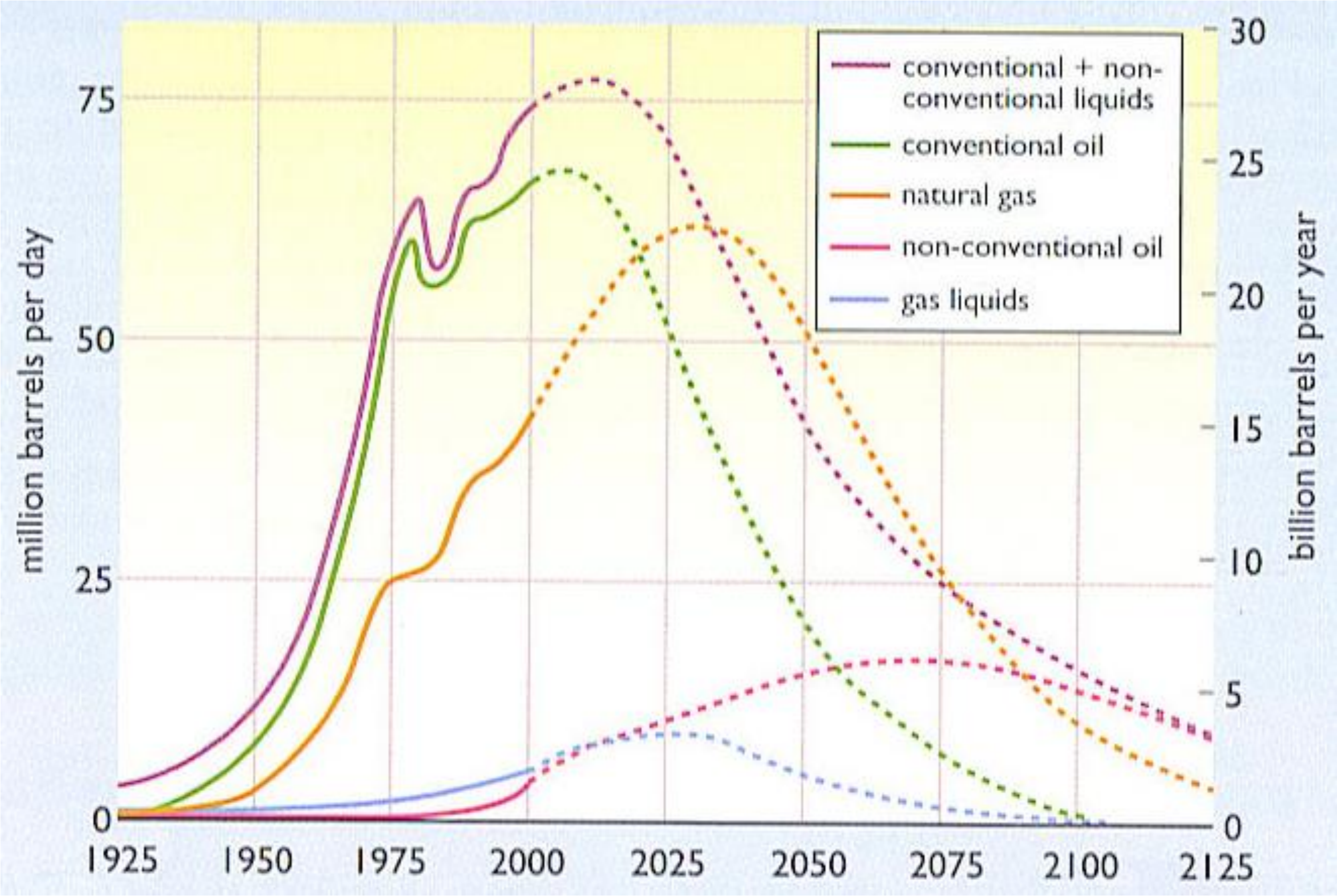
1 Mtoe = 41.9 PJ is a measure of energy often simply expressed in unit ‘million tonnes of oil equivalent‘.

1.3 World Energy Scenario

Trend of Energy Consumption of the world changes with time but generally are fossil dependent at 87% in 2013. After every twenty to thirty years the choice of primary energy tends to change. Approximately 40% of total energy demand is for transportation sector, fulfilled by i) petroleum ii) petroleum products derived from natural gas, oil, bio-mass iii) electrical energy from non-conventional resources.

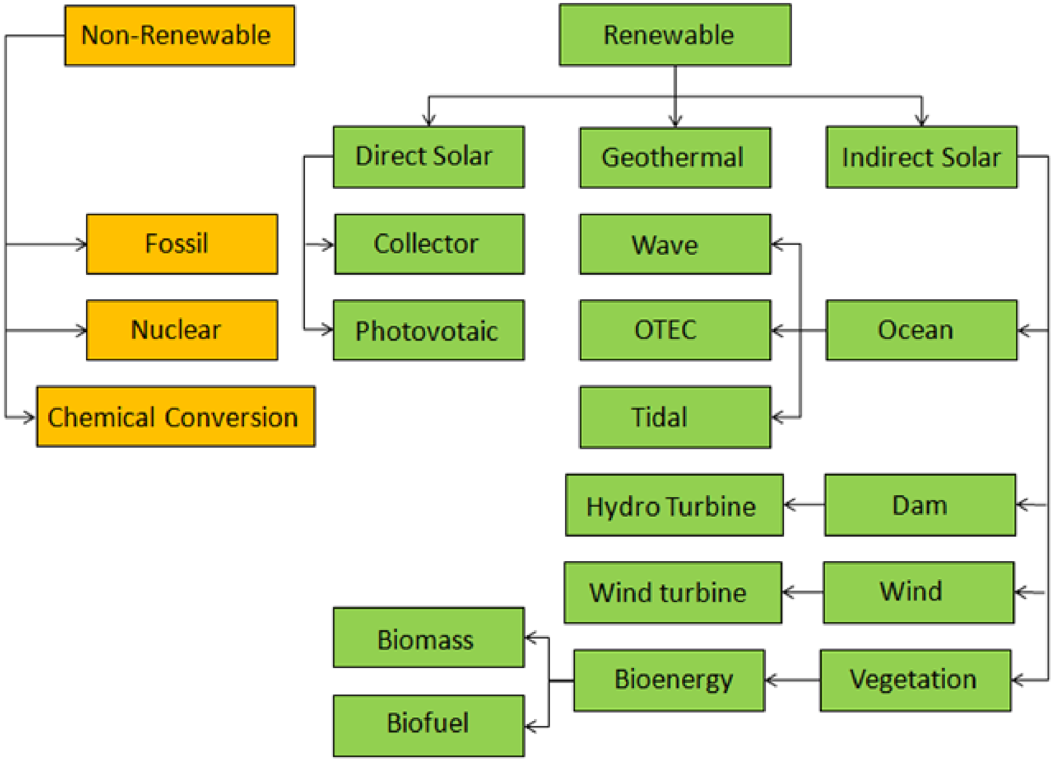


1.3 World Energy Scenario - World Oil & Gas Production



1.4 Energy Resources

Human extracts energy from the nature in the form of raw energy (primary energy resources), processed and transformed to intermediate and finally useable energy forms. Energy conversion processes are accompanied with pollution problems. A major portion of energy is transformed to electrical form by fossil powered plants, emit solid particles, SO_x, NO_x, CO, CO_2 into the environment and disturbs the ecological balance.



The world's annual energy consumption rate increases at a rate of 2-4%. Nuclear power plants, thermal power plants, chemical conversion plants are emitting solid, liquid and gaseous pollution in the environment, causing greenhouse effect and global warming.

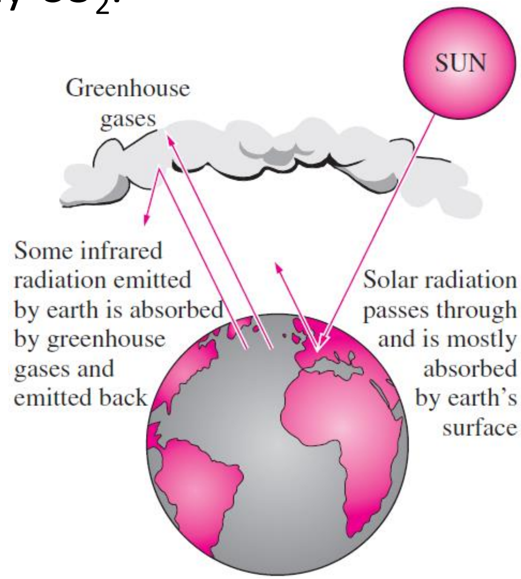
1.5 Environmental Impact and Climate Change

Greenhouse Gases and Greenhouse Effect

The surface of the earth warms up during the day as a result of the absorption of solar energy, cools down at night by radiating part of its energy into deep space as infrared radiation. Carbon dioxide (CO_2), water vapor, and trace amounts of some other gases such as methane and nitrogen oxides act like a blanket and keep the earth warm at night by blocking the heat radiated from the earth. The phenomenon is known as **greenhouse effect** the gases are called **greenhouse gases** which are primarily CO_2.

Water vapor comes down as rain or snow as part of the water cycle and human activities do not make much difference in its concentration due to evaporation from rivers, lakes, oceans. However, human activities make a difference in CO_2 concentration.

Greenhouse effect makes life on earth bearable at 30°C. However an excessive amounts of these gases could lead to increase in earth temperature and undesirable **global warming** or **global climate change.**



1.5 Environmental Impact and Climate Change

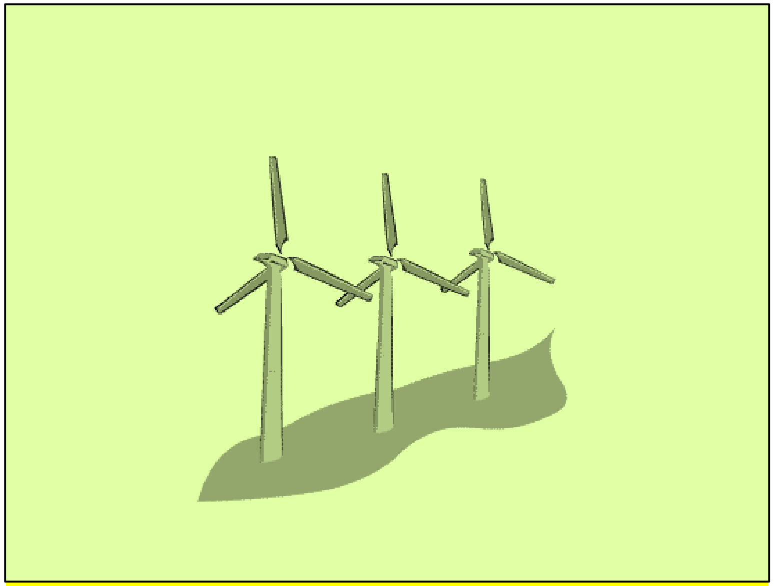
Global Warming and Climate Change

- **A 1995 report**: The earth has already warmed about **0.5°C** during the last century, and they estimate that the earth's temperature will rise another **2°C** by the year 2100.
- A rise of this magnitude can cause **severe changes in weather patterns** with storms and heavy rains and flooding at some parts and drought in others, major floods due to the melting of ice at the poles, loss of wetlands and coastal areas due to rising sea levels, and other negative results.
- **Improved energy efficiency, energy conservation, and using renewable energy sources** help minimize global warming.

1.5 Environmental Impact and Climate Change

Global Warming and Climate Change

Average car drives 20,000 km/year, consumes 2300 liters of gasoline, and produces 2.5 kg of CO_2 per liter, several times its weight



Renewable energies such as wind are called ‘green energy’ since they emit no pollutants or greenhouse gases

1.5 Environmental Impact and Climate Change

- Air pollution and acid rain.
- The depletion of natural resources.
- The dangers from nuclear radiation.
- Change of global climate due to emissions of greenhouse gases from fossil fuel combustion; principally are water vapor, carbon dioxide and methane. Solar radiation enters the earth’s atmosphere but inhibited the outflow of infrared radiation. The natural 'greenhouse effect‘ is essential to maintain the earth's surface temperature at a life sustaining level, around 15 °C.

1.5 Environmental Impact and Climate Change

- Carbon dioxide emissions from the combustion of fossil fuels is the principal contributor and if not curbed, the earth's surface temperature is expected to rise 1.4-5.8°C and probably cause an increased frequency of climatic calamities including floods, droughts, and disruption to agriculture and natural eco-systems. The mean sea levels are likely to rise by 0.5 m towards the end of the century and inundate some low-lying areas.
- Beyond 2100, sea level rises when major Antarctic ice melt.
- The threat due to the change of global climate caused by emissions of carbon dioxide from combustion of fossil fuel is one of the main reasons for the growing consensus to reduce such emissions. By the end of the 21st century reductions in the range 60-80% may be required and, ultimately, a switch to low or zero-carbon energy sources.

1.5 Environmental Impact and Climate Change

- A world summit in 1992 in Rio de Janeiro, Brazil, attracted world attention to the problem of global warming and an agreement was by the committee in 1992 to control greenhouse gas emissions was signed by 162 nations.
- In a meeting in Kyoto (Japan) in 1997 , the world's industrialized countries adopted the **Kyoto protocol** and committed to reduce their CO_2 and other greenhouse gas emissions by 5% below the 1990 levels by 2008 to 2012. This can be done by increasing conservation efforts and improving conversion efficiencies, while meeting new energy demands by the use of renewable energy (such as hydroelectric, solar, wind, and geothermal energy) rather than by fossil fuels.

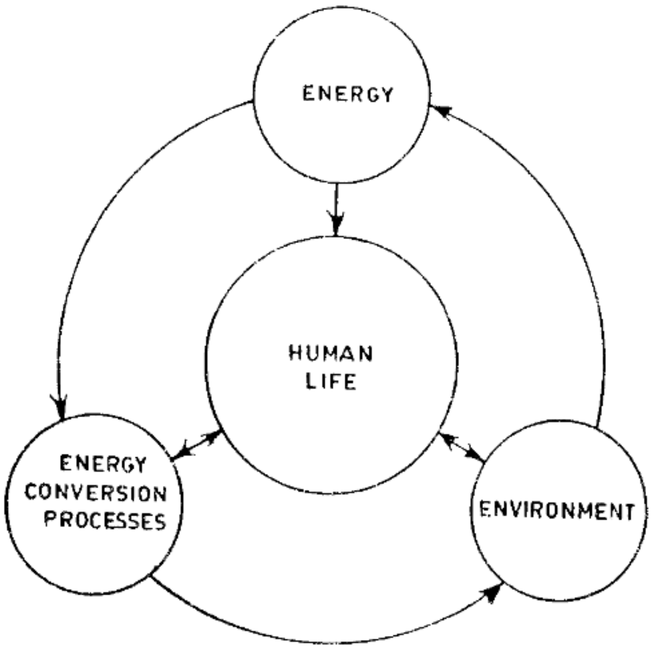
  NB: Berita Harian 24/09/2014 Malaysia reduces CO_2 emission to 33% from target 40% in 2020 as pledged in Copengahen 2009 by Prime Minister.

1.6 Need For Utilization Of Renewable Resources

- There is a depletion of reserves with associated hazards of pollution mainly,
  - global heat balance
- The dependence for oil/natural gas on other countries may destabilize energy security. Response in mitigation,
  - building stockpiles,
  - diversification of energy supply sources,
  - energy efficiency,
  - sustainable development, and
  - development of renewable energy sources.
- Energy conservation

1.6 Need For Utilization Of Renewable Resources

Renewables energy resources are available from nature in renewable but periodic and intermittent form. Energy technologies to utilize renewable resources have been rapidly developed. Present contribution of renewables in the world is less than 2% (excluding hydro). This is likely to increase to about 10% by 2015 and to about 15% by 2025 with environmental impact in a fine balance. They are cheap, clean energy resources but are intermittent, highly diffused and their conversion technologies are presently costly and suitable for smaller plant capacities with 100% storage facility.



Fine balancing between human need in energy and safeguarding of the environment .

1.6 Need For Utilization Of Renewable Resources

Energy Strategies, include the long term policies, short-term and Mid-Term planning, Economic planning, Social and Environmental Aspects of various energy routes; analyzed from the perspectives of the world, Region, Nation, States, sub-regions, various economic sectors, communities and individuals.

Energy efficiency is said achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Reduction in energy consumption leads to sustainable development

Sustainable development is one that meets the needs of the present, without compromising the ability of future generations to meet their own needs. Future energy requirements will not be met by any single energy resource or technology. Renewable energy technologies may play a "complementary" role rather than an "alternative" role.

1.6 Need For Utilization Of Renewable Resources

Renewable Energy In Developing Countries

Renewable energy can be particularly suitable for developing countries. In rural and remote areas, transmission and distribution of energy generated from fossil fuels can be difficult and expensive. Producing renewable energy locally can offer a viable alternative.

Renewable energy projects in many developing countries have demonstrated that renewable energy can directly contribute to poverty alleviation by providing the energy needed for creating businesses and employment.

Renewable energy technologies can also make indirect contributions to alleviating poverty by providing energy for cooking, space heating, and lighting. Renewable energy can also contribute to education, by providing electricity to schools.

1.6 Need For Utilization Of Renewable Resources

Renewable Energy In Developing Countries

Kenya is the world leader in the number of solar power systems installed per capita (but not the number of watts added). More than 30,000 very small solar panels, each producing 12 to 30 watts, are sold in Kenya annually. For an investment of as little as $100 for the panel and wiring, the PV system can be used to charge a car battery, which can then provide power to run a fluorescent lamp or a small television for a few hours a day.

In India, a solar loan program sponsored by UNEP has helped 100,000 people to finance solar power systems in India.

Tunisia, Morocco, Indonesia and Mexico have similar solar projects

1.6 Need For Utilization Of Renewable Resources

Top Countries with Installed Renewable Electricity by Technology (2011)

Hydro	Geothermal	Wind	Solar PV	STEG	Biomass
1 China	1 United States	1 China	1 Germany	1 Spain	1 United States
2 Brazil	2 Philippines	2 United States	2 Italy	2 United States	2 Brazil
3 United States	3 Indonesia	3 Germany	3 Japan	3 Algeria/Egypt/Morocco	3 Germany
4 Canada	4 Mexico	4 Spain	4 Spain	4 Iran	4 China
5 Russian Federation	5 Italy	5 India	5 United States	5 India	5 Japan

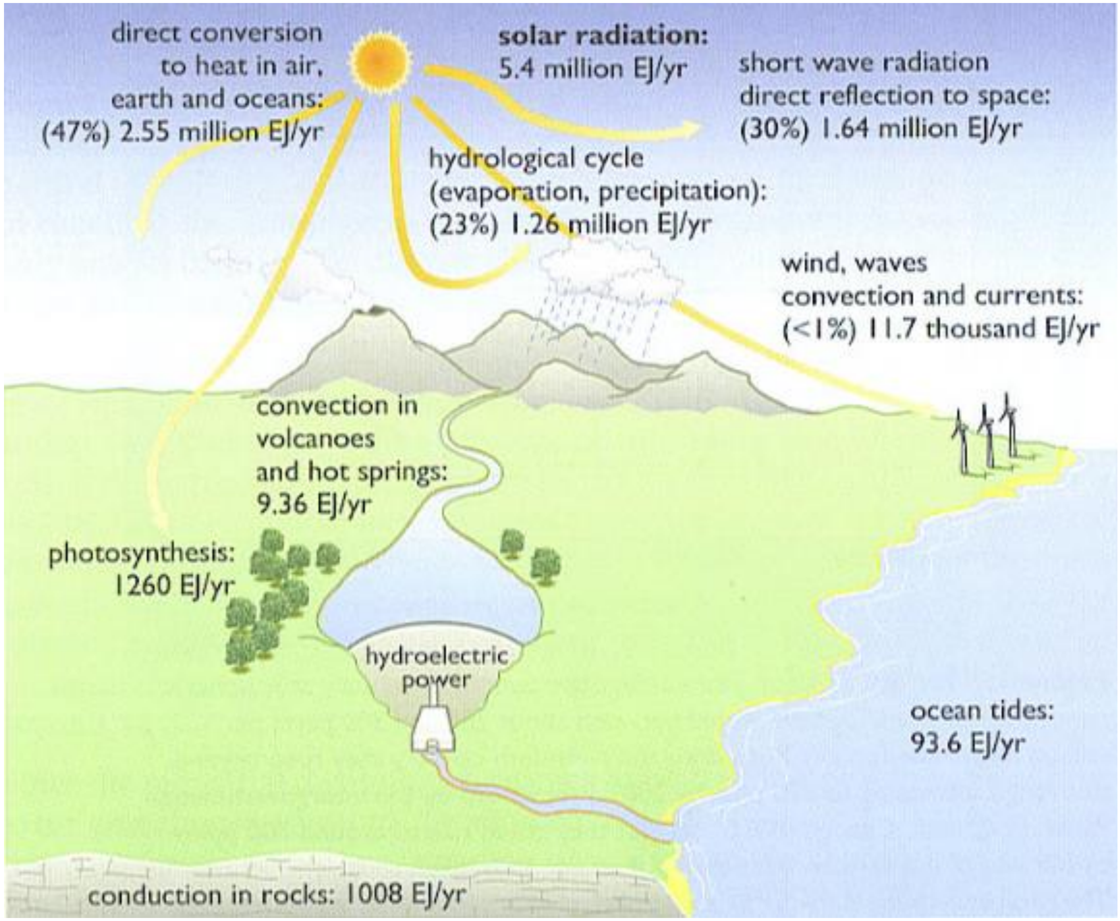
1.7 Classification of Renewable Resources

Renewable energy come from natural processes that are replenished constantly. It is derives directly from the sun, or from heat generated deep within the earth, including electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources. Each of these sources has unique characteristics which influence how and where they are used. Main forms namely,

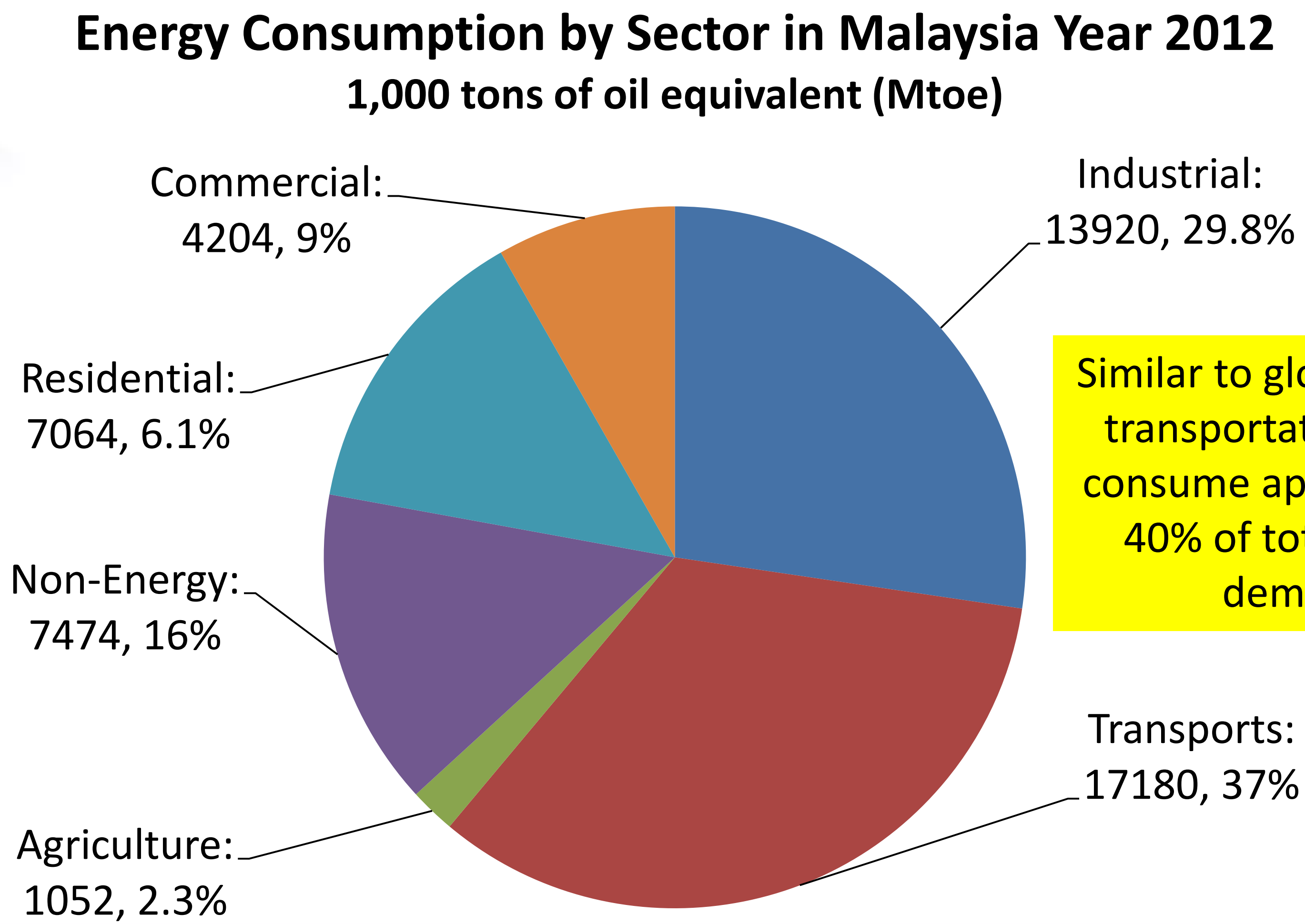
1. Wind power
2. Hydropower
3. Solar energy
4. Biomass
5. Ocean
6. Geothermal Energy

1.7 Classification of Renewable Resources

Renewable energy estimates from natural processes



1.8 Energy Resources in Malaysia



Similar to global trend in transportation sector, consume approximately 40% of total energy demand.

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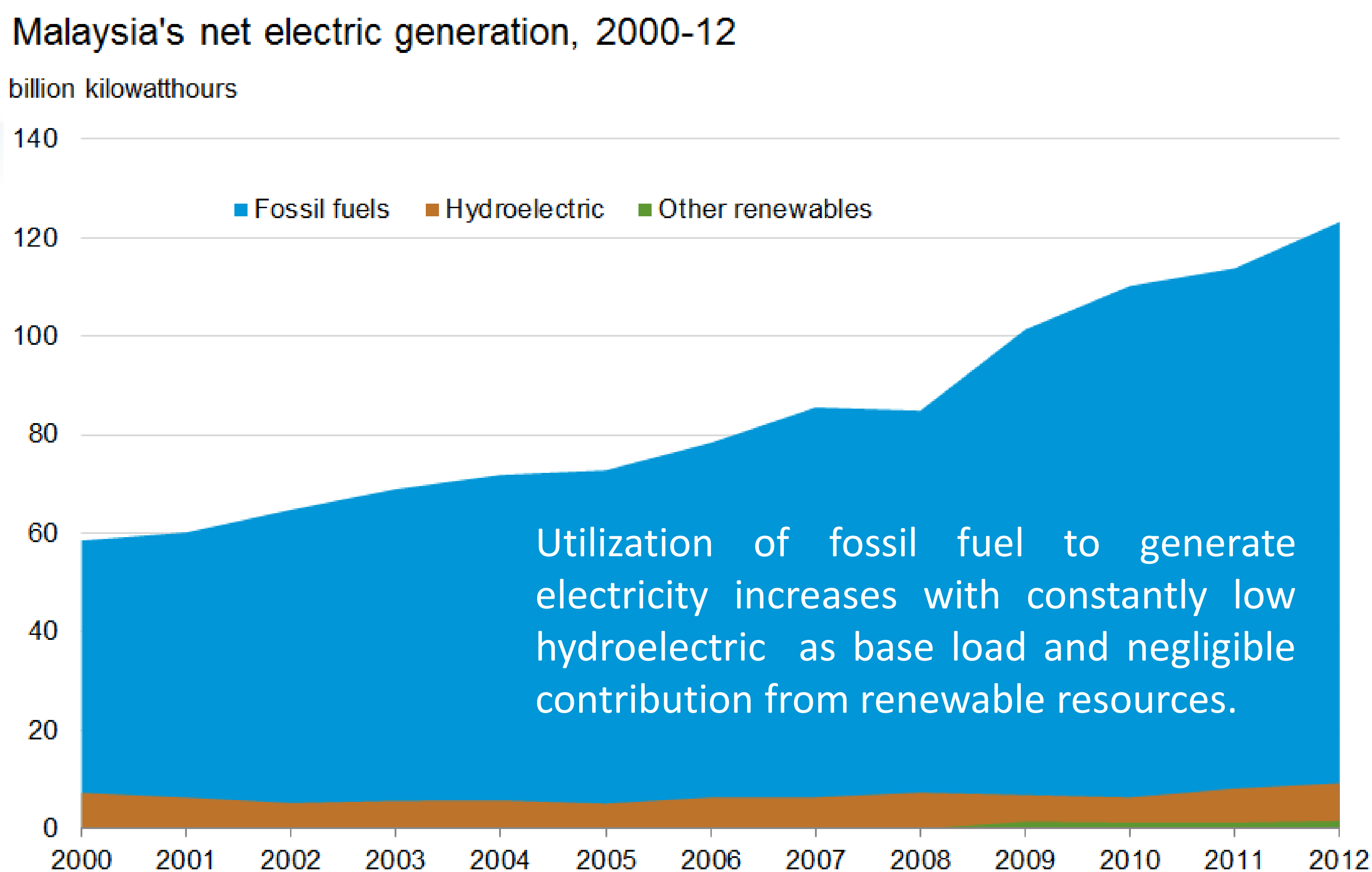
1.8 Energy Resources in Malaysia

ENERGY CONSUMPTION BY SECTOR IN MALAYSIA YEAR 2012

1,000 tons of oil equivalent (Mtoe)

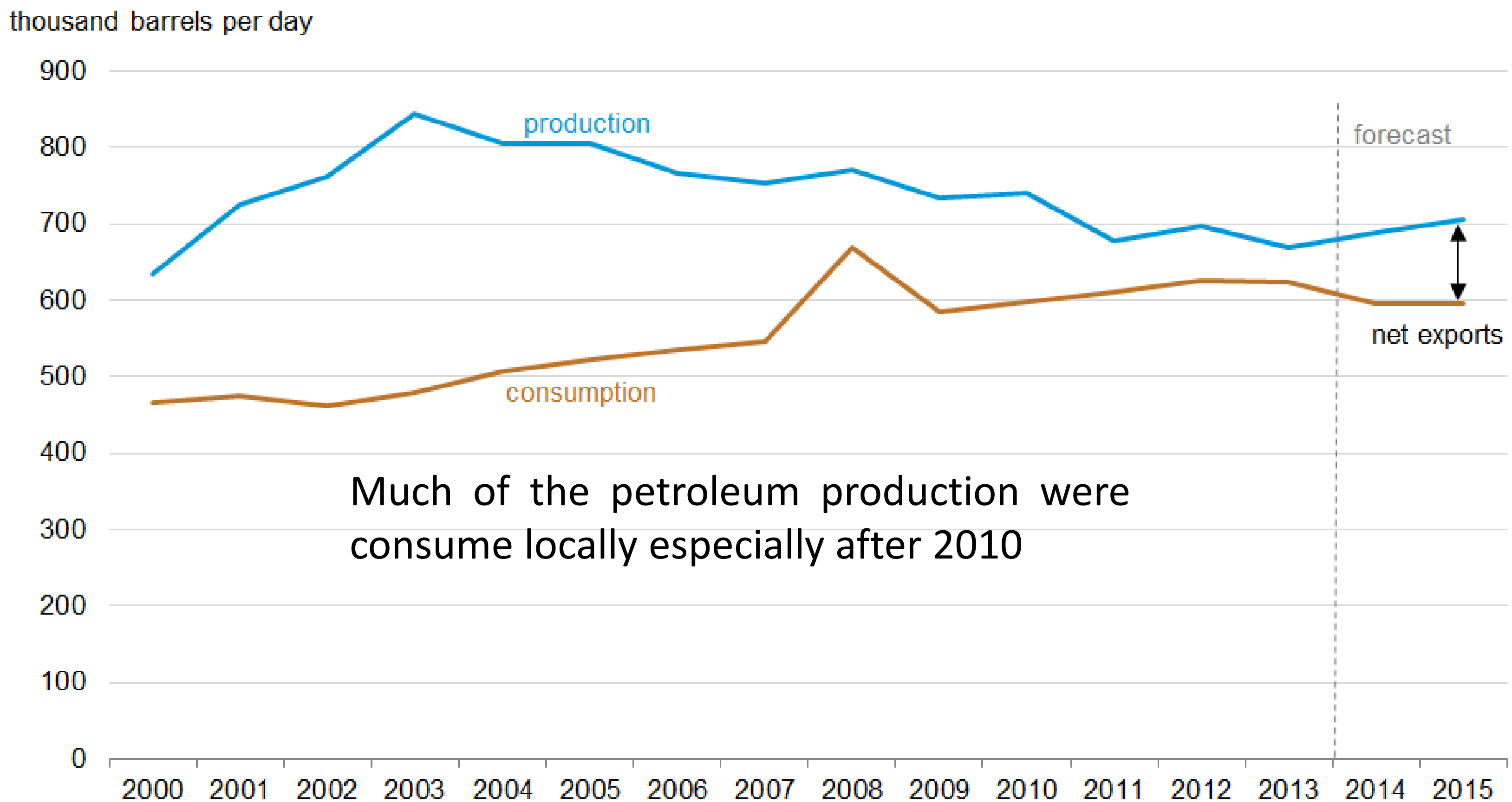
Consumption	Malaysia	Asia (excl. Mid-East)	World
Industry	13,920	752,092	2,140,474
Transportation	17,180	335,749	1,755,505
Residential	7,064	731,518	1,845,475
Commercial	4,204	101,129	511,555
Agriculture	1,052	64,834	166,287
Non-Energy	7,474	79,643	333,981
Total Final Energy Consumption	**46,711**	**2,064,965**	**6,753,276**

1.8 Energy Resources in Malaysia



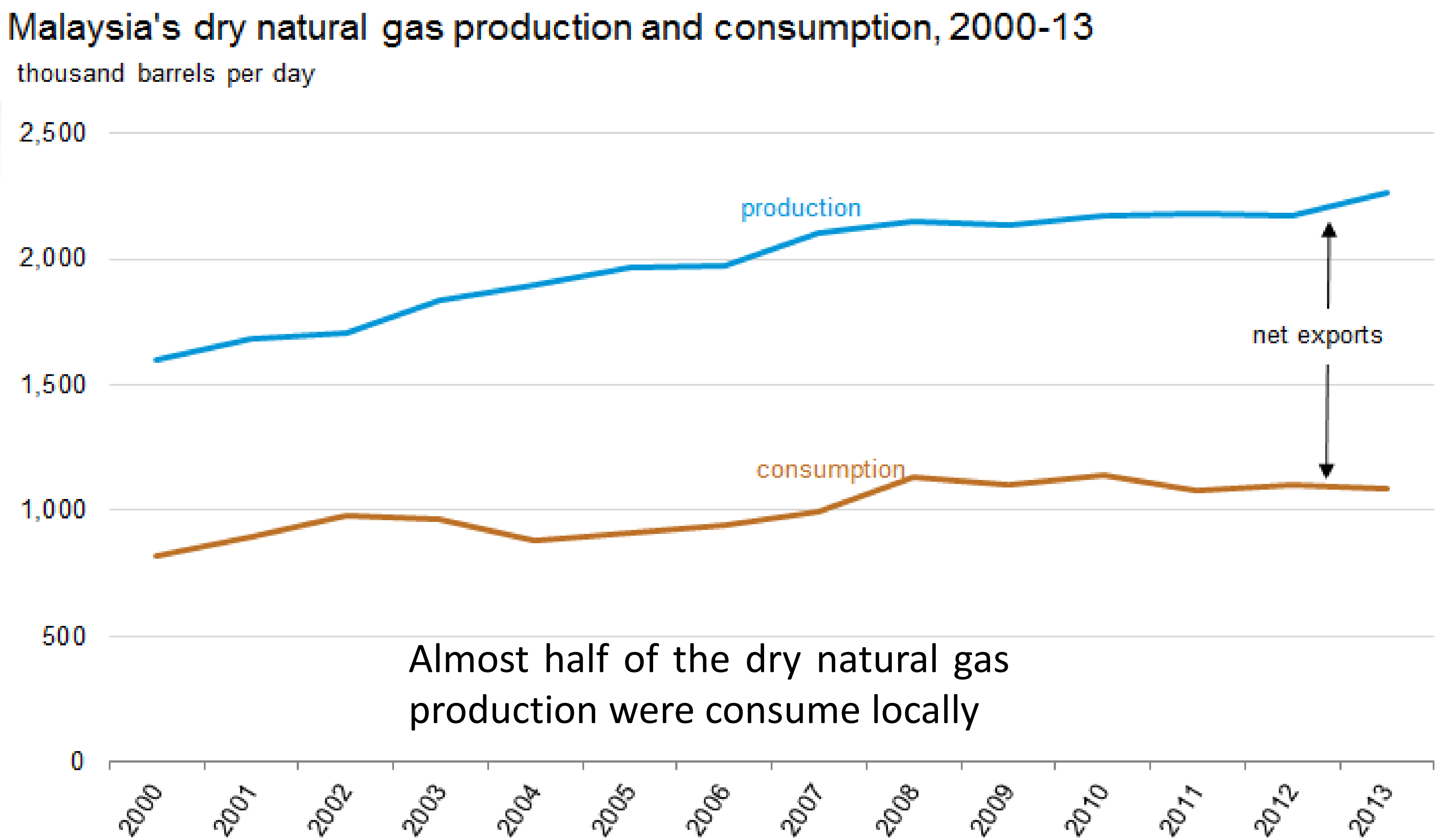
1.8 Energy Resources in Malaysia

Malaysia's petroleum and other liquids production and consumption, 2000-15



Much of the petroleum production were consume locally especially after 2010

1.8 Energy Resources in Malaysia

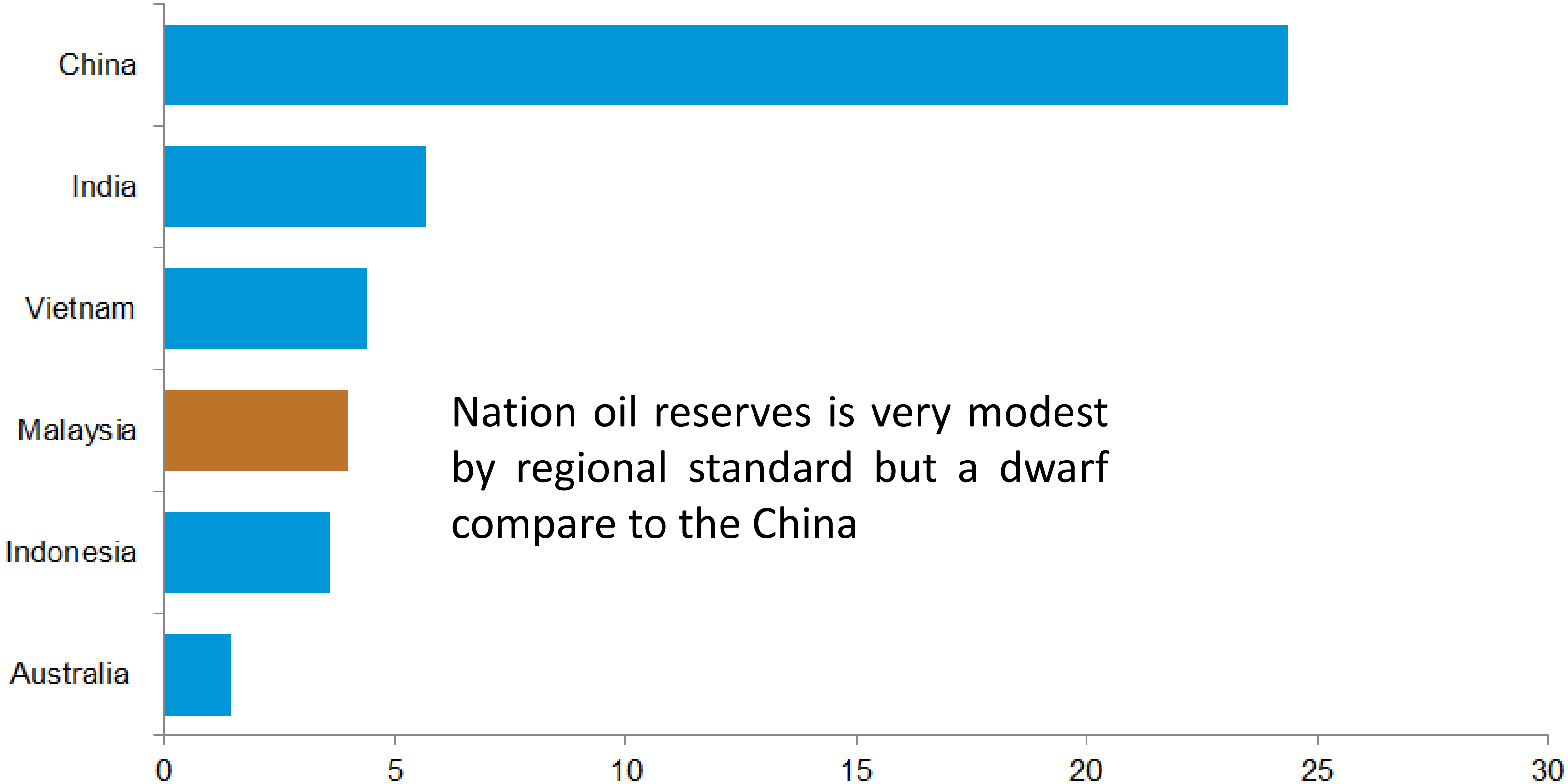


Almost half of the dry natural gas production were consume locally

1.8 Energy Resources in Malaysia

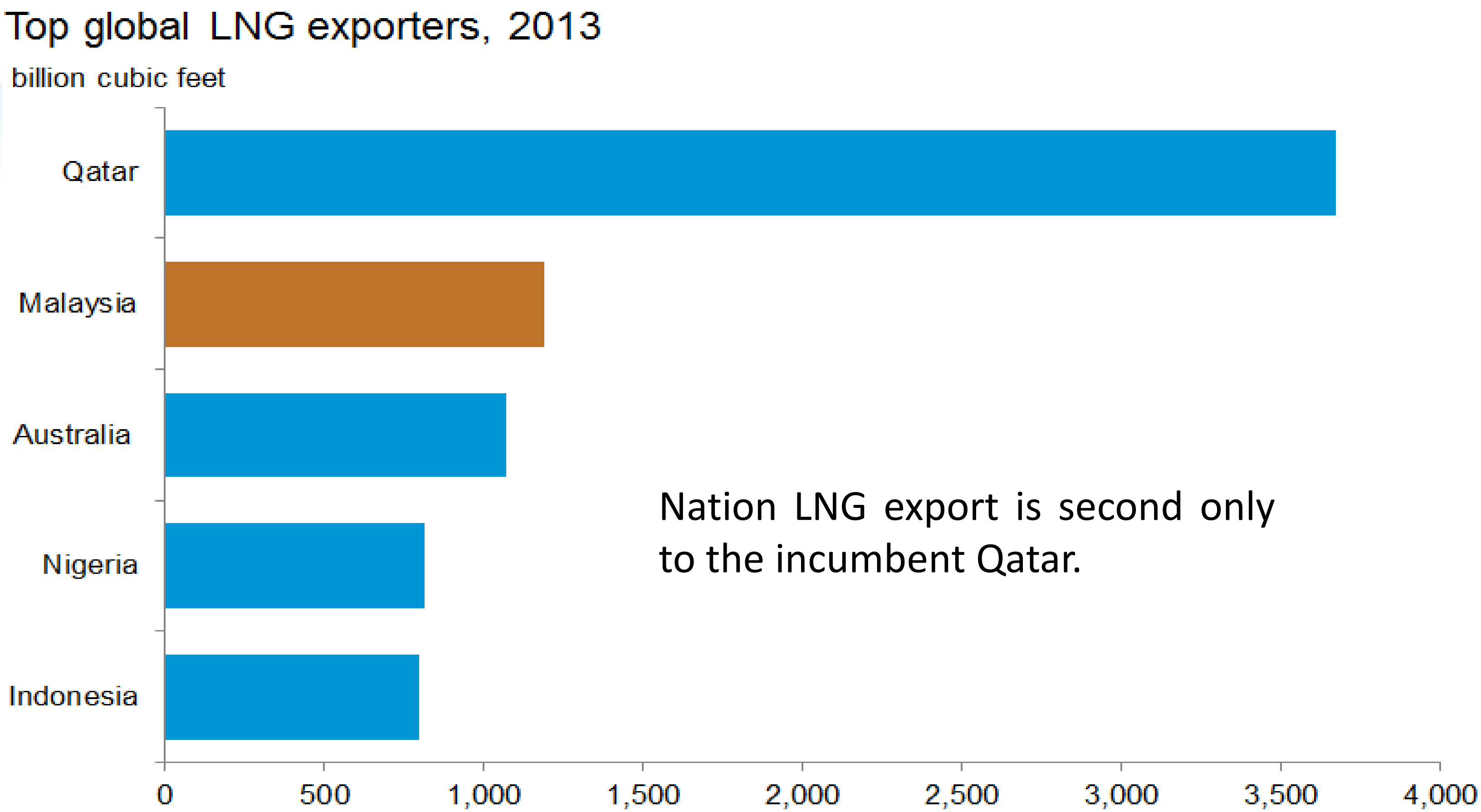
Top Asia-Pacific proven oil reserve holders, January 2014

billion barrels



Nation oil reserves is very modest by regional standard but a dwarf compare to the China

1.8 Energy Resources in Malaysia



Nation LNG export is second only to the incumbent Qatar.

1.8 Energy Resources in Malaysia

RESERVE AND PRODUCTION CAPACITY OF VARIOUS ENERGY SOURCES IN MALAYSIA

Energy source	Reserves (Potential)	Production
Oil and condensates	5.46 billion barrels	550 000 barrels/day
Gas	88.00 tscf/d[a]	5700 mmscf/d
Hydroelectric	1843 million ton	383 000 ton
Mini-hydroelectric	20 000-22 000 MW	4000 MW
Biomass	500 MW	30.3 MW[b]
Biogas	1340 MW (by 2030)	39 MW[b]
Municipal solid waste	360-400 MW (by 2022)	4.45 MW[c]
Solar PV	(Unlimited)	7.1 MW
Low wind speed	(Not reported)	0.2 MW[d]

[a] Trillion standard cubic feet/day
[b] Total capacity under construction of July 2009.
[c] Commissioned on 1 August 2009.

1.8 Energy Resources in Malaysia

SUPPLY OF PRIMARY COMMERCIAL ENERGY IN MALAYSIA (1980-2010)

Energy source	Energy supply (%)				
	1980	1990	2000	2005	2010
Crude oil/petroleum products	86.2-87.9	71.4	45.5-49.3	46.8	44.7
Natural gas^{+}	7.5	15.7	42.2-45.3	41.3	41.6
Coal and coke	0.5-2.2	7.6	5.2-5.6	9.1	11.2
Hydroelectric	4.1	5.3	3.3-3.6	2.8	2.5
Renewables	0	0	0	0	< 1.0
Nuclear	0	0	0	0	0
Total (peta Joule, PJ)	n.a*	n.a*	2003.1	2526.1	3127.7

1.8 Energy Resources in Malaysia

Generation Fuel Options

The New Five-Fuel Diversification Strategy replaces the Four-Fuel Diversification Strategy, in which the fifth fuel under the New Strategy is non-hydro renewable energy (RE) alongside the existing four fuels utilised for power generation, namely, oil, gas, coal and hydro. The Four-Fuel Strategy and subsequently the New Five-Fuel Strategy has been successful in bringing down oil consumption for power generation from more than 80% in the 1980's to about 32% in 1998 and further down to about 4% in 2000. The Government is also looking into efficient energy utilisation and consumption through the National Energy Efficiency Strategy. There are therefore no firm plans at present for the introduction of nuclear power generation, although TNB maintains an interest in nuclear power technology through a continuing programme of technical and manpower training. TNB has the largest generation capacity of over 7,500 MW or 62% of the total power generation of Peninsular Malaysia.

1.8 Energy Resources in Malaysia

Oil

In the early eighties, oil-fired generation contributes to a substantial proportion of TNB's output and operating costs were significantly affected by excursions in oil prices since late 1973. Despite current low prices of fuel oil, oil-fired generating plants are not considered to be strongly competitive options for long term planning purposes, in view of the uncertainties of future prices, and other available alternatives. In TNB, oil requirement has reduced over the years.

1.8 Energy Resources in Malaysia

Natural Gas

Natural gas has become an important fuel for gas turbines and combined-cycle plant developments, both for TNB and IPPs. The Phase II of the Peninsular Gas Utilisation Pipeline Project has made available natural gas to the West Coast and South of Peninsular Malaysia in the late 1991.

With the completion of the gas pipeline project and the advent of Independent Power Producers (IPP) in 1994, gas utilisation in power generation has increased tremendously. To-date, gas contributed to about 76% of the total generation capacity mix.

1.8 Energy Resources in Malaysia

Coal

Coal is also commercially available from foreign sources and this fuel is an option for our power generation development studies. Current indications are that imported coal will be a competitive fuel source for electric power generation in Malaysia. The third phase Port Klang Power Station, which was scheduled to be commissioned in 2001, comprises two 500 MW coal-fired units capable of burning coal/gas/oil. In addition, the Janamanjung Power Station which is a 2,100 MW coal-fired plant, is expected to come online in year 2003.

More coal-fired plants (including IPPs) have been proposed in the years beyond 2000 for security of power supply and to conform with the diversification of fuel usage in power sector as required by the national fuel policy. Currently coal-fired generation constitutes about 5% of the total generation capacity mix.

1.8 Energy Resources in Malaysia

Hydroelectricity

It is estimated that the indicative hydro potential in Peninsular Malaysia totals some 16 TWh/year. Nine major hydro stations with a capacity of 1,874 MW are currently in service. This total capacity includes the recently commissioned Pergau Hydroelectric Station (in 1997) which contributes a total peaking capacity of 600MW. Three other hydroelectric projects have been identified and under planning stage namely, Ulu Terengganu (300MW), upgrading of Kenyir Hydro station (300MW) and Ulu Jelai's mixed pumped storage (1,000MW- 1,200MW) with 300MW conventional hydro scheme.

1.8 Energy Resources in Malaysia

Renewable Energy

Renewable energy (RE) has been identified and finalised by the Government as the fifth fuel under the New Five-Fuel Diversification Strategy. The RE focus would be on biomass, especially from palm oil and wood wastes. The target of contribution towards the total electricity generation mix from RE is 5% by 2005 and 10% by 2010, after which this ratio could be maintained thereafter.

1.8 Energy Resources in Malaysia ….Bernama April 27, 2010 [7]

1. Malaysia will become a net energy importer before 2020 and is therefore committed to find alternative means of energy that are sustainable.
2. Country's energy requirement was estimated to rise by 6.3% annually and by 2030, the level would have reached 28%.
3. Malaysia in the midst of implementing a number of initiatives with regard to policy review, research and development (R&D) and applications and had given emphasis to the R&D of renewable energy since the 7th Malaysia Plan.
4. In total, 185 projects related to the development of technologies focusing on harnessing energy from resources such as biomass, solar, hydro, wind and tidal waves costing RM158 million have been carried out.
5. Biomass would be a feature in the source of renewable energy mix for the country in the near future since Malaysia has an abundance of the resources.
6. Steps to develop a renewable energy technology roadmap in five focus areas comprising biomass, solar, wind, micro-hydro and tidal power.
7. The use of renewable energy plays an ever increasing role in meeting the requirements of our energy security and the effects of climate change due to the greenhouse gases emission.

1.8 Energy Resources in Malaysia

Energy Mix For The Future

A judicious mix of fossil must be developed to facilitate the optimum use of the available energy resources to meet the energy requirements of the country. The mix would include nuclear and renewable sources backed by appropriate technologies and scientific analysis for efficiency, emissions, economics, and reliability, as applicable to different power capacity.

1.8 Energy Resources in Malaysia

Fuel Mix for Power Generation in Malaysia 2000 - 2030

Fuel Type	Electricity mix (%)													
	1980	1990	2000	2001	2003	2005	2006	2007	2009	2010	2015+	2020+	2025+	2035+
Natural Gas	705	15.7	77.0	71.8	71.0	70.2	62.6	56.6	62.8	55.9	25.0	21.0	20.0	25.0
Coal	0.5	7.6	8.8	13.7	11.9	21.8	20.9	34.2	27.3	36.5	45.0	49.0	47.0	43.0
Hydro	4.1	5.3	10.0	10.1	10.0	5.5	9.5	6.9	6.9	5.5	26.0	25.0	26.0	23.0
Oil/Petroleum Products[a]	87.9	71.4	4.2	4.4	6.0	2.2	7.0	2.3	2.1	0.2	1.0	1.0	< 1.0	< 1.0
Renewables (non-hydro)	0	0	0	< 1.0	1.1	0.3	< 1.0	< 1.0	0.9[b]	1.8	3.0	4.0	3.0	3.0
Nuclear	0	0	0	0	0	0	0	0	0	0	0	0	4.0	6.0

+ Projection are taken from Mohamed (2009)

a Mainly refer to diesel

b Detail composition in reported to be biomass (0.7%), bio-oil (0.1%) and others (0.1%)

Source: Yob *et al.* (2011), EPU (2010), Jaffar (2009), Mohamed (2009), DoESREC (2007), Mohamed & Lee (2006), ASM (2010)

1.9 Energy Efficiency Governance in Malaysia

- Efficiency measures are found to make the largest contribution in climate change mitigation. Unfortunately important topic of rational and efficient use of energy is rarely pursued vigorously in national or supranational plans in spite of the fact that study after study has shown that this route provides the most cost effective way to meet sustainability goals.
- In most countries, regulations and financial incentives are now in place to encourage energy efficiency but their effect is modest and national energy consumption figures continue to rise year on year. Energy efficiency must be the linchpin of any future energy strategy.

i. Using energy as efficiently as possible is the most cost effective way to manage energy demand, and thus to address carbon emissions. Saving energy is cheaper than making it.

ii. By reducing demand on gas and electricity distribution networks, energy efficiency will improve the security and resilience of these networks and reduce dependence on imported fuels.

iii. By reducing energy bills, energy efficiency will help businesses to be more productive and competitive.

iv. Improving the energy standards of homes has an important role in reducing spending on fuel by those in fuel poverty

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1.9 Energy Efficiency Governance in Malaysia

Year	Policy Plan	Thrust / Objective
1975	National Petroleum Policy	Ensure optimal use of petroleum resources via regulation of ownership and management of the industry including related economic, social, and environmental safeguards.
1979	National Energy Policy	Achieve supply and utilization of energy resources with environmental considerations.
1980	National Depletion Policy	Guard against over-exploitation and hence dependency on crude oil and natural gas.
1981	Four-Fuel Diversifications Policy	Strategize generation mix as based on oil, gas, coal, and hydro.
1998	National Mineral Policy	Utilized locally sourced coal.
2001	Five-Fuel Diversifications Policy	Recognize renewable as fifth fuel in generation mix.
2001	Small Renewable Energy Power (SREP) program	Encourage small private power generation projects using renewables.
2009	National Green Technology Policy	Use green technology and promote cogeneration and renewables in power generation.
2010	New Energy Policy	Enhance energy security to include economic, environmental, and social considerations.
2011	*Renewable Energy Act*	Enforce Feed-in-Tariff (FIT) scheme for RE.
2011	National Biomass Strategy 2020	Recognize use of biomass waste for biofuels.

1.9 Energy Efficiency Governance in Malaysia

Kementerian Tenaga, Teknologi Hijau dan Air Malaysia

KeTTHA

KEMENTERIAN TENAGA, TEKNOLOGI HIJAU DAN AIR

Logo Kementerian Tenaga, Teknologi Hijau dan Air Malaysia

Kerajaan Malaysia

Ringkasan agensi	
Ditubuhkan	1973
Nama Lama	Kementerian Tenaga, Air dan Komunikasi
Ibu pejabat	Putrajaya
Menteri bertanggungjawab	Maximus Johnity Ongkili, Menteri Tenaga, Teknologi Hijau dan Air
Anak agensi	Suruhanjaya Perkhidmatan Air Negara

1.9 Energy Efficiency Governance in Malaysia

Kementerian Tenaga, Teknologi Hijau dan Air Malaysia (KeTTHA)

Kementerian telah berubah daripada sebuah kementerian yang menyediakan perkhidmatan kepada kementerian yang menggubal dasar dan mengawalselia perkhidmatan bagi sektor Tenaga, Air dan Komunikasi.

Dengan ini, teras utama peranan Kementerian adalah memudahkan juga mengawal pertumbuhan industri di dalam sektor-sektor tersebut bagi memastikan perkhidmatan yang diberi kepada pengguna seluruh negara adalah berkualiti tinggi, efisyen dan selamat digunakan dengan harga yang berpatutan. Tugas-tugas kawalselia Kementerian dilaksanakan oleh badan-badan kawalselianya iaitu Suruhanjaya Tenaga juga Suruhanjaya Komunikasi dan Multimedia.

VISI: Menjadi pemangkin utama bagi pembangunan yang dinamik dan berdaya tahan dalam industri tenaga, air dan komunikasi Malaysia.

MISI: Membangun serta menggubal dasar yang inovatif dan strategik, merangka rangka kerja kawalselia sendiri serta membentuk satu sistem pengurusan yang berdaya maju, berkesan juga efisyen.

1.9 Energy Efficiency Governance in Malaysia

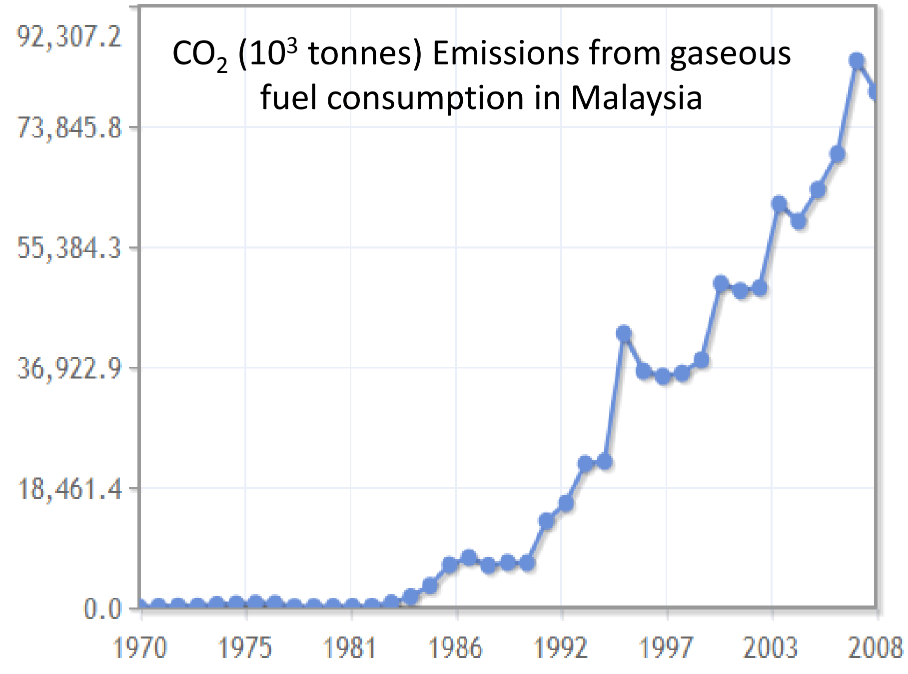
OBJEKTIF KeTTHA

- Untuk memastikan wujudnya satu infrastruktur yang bersepadu, efisyen dan berkualiti tinggi bagi industri tenaga, air dan komunikasi.
- Untuk menyediakan persekitaran yang sesuai bagi pembangunan industri tenaga, air dan komunikasi.
- Untuk memastikan kemajuan teknologi bagi industri tenaga, air dan komunikasi yang berterusan menerusi penyelidikan dan pembangunan
- Untuk memastikan servis mahupun penghantaran tenaga, air dan komunikasi di seluruh negara adalah efisyen serta efektif dengan harga yang termampu di samping meningkatkan produktiviti seharian juga kualiti hidup.
- Untuk memastikan bekalan atau keperluan mahupun peruntukan tenaga, air serta komunikasi sentiasa berterusan dan terjamin.
- Untuk mewujudkan sistem pengawalseliaan yang dinamik dan progresif bagi menggalakkan pertumbuhan pasaran di samping mengawal kesan yang mungkin timbul daripada industri tenaga, air dan komunikasi kepada masyarakat mahupun persekitaran.
- Untuk terus-menerus mempertingkatkan sistem sokongan pengurusan korporat.

Case Study 1: CO_2 emissions

Typically, a new household refrigerator uses about 700 kWh/year of electricity. Determine the reduction in CO_2 emissions in a city with 300,000 households, had a renewable energy source been used in its place. Assume 0.59 kg of CO_2 is produced for each kWh of electricity generated from a power plant that burns natural gas.

With reference to Figure below, discuss if the reduction would have a significant effect on Malaysia's effort to reduce CO_2 emission by 40% by 2020 from that of 2005 level as announced by the Prime Minister in the United Nation Framework on Climate Change (UNFCC) conference on 15 December 2009 in Copenhagen. The Malaysian population is expected to reach 28.8 million by 2020.



Case Study 1: CO_2 emissions

1 household consumes 700 kWh of electricity for refrigeration

Amount of CO_2 produced $= 700 \times 0.59 = 413$ kg per year

Total CO_2 produced by 300,000 household $= 413 \times 300{,}000 = 123{,}900$ ton per year

Refrigerators in the city are responsible for the production of 123,900 tons of CO_2 /year.

The value for CO_2 emissions from gaseous fuel consumption in Malaysia estimated 64,000 x 10^3 ton as of 2005 from the graph.

Target reduction 40% by 2020 $= 0.60 \times 64{,}000 \text{ x } 10^3 = 38{,}400 \text{ x } 10^3$ ton per year

By 2020 the population 28.8 million with average of 5 members in a household

Estimated household is $= \frac{28.8 \times 10^6}{5} = 5760 \times 10^3$

Projected CO_2 production from refrigerator requirement as compared to projected CO_2 reduction by 2020

$$= 5760 \times 10^3 \times 413 = 2{,}380 \times 10^3 \text{ton per year} = \frac{2{,}380}{38{,}400} = 6\%$$

It has a significant effect

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Case Study 2: Environmental Index (EPI

The New Straits Times, 22 October 2012 reported a Malaysia's progress in Environmental Index (EPI) as shown by Yale-Columbia universities. The ranking which covers 132 countries reveal Malaysia's position moving from 54th to 25th, being third in Asia Pacific. The success was attributed to the introduction of a more comprehensive Environmental Quality (Amendment) Act 2012 which was gazetted on 16 August 2012 and to be fully implemented by 2 January 2013.

Reasons For The Achievement [6]

1. Environmental watch group and report cases ranging from open burning to toxic waste disposal.
2. Incentives by the Natural Resources and Environment Ministry to report environment breaches.
3. Lack of enforcement officers had restricted the ministry from getting enough evidence to prosecute environmental offenders
4. Appeal to the public to come forward and become the ministry's eyes and ears
5. Action will be promptly taken as we are serious about acting against activities which damage the environment."
6. Amendments to the act also provide anonymity and protection to whistleblowers.
7. Provide the director-general power to issue stop-work orders on projects that damage the environment, which was previously solely under the minister's purview.
8. Officers in the environment department also have the power to arrest those who commit environmental offences and hand them over to a police station
9. Fines for environmental offences increased to a deterrent quantum.
10. The amendment of the act focuses on strengthening the management of the Environment Impact Assessment.
11. More proactive enforcement mechanism so that the development projects do not harm the quality of the environment and the health of the people

Case Study 3: Feed-In Tariff (FIT) system

Renewable Energy Act 2010 provides for the establishment and implementation of **Feed-In Tariff** (FIT) system to facilitate the uptake of renewable energy in grid-connected areas and make it cost-effective for people to generate their own clean electricity and sells the excess electricity to the people. Suggest **FIVE (5)** benefits from the FIT system if effectively implemented.

1. **Reduce CO2 emissions** by replacing fossil fuel-based power production with clean, renewable sources of energy
2. **Create jobs** - for example the German renewables industry employs around 234,000 people. Almost 60% of which were employed as a direct result of the German FIT law.
3. **Secure domestic energy supply** - enabling countries to stop relying on imported fossil fuels
4. **Guarantee investment security** for renewable energy investors
5. **Drive technological innovation**, and
6. **Provide fair market conditions** for renewables which without this system, compete with heavily-subsidized conventional energy.

Case Study 4: Proper Management of MSW

Malaysian disposed almost 930 tonnes of food waste daily (The STAR, 2011). There are 296 landfill/dumpsites in Malaysia. and 166 are still in operation which include 9 sanitary landfills. Landfill produces one of the greenhouse gases (GHG), methane which is 21 times more harmful than carbon dioxide.

Sanitary landfills is a more proper management of MSW that will provide public wellness and contributes to the reduction of GHG emission.

Case Study 5: Clean Alternative Energy Utilization

Malaysia is less favorable to benefit from clean alternative energy utilization from ocean energy conversion in spite of its vast coastline of approximately 4,675 km and main river waterways of 38,000 km. The average depth of Malaysian sea water is around 200 meters measured at 200 km from the shoreline. The maximum range between low and high tides is approximately 5.0 meters. The average sea water current speed is around 0.8 m/s. Operation of a hydrokinetic device for stream tidal is typically 2–4 knots (1–2.1 m/s).

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Case Study 6: Renewable Energy Potential from Agro Residue

To date, Malaysia is still a net energy exporter. The Malaysian government has embarked on a number of energy related policies in accordance with sustainability and security of energy supply. By the target year of rice self-sufficiency in 2015 at 2.6 million tonne, Malaysia stands to gain from its own renewable energy potential from rice husks and rice straw generated at the rate of 20% and 70%, respectively. Rice husks and rice straw have an estimated heating calorific value of 18 GJ/tonne. The rice production in 2010 was 2.48 million tonne.

Given data: 1 KWh = 3.6 MJ = 3.6 x 10^{-3} GJ

1 Billion barrel of oil equivalent (bboe) = 6.12 GJ = 1.7 MWh

Rate of biomass fuel conversion to electric = 35%

Cost of 1 bboe = US $66 and 1 US$ = RM 3.40

Fuel Mix (per cent) in Total Electricity Generation, Malaysia, 2000–2010

Year	Oil	Coal	Gas	Hydro	Renewable Energy	Total (GWh)
2000	4.2	8.8	77.0	10.0	0.0	69,280
2005	2.2	21.8	70.2	5.5	0.3	94,299
2010	0.2	36.5	55.9	5.6	1.8	137,909

Source of Data: Ninth Malaysia Plan 2006–2010, Table 19-5

Their contribution in renewable energy resources for the electrical energy generation in 2010 had it been fully utilized in accordance to 9th Malaysian Plan (2006-2010) target of renewable energy in total energy mix at 5%

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Case Study 6: Renewable Energy Potential from Agro Residue

The production of 2.48 million tonne rice in 2010

Rice husk generated $= 2.48 \times 10^6 \times 0.20 = 496 \times 10^3$ tonne

Rice straw generated $= 2.48 \times 10^6 \times 0.70 = 1{,}736 \times 10^3$ tonne

Heat from husk-straw $= (1{,}736 + 496) \times 10^3 \times 18 = 40{,}176 \times 10^3 \text{GJ}$

Elect conversion at 35% $= 40{,}176 \times 10^3 \text{GJ} \times 0.35 = 14{,}062 \times 10^3 \text{GJ}$

$$= 14{,}062 \times 10^3 \text{GJ} \times \frac{1}{3.6 \text{ x } 10^{-3}} \frac{\text{kWh}}{\text{GJ}}$$

$$= 3.91 \times 10^9 \text{kWh} = 3{,}910 \text{ GWh}$$

Total electricity generation in 2010 is 137,909 GWh

Hence, 3,910 GWh from biomass rice hull-straw $= \frac{3{,}910}{137{,}909} \times 100 = 2.84\%$

Contribution from rice hull-straw if fully utilized, estimated at 2.84% is significant i.e. more than 50% of the 9th Malaysian Plan target of 5% renewable energy in total energy mix. There are other renewable energy resources particularly more dominant agriculture residue from oil palm plantation.

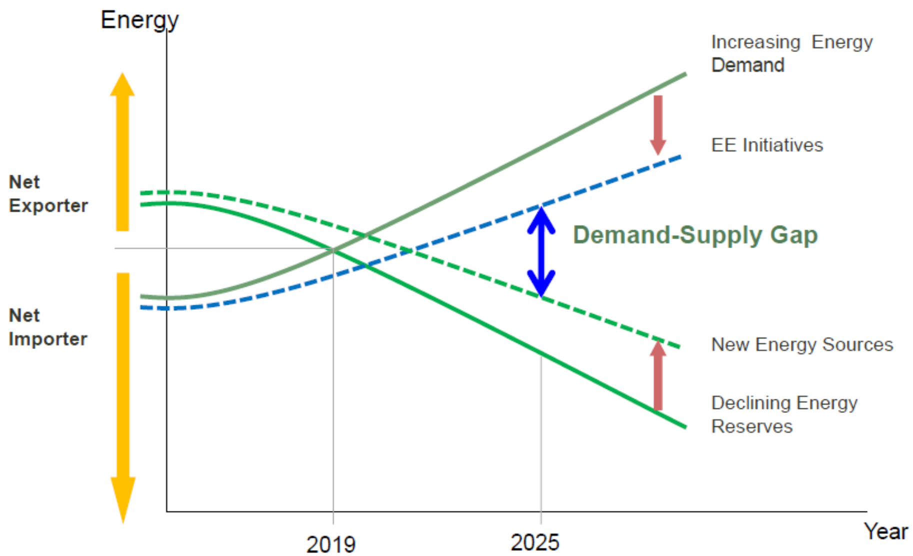
Case Study 7: Energy Security

Nation's Future Power Needs And Energy Security with respect to:

1. Feed-in Tariff Policy (FiT)
2. Renewable Energy Act 2010
3. Sustainable Energy Development Authority (SEDA) Bill

8th	Malaysian Plan	2001-2005
9th	Malaysian Plan	2006-2010
10th	Malaysian Plan	2011-2015

Malaysian Energy Demand-Supply Balance

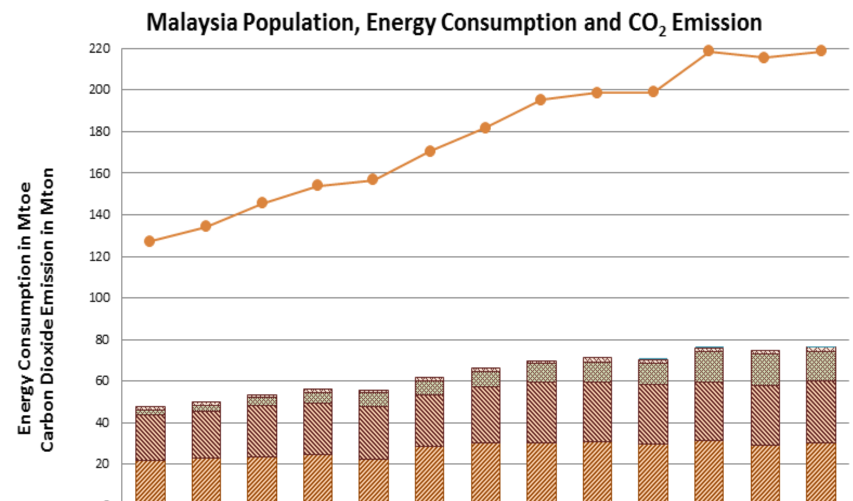


- Energy demand is projected to increase from 2,000 PJ in 2009 to 4,013 PJ in 2030
- Average rate of 3.6% p.a.

Case Study 8: Renewable Energy Mix Program

Biomass would be a feature in the source of Malaysia renewable energy mix in the near future from abundance of the resources in oil palm and rice production as it aspire to become rice self-sufficient in year 2015 while maintain as the chief exporter of world palm oil. In conjunction with zero CO_2 emission fluidized bed technology seem to be an attractive possibility of future for power generation while addressing the solution of waste disposal problems and the reduction of greenhouse gases.

Discuss the potential of renewable energy mix program from the following standpoints:-



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
TOTAL (Mtoe)	47.6	49.7	53.1	55.7	55.7	61.3	65.9	69.6	71.0	70.6	76.1	74.9	76.3
POPULATION (Million)	23.5	24.1	24.7	25.3	25.9	26.5	26.8	27.2	27.5	27.9	28.3	28.5	29.2
RENEWABLE (Mtoe)	-	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.3
HYDROELECTRIC (Mtoe)	1.7	1.5	1.2	1.3	1.3	1.2	1.6	1.5	2.0	1.6	1.6	1.9	1.8
COAL (Mtoe)	2.5	3.0	3.6	5.3	6.6	6.9	7.3	8.8	9.8	10.6	14.8	14.8	14.3
OIL (Mton)	21.7	22.5	24.7	24.5	25.5	25.0	26.6	29.2	28.8	28.3	28.4	29.1	29.8
GAS (Mtoe)	21.7	22.7	23.6	24.6	22.2	28.3	30.4	30.1	30.4	29.7	31.0	28.8	30.0
CO2 (Mton)	127.6	134.2	145.5	154.0	156.7	170.4	181.9	195.3	198.6	198.7	218.6	215.5	218.8

i. New Five-Fuel Diversification Strategy
ii. Energy Security
iii. Environmental Impact
iv. Commitment in **Kyoto protocol** to reduce their CO_2 emissions by 5% below the 1990
v. Certified Emission Reduction (**CER**) credits
vi. Saving In Energy Cost

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Case Study 9: Worst Mining Disasters Worldwide

1. April 26, 1942 Honkeiko Colliery, China 1,549 miners died
2. March 10, 1906 Courrieres, France, 1,100 died in a coal dust explosion.
3. November 9, 1963 Omuta, Japan. An explosion in a coal mine killed 447.
4. October 14, 1913 Senghenydd, Wales, UK. The worst of the Welsh coal mining disasters killed 438 men and boys
5. January 1, 1960 Coalbrook, South Africa. 437 casualties.
6. June 6, 1972 , Wankie, Rhodesia. A coal mine explosion kills 427.
7. May 28, 1965 Dhanbad, India. 375 miners die in a coal mine fire.
8. December 27, 1975 Chasnala, India, coal mine explosion and flood killing 372.
9. December 12, 1866 Barnsley, England, UK. 361 casualties.
10. December 6, 1907. Monongah, WV 361 casualties.

NB: The worst mining disaster in US history is said to have provided the origins of the first Father's Day celebration. A woman named Grace Clayton asked her church to hold a Sunday memorial for the fathers lost in the mine. The commemoration was held in a church in Fairmont, West Virginia.

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