KEMENTERIAN TENAGA, SAINS, TEKNOLOGI, ALAM SEKITAR DAN PERUBAHAN IKLIM
MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY, ENVIRONMENT & CLIMATE CHANGE

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DEMAND SIDE MANAGEMENT
DSM
PRELIMINARY STUDY

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The Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) is pleased to acknowledge the initiative by the Ministry of Economic Affairs (MEA) formerly known as Economic Planning Unit (EPU), Prime Minister's Department in the completion of the Demand Side Management (DSM) Preliminary Study and United Nations Development Programme (UNDP) for the financial support. The study is a significant milestone for MESTECC to pursue Demand Side Management (DSM) in the Energy Sector more comprehensively and holistically.

MESTECC also deeply appreciates the pool of knowledgeable and wide experienced consultants and researchers from electrical, thermal and transportation sector in completing the study. The Ministry expresses its gratitude and special thanks to government officials from Ministries/Agencies and individuals who contributed ideas, comments and suggestions in the whole process for the DSM Report to be successfully completed.

FOREWORD

Minister of Energy, Science, Technology, Environment and Climate Change

Demand Side Management (DSM) is another piece of the puzzle in the energy management landscape and is recently receiving more serious attention since Malaysia embarked on the green growth journey to create a low carbon and resource efficient economy. Efficient management of energy resources is crucial in achieving a balanced management of the energy spectrum and reduction of our national carbon footprint.

The DSM report offers an abridged review and data analysis to provide an extensive outlook of the current state of electrical, thermal and transport energy consumption in Malaysia. It identifies the increased DSM feasibility through many new technologies, including mini and smart grids, which will further enhance the implementation of DSM at the national level.

In our aspiration to be a developed country, Malaysia is obviously in a great position to be more energy efficient and achieve low carbon high income economy through the full implementation of the DSM recommendations.

Yeo Bee Yin

YB Puan Yeo Bee Yin

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ABBREVIATIONS

ABS	Australian Bureau of Statistics
APEC	Asia Pacific Economic Cooperation
ASM	Academy of Sciences Malaysia
ATF	Aviation Turbine Fuel
BAU	Business-As-Usual
BEI	Building Energy Intensity
BEV	Battery Electric Vehicle
Boe	Barrel of oil equivalent
BSEEP	Building Sector Energy Efficiency Project
cc	cubic centimetres
CEMEP	European Committee of Manufacturers of Electrical Machines and Power Electronics
CFL	Compact Fluorescent Light
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
DCA	Department of Civil Aviation
DoF	Department of Fisheries
DEDE	Department of Alternative Energy Development and Efficiency
DHC	District Heating and Cooling
DOSM	Department of Statistics Malaysia
DSM	Demand Side Management
EAS	East Asia Summit
ECCJ	Energy Conservation Centre of Japan
EE	Energy Efficiency
EEI	Energy Efficiency Indicator
EE&C	EE and Conservation
EEDP	Energy Efficiency Development Plan
EEV	Energy Efficient Vehicles
EFB	Empty Fruit Bunch
EIA	Energy Information Administration
EMEER	Efficient Management of Electrical Energy Regulations
EMU	Electric Multiple Unit
EnMS	Energy Management System
EPC	Energy Performance Contracting
EPU	Economic Planning Unit
ERIA	Economic Research Institute for ASEAN and East Asia
ESCO	Energy Service Company
ET	Electric Train
EToU	Enhanced Time of Use
ETP	Economic Transformation Programme
ETS	Electric Train Service
EU	European Union
EV	Electric Vehicles

FDAM	Fisheries Development Authority of Malaysia
FE	Fuel Economy
FiT	Feed-In-Tariff
FM	Freight Metrics
FMFF	Federation of Malaysian Freight Forwarders
FMM	Federation of Malaysian Manufacturers
FY	Fiscal Year
GBI	Green Building Index
GDP	Gross Domestic Product
GDPSM	Gross Domestic Product Statistic Malaysia
GEF	Global Environment Facility
GEO	Green Energy Office
GFEI	Global Fuel Economy Initiative
GHG	Green House Gas
GMB	Gas Malaysia Berhad
GRT	Gross Register Tonnage
GSIAC	Global Science and Innovation Advisory Council
GTFS	Green Technology Financing Scheme
GWh	Giga Watt Hour
HEPS	High Energy Performance Standards
HEV	Hybrid Electric Vehicle
HDV	Heavy Duty Vehicle
ICE	Internal Combustion Engine
INDC	Intended Nationally Determined Contribution
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standardisation Organisation.
ITA	Investment Tax Allowance
JKR	*Jabatan Kerja Raya* (Public Works Department)
JLM	*Jabatan Laut Malaysia* (Marine Department Malaysia)
JPJ	*Jabatan Pengangkutan Jalan* (Road Transport Department)
KeTTHA	Ministry of Energy, Green Technology and Water
KPDNKK	*Kementerian Perdagangan Dalam Negeri, Koperasi dan Kepenggunaan* (Ministry of Domestic Trade, Co-operatives and Consumerism)
KTM	Keretapi Tanah Melayu
KTMB	Keretapi Tanah Melayu Berhad
ktoe	kilo tonne of oil equivalent
ktonne	kilo tonne
LCV	Light Commercial Vehicle
LDCV	Light Duty Commercial Vehicle
LDV	Light-Duty Vehicles
LEO	Low Energy Office
Lge	Litres of gasoline equivalent
LKIM	*Lembaga Kemajuan Ikan Malaysia* (Fisheries Development Authority of Malaysia)
LLM	*Lembaga Lebuhraya Malaysia* (Malaysia Highway Authority)
LPG	Liquefied Petroleum Gas

LRT	Light Rapid Transit
LT	Locomotive Train
LULUCF	Land Use, Land Use Change and Forestry
MAB	Malaysia Airlines Bhd
MEPS	Minimum Energy Performance Standard
MESH	Malaysia Energy Statistics Handbook
METI	Ministry of Economy, Trade and Industry, Japan
MGTC	Malaysia Green Technology Corporation
MIEEIP	Malaysian Industrial Energy Efficiency Improvement Project
MoE	Ministry of Energy, Thailand
MOT	Ministry of Transport, Malaysia
MP	Malaysia Plan
MRT	Mass Rapid Transit
MRV	Measuring, Reporting and Verification
MSIC	Malaysian Standard Industrial Classification
MW	Mega watt
NAP	National Automotive Policy
NEB	National Energy Balance
NEDC	New European Driving Cycle
NEEAP	National EE Action Plan
NEEMP	National EE Master Plan
NEMS	National Agency Modelling System
NET	Non-Electric Train
NPP	National Physical Plan
NUP	National Urbanisation Policy
OCMLT	Office of Commissioning for Management of Land Traffic
OECD	Organisation for Economic Co-operation and Development
PLUS	*Projek Lebuhraya Utara Selatan*
PHEV	Plug-in Hybrid Electric Vehicle
PPP	Public-Private-Partnership
PS	Pioneer Status
PV	Photovoltaic
PVs	Passenger Vehicles
R&D	Research & Development
RE	Renewable Energy
RFP	Request for Proposal
SDG	Sustainable Development Goal
SEB	Sarawak Energy Berhad
SE4ALL	Sustainable Energy for All
SESB	Sabah Electricity Sdn Bhd
SESCO	Sarawak Electricity Supply Corporation
SMVU	Survey of Motor Vehicle Use
SPAD	*Suruhanjaya Pengangkutan Awam Darat* (Land Public Transport Commission)
ST	*Suruhanjaya Tenaga* (Energy Commission)
SUV	Sport Utility Vehicles
TNB	Tenaga Nasional Berhad

TOR	Terms of Reference
RFP	Request for Proposal
TPA	Third Party Access
TPES	Total Primary Energy Supply
TRIPS	Transportation Regional Improvement Projects and Survey
TSM	Transport Statistics Malaysia
TWh	Terra Watt Hour
UBBL	Uniformed Building by Law
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
VKT	Vehicle Kilometres Travelled
WB	World Bank
WEO	World Energy Outlook
WG	Working Group
WLTC	World Light-duty vehicle Test Cycle

International System (SI) of units

MJ = megajoule = 10^6 joule
GJ = gigajoule = 10^9 joule
EJ = exajoule = 10^{18} joule

Conversion between units
1 toe = 39.68 mmBTU
1 boe = 0.14 toe = 5.63 GJ*
1 mbd = 2.05 EJ/year
1 million cubic metre gas = 34,700 GJ*
1 tonne coal = 25 GJ*
1 kWh = 3.6 MJ
1 ktoe = 11630000 kWh = 11.63MWh

1 bcm =Billion Cubic Metres, a unit of measure equivalent to 1 cubic kilometre,

* *This is a typical average but the energy content of a carrier may vary.*

Trigeneration or combined cooling, heat and power (CCHP) refers to the simultaneous generation of electricity and useful heating and cooling from the combustion of a fuel or a solar heat collector.

Cogeneration is a thermodynamically efficient use of fuel. It is the simultaneous generation of electrical or mechanical power and useful thermal energy from a single source of primary energy.

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EXECUTIVE SUMMARY

The study aims to analyse the trend in electrical and thermal energy consumption in industrial, commercial and residential sectors as well as the energy consumption and CO_2 emission by the transportation sector in Malaysia as part of Demand Side Management (DSM). This project is an initiative of Economic Planning Unit (EPU), Prime Minister's Department, Malaysia in collaboration with United Nations Development Programme (UNDP). The project also aims to provide a baseline understanding of the current state of electrical and thermal energy consumption in the energy demand side of Malaysia, and to identify focus areas and boundary setting, and to establish a framework and activities for the proposed detailed DSM study. DSM is a planned initiative under the 11th Malaysia Plan for sustainable production and consumption under Focus Area B, Strategy B3. It marks an important paradigm shift for Malaysia towards efficient management of energy resources where it will give due emphasis to the demand side for a balanced management of the entire energy spectrum.

The scope and objectives of the study for electrical energy covers electricity consumption by industrial, commercial and residential sectors and mainly as listed below:

- To conduct preliminary energy baseline study on DSM via review and gap analysis against the NEEAP implementation document and other related documents; and

- To prepare a detailed masterplan for the implementation of DSM initiatives with targets to be specified and effective measures for the implementation of a long-term DSM programme in Malaysia that is expected to be rolled out and covered in 12th and 13th Malaysia Plans.

For thermal energy and transport energy use, study will investigate the current baselines in the national energy consumption, identify scope and the relevant areas and finally to propose a comprehensive term of references and consultancy document in the form of a complete tender document in line with the Government of Malaysia's format for the detailed DSM study to be conducted later.

To date a total of five (5) workshops with stakeholders were conducted from the end of June 2016 until February 2017. Other than workshops, meetings and discussions were held with some organisations and agencies separately for data and information gathering. The project objectives and outcomes for the preliminary DSM study have been achieved in accordance with the requirements of the project document.

In this report, the electrical energy is confined to electricity consumption by industrial, commercial and residential sectors. For thermal and transport energy use, consultations with stakeholders and analyses carried out using the acquired data have enabled consultants to define the scope and boundary to be covered in the study.

This study has identified 11 industrial sub-sectors and two (2) other sectors namely commercial and residential for thermal energy and three (3) major transportation modes namely land, air and water for transport energy use. For transport energy use, information from studies and country reports have been mainly focusing on road transports which are largely based on new registration of vehicles and cars.

The report offers an abridged review and analysis of annual data from 2005 to 2014 for electrical and thermal energy consumption describing types of energy consumption, carbon dioxide (CO_2) emission, etc. However, in case of transportation sector, a more detailed review and analysis of annual data from 2005 to 2014 describing transportation mode, vehicle type and usage behaviour, number of vehicle, fuel and its consumption, annual average travel distance, carbon dioxide emission, etc. has been considered.

The major challenge in this study was the data and information gathering especially for transport and thermal energy use. At the beginning, the consultations with stakeholders from various agencies and organisations were held focusing on understanding types and purposes of each data to be collected. Subsequent consultations identified the availability of each data needed and their sources to be gathered within the agreed data period (2005-2014).

For electrical energy, most data were available at ST and sourced from utility companies. Challenges faced by electrical energy study are mainly to consolidate findings from various studies and DSM-related programmes that have been conducted and programmes that are still in-progress for the purposes of recommending a holistic and sustainable plan for DSM initiatives.

Various EE initiatives have been undertaken to promote the adoption of EE measures and strategies with international assistance programmes since 1998, but their outcomes on the nation’s energy supply and demand planning have not been monitored, quantified and reported. Those initiatives had been conducted on project-based approaches with a lack of synergy between them, and without any integrated plan for the continuation of the activities after the project periods ended.

The reviews from the previous studies, existing DSM initiatives and the consultation with stakeholders have found and agreed that there are critical key barriers identified that have prevented a wide-spread adoption of energy efficient practices as described as follows:

- Lack of comprehensive EE&C Law;
- Lack of support from financial system for EE initiatives implementation;
- Fragmented overall national plan for EE initiatives;
- The absence of a dedicated EE&C entity;
- Lack of EE funding sources and financing mechanisms; and
- Limited availability of certain energy related data such as for thermal energy consumption data.

For thermal energy, data for industrial sub-sectors were only made available from 2010 to 2014 as they were based on the ST's manufacturing survey conducted in 2013. The set of data obtained from ST comprised fuel oil, natural gas, Liquefied Petroleum Gas (LPG), kerosene, petrol, diesel, coal and coke only. Biogas and biomass data were not available in the set of data from ST. It was learned that such data may not continue to be monitored and reported as such collection of industrial sub-sector data is not a regular programme. To formulate and implement effective DSM policy strategies and measures, it is imperative to institute a continuous and effective MRV programme. Without data, it is difficult to formulate and optimise EE policies and monitor progress and failures.

It was learned that Gas Malaysia Berhad (GMB) could readily provide natural gas consumption data under the 15-identified industrial sub-sectors as they were able to identify and categorise their clientele's manufacturing operations. For the thermal energy consumption data for other fuel sources, it was fortunate that ST conducted an energy consumption survey for the manufacturing sector in 2013 for Peninsular Malaysia, and hence, it was possible to collect the required data for the identified industrial sub-sectors. Thermal energy consumption data provided for Sabah and Sarawak were also made available by ST.

In other words, except for natural gas, thermal energy consumption data for each industrial sub-sector is not normally available. If there were no continuous programmes to monitor the thermal energy consumption in the industrial sub-sectors, effective formulation and implementation of DSM will become a challenge. Having reliable end-use energy statistics will be crucial in monitoring and evaluating the energy saving targets and action plans and in conducting a robust analysis of energy saving potentials.

EE indicator for industrial sub-sectors provides an overall indication of EE in manufacturing processes. They are usually composed of energy consumption as numerator and an activity data as denominator.

Unlike the industrial sector, the commercial sector has established building energy intensity (BEI) as an EE indicator. However, it will be a challenge to establish EE indicator for the industrial sector due to unavailability of commonly agreed EE indicator and the data collected in this preliminary study are insufficient to be analysed. It is recommended that the detailed DSM study will investigate this further and make suitable recommendations for DSM policy formulation and implementation.

For transport energy use, energy data gathering has been much more challenging and difficult. This is due to the nature of transportation sector which involves various modes such as land, water and air with different types of vehicles used for each mode. The challenges faced throughout the study includes lack of historical data for vehicles and energy consumption for each type of vehicle, accuracy of actual distance as accrued by vehicle, data topography and governance, data completeness and granularity.

The report also deliberates on some of the principal findings and recommendation for each type of energy use:

Electrical Energy

For the purpose of the DSM preliminary study, the boundary for electrical sector is confined to industrial, commercial and residential sectors. For electrical energy consumption, the industrial sector consumed 58,951GWh (46%) and followed by commercial sector with 41,441GWh (32%) and residential sector with 27,264GWh (21%) respectively (ST, 2014). The transportation energy is excluded in this sector as there is a concurrent DSM preliminary study for energy use in transport sector. Besides electricity usage in transport constitutes only 0.27% of the total final energy used as electricity. Agriculture also constitutes 0.73% of the total final energy of electricity and is therefore excluded from this study.

The study recommends the holistic approach based on the five (5) Strategic Thrusts as elaborated in Chapter 8 and summarised below:

Strategic Thrust 1: Energy Security and Sustainable Energy;
Strategic Thrust 2: Social Development;
Strategic Thrust 3: Low Carbon Economy;
Strategic Thrust 4: Human Capital Development; and
Strategic Thrust 5: Global Climate Change Commitment.

The exercise has identified some critical enablers to facilitate the successful adoption of the DSM programmes, which received stakeholder concurrence.

The followings are the main barriers and critical enablers identified and recommendations to enable the establishment of the desired institutional framework for the successful promotion and adoption of the proposed DSM programmes at national level.

i) Lack of EE funding sources and financing mechanisms

The lack of a continuous and guaranteed annual EE budget for EE activities has been a limiting factor for the intended growth.

The lack of funding options that can be offered, especially by local banks, has hindered the implementation of EE projects by the facilities owners themselves or by the service providers such as ESCOs through the Energy Performance Contracting (EPC) business model which could be further explored.

This study recommends various possible alternative options of sustained funding sourcing mechanisms to satisfy this critical need that should be considered by the government, which has been deliberated in the Section 8.2.1: Sustainable Energy Efficiency Funding. However, the following are two (2) public funding sources that were proposed to be explored after the deliberation among key stakeholders in the National Steering Committee No.1/2017:

- A very small levy (RM0.01 per litre) on the sale of liquid fuels for transport (petrol and diesel); and
- Implementing a "Green Tax" mechanism on the principle of "polluters pay" on electricity generators.

The government has the option to select the most suitable option according to its overall socio-economic assessment. The proposed fund could be from multiple sources and to be administered by ministry responsible for electrical energy sector which is the Ministry of Energy, Green Technology and Water (KeTTHA).

The study also has identified the potential funding schemes that will enable the investment from the private sectors other than from the internal funds but from the loans from a special fund such a revolving fund created by the government and other funding organisations such as commercial banks.

With the clear targets, strategic actions and the support measures which will provided by the government in the implementation of EE initiatives, it is expected the private sectors with energy intensive operations will be playing their roles in implementing EE initiatives to improve their business profits and to remain competitive from producing products or delivering services at lower costs by using less energy.

The proposed options for private funding are as follows: -

- **Energy Efficiency Funding Scheme**

The Energy Efficiency Funding Scheme (EEFS) is proposed to be created to boost the implementation of EE&C projects by the private sectors. The main aim of the fund would be to provide low interest loans for EE&C projects to qualified industrial and commercial users with the facilitation from government and disburse through a designated entity. The similar mechanism like the existing fund under the Green Technology Financing Scheme (GTFS is now being setup by the government and with such mechanism, the Government is not required to allocate additional funds from its budget.

- **Energy Performance Contracting Model**

Energy Performance Contracting (EPC) Model which is also known as Energy Saving Performance Contracting (ESPC) in some countries such as United States, Australia and some European countries is a concept for implementation of energy conservation measures through direct investments by the private sector or by Energy Service Companies (ESCOs) with "Zero Upfront Costs" concept to the owner of building or industrial facilities in private and government sectors. The adoption of EPC has been widely practiced in the private sectors and in many countries, such as United States, Thailand, Taiwan and Japan.

For the government sector, the adoption of EPC concept will ease the financial burdens of the government spending to implement sustainable energy saving measures in its buildings and the money would be able to be spent for other important purposes such as education, healthcare and infrastructure development needs for the people.

For the private sector, the EPC will enable competent third parties to identify and implement energy saving measures while they can focus on their core businesses. In both sectors, the EPC mechanism will allow them to transfer the financial commitment and risks to invest in EE projects to the third party and in the same time to be assured the savings which will benefit the in a long run.

The government has started to promote the implementation of EPC model under the ETP from 2011. However, the progress of the implementation for the government-owned building facilities has been delayed due to some issues related to the government's procurement procedures that needed some changes.

ii) The absence of a dedicated EE&C entity

It is very important to have a dedicated EE&C entity to drive EE efforts in Malaysia, with legal provisions to enforce the laws and regulations relating to EE with the provisions on sourcing and administration of fund, engage all stakeholders and oversee all issues and activities related to EE in medium and long-term.

This does not mean the establishment of a new agency, but simply the assignment and empowerment of the authority and responsibility for implementing the EE&C Law to a dedicated, existing entity such as ST. The commendable experience of SEDA in promoting the development of RE industry in Malaysia since 2011 provides a good example of what can be achieved if a suitable institutional framework is established to execute the strategies that government policy decisions require.

iii) Fragmented overall national plan for EE initiatives

EE has been a part of every Malaysian Plan since 8MP, but there has not been any underlying road map or strategic action plan for the whole spectrum implementation of EE programmes.

A dedicated implementing entity with sufficient resources and capacity will be able to ensure the development of an appropriate long-term DSM roadmap or master plan, and to ensure sustained promotion and adoption of the desired energy saving initiatives and measures for the targeted energy using sectors.

iv) The lack of a comprehensive EE&C Law

The electricity laws and regulations are mostly directed towards supply and safety whereby the element of energy efficiency (EE) has not been given enough emphasis. The Efficient Management of Electrical Energy Regulations (EMEER) 2008 enforced by ST is confined to electrical energy and for limited installations only. It also lacks of detailed requirements in its provision to ensure the implementation of EE measures for affected installations.

Due to the lack of encapsulating and comprehensive legal provisions for electrical energy, thermal energy and transport energy use sectors, the thermal and transport energy users have no legal obligation to comply with requirements for efficient utilisation of energy resources, and thus efforts to promote EE have therefore been confined to voluntary activities for these sectors.

The DSM programmes could be accelerated if a comprehensive EE&C Law to cover all sectors has been gazetted and duly enforced. The EE&C law to be enforced must be comprehensive with needed provisions enough to cover all energy using sectors and supported with necessary resources to ensure its effectiveness to achieve the national objectives and goals for the DSM programmes.

This study recommends the enactment and implementation of a comprehensive EE&C law with the key provisions for electrical energy as outlined in this report whereas the detailed requirements for thermal energy and transport energy use sectors are expected to be proposed from the full study findings.

Implementation Strategies

The successful establishment of the institutional framework will permit the execution of specific strategies and measures that need to be developed on a national basis to satisfy the time-based DSM aspirations over the short-term (2016 to 2020), medium-term (2021 to 2025) and long-term (2026 to 2030).

The study has identified five (5) categories of EE initiatives (EEI) which have been evaluated in detail for their cost-effectiveness and are recommended for promotion and adoption to achieve the desired DSM benefits for the nation. The five (5) categories are listed below and their economic assessment is given in the calculation model used for the exercise.

i) Physical promotion of the five (5) key EE Initiatives as listed below:

- EEI 1: Promotion of High Efficiency Performance Standards (HEPS) Appliances
  Introduction and promotion of high efficiency performance standards (HEPS) for electrical appliances such as refrigerators, air conditioners and lighting used in commercial and residential sector.

- EEI 2: Minimum Energy Performance Standards
  Expanding the mandatory legal requirements of Minimum Energy Performance Standard (MEPS) for more electrical appliances:
  - Industrial Appliances: Electric motors, cooling tower and industrial fans.
  - Domestic Appliances: Washing machine, rice cookers, water heater, electric oven etc.

- EEI 3: Sustainable EE Implementation for Industrial and Commercial Sectors
  Implementing sustainable EE programmes for industrial and commercial sectors targeting medium/large commercial and industrial facilities as well as Government/public facilities.

- EEI 4: Promotion of In-House Cogeneration Facilities
  To promote an uptake of cogeneration, barriers such as the high top up and standby rates need to be overcome in this DSM plan. This study recommends that key strategic measures be taken to overcome the specific barriers identified covering the design of standby, top-up, load-connected and stand-by charges and revisiting the existing incentives and local manufacturers' capacity building.

Strategies and approaches used by other countries in promoting cogeneration systems for their markets should be examined to explore the possible adoption with some changes that will suit our local market.

- EEI 5: Energy Efficient Building Codes Regulatory and Compliance
  The Energy Efficient Building Code Programme is planned to enforce the provision of MS1525 through the UBBL with the cooperation from various parties and support with future EE&C Law to facilitate this initiative.

ii) Continue to pursue and enhance the following:

- Capacity Building Development Programmes;
- Competency Development Programmes;
- Research and Development in EE Technologies and Applications; and
- On-Going Awareness and Communications Programmes.

The table below shows a summary of the projected impacts that can be realised from the successful implementation of the planned DSM initiatives over the three (3) time-periods which is the projected impacts and benefits from the DSM programmes. It is therefore essential that the institutional framework is effectively and expeditiously developed to enable the successful implementation of the planned DSM initiatives.

No	Item	Short-term (2016 - 2020)	Medium-term (2021 - 2025)	Long-term (2026 - 2030)
1	Impacts (Electricity Savings[1]) of Programmes	3,701GWh	9,266GWh	7,362GWh
2	Cumulative Electricity Savings[2]	7,406GWh	45,628GWh	85,736GWh
3	Capacity Savings	754MW	1,889MW	1,501MW
4	Demand Savings	604MW	1,511MW	1,201WW
5	Cumulative CO_2 Avoidance[3]	5,498 ktonne	32,489 ktonne	58,221 ktonne
6	Public Funding	RM260 million	RM285 million	RM505 million

Note:
1. The electricity savings is the total of respective yearly electricity savings excluding the carryover savings from the previous year within the corresponding period.
2. The cumulative electricity savings in the accumulated electricity savings including the carryover savings from the previous year of the corresponding period.
3. The cumulative CO_2 avoidance is the accumulated CO_2 avoidance achieved including the carryover savings from the previous year of the corresponding period.

The short-term period coincides with the bulk of the 11MP period (2016 to 2020) and involves mainly voluntary adoption of existing EE measures from the NEEAP.

The medium-term period covers the 12MP period (2021 - 2025) and is based on the enactment and implementation of the EE&C Law as scheduled, i.e. by 2020, in order to benefit from the cumulative effects of the savings over the period concerned. This period is expected to produce the most significant impacts with the full enforcement of the EE&C law and coupled with higher penetration rates of the proposed EE initiatives, especially the sustainable EE implementation for industrial and commercial sectors. which have also been identified in this study as the largest users of electrical energy.

The long-term period covers the 13MP period (2026 - 2030) and is based on the assumption that the enactment of the EE&C Law by 2020 will accelerate the implementation of EE initiatives by all targeted sectors.

One of the other key success factors for the proposed EE initiatives in this study is the availability of sufficient and sustainable funding sources. The total estimated budget required to successfully implement the EE initiatives proposed in order to achieve the energy consumption reduction targets as stated above will be approximately RM10.325 billion of which RM9.275 billion is expected to be invested by the private sector and the remaining RM1.050 billion would come from the funding sources to be provided by the government.

The projected accumulated total savings over the period from 2016 to 2030 shall be a minimum of 138,775GWh or equivalent to RM46.92 billion savings on the electricity consumption costs by consumers from all targeted sectors. In the same time, there are more costs will be saved from the reduction of generating power plant capacity requirement that will avoid the development, operation and maintenance of new power plants and costs that need to borne by the government for the subsidies for fuels in power generation.

For the protection of our future environment, the DSM programmes is also projected to result in the total amount of CO_2 avoided for the corresponding period at 96,209ktonne.

Thermal Energy

Study Finding 1: Baseline Studies on DSM Related Initiatives

The analyses, carried out using the data acquired in the preliminary study, have demonstrated that thermal energy use is a significant part of the entire spectrum of the consumption in the energy sector. The industrial sector takes up the share of 86.40% of the combined total thermal energy consumption by the three (3) main sectors, namely industrial, commercial and residential sectors in the country, and this share is significant.

The average share of thermal energy consumption by the industrial sector is at 65.80% of the average final energy consumption (2010 – 2014) as reported in NEB 2014. If the combined average of total thermal energy consumption of 9,996ktoe (combined industrial, commercial and residential sectors from 2010 to 2014) is compared with the average final energy consumption for industrial, commercial and residential sectors reported for the same period in NEB 2014, the share of thermal energy consumption is about 49.30%. This share of thermal energy consumption is lower because the energy for the commercial and residential sectors is sourced mainly from electrical energy. It is anticipated that there will be significant saving potentials in DSM on thermal energy consumption especially in the industrial sector. Refer to Table 7.1: Summary of thermal data analysis (2010-2014) for details.

Based on the above analysis and in terms of the extensiveness in thermal energy use, it can be categorised into three (3) groups from the highest to the lowest as follows (refer to Figure 7.2 for details):

i) Large consumption group (>1,500ktoe per annum): Iron and steel, non-metallic mineral products (incl. cement, concrete, ceramic and glass), and food, beverages and tobacco;

ii) Medium consumption group (≥500ktoe per annum and ≤1,500ktoe per annum): Chemical, residential, commercial, and transportation equipment; and

iii) Small consumption group (< 500ktoe per annum): Pulp, paper and printing, textiles and leather, wood and wood products, machinery, non-ferrous metals and not elsewhere specified.

Study Finding 2: Identification of focus and boundary setting

Based on the data obtained, the most significant thermal energy consumption lies in the industrial sector which takes up the majority share at 86.40% of the combined total thermal energy consumption in the industrial, commercial and residential sectors. It has been identified that the focus area in terms of significant thermal energy consumption is the industrial sector as discussed in Section 7.2.2.

Effective DSM plan and programmes in this sector will contribute significantly to energy savings and reduction in greenhouse gas (GHG) emission in the country. However, it is recognised that the combined share of thermal energy consumption of the commercial and residential sectors at 13.60% is significant and should be included in the detailed DSM study. In other words, a holistic development and effective implementation of DSM policies will generate significant impacts to the country's energy performance.

The proposed scope and boundary for the comprehensive study is to cover industrial, commercial and residential sectors.

The boundaries for a comprehensive DSM detailed study should be based on the following categories of thermal energy sources:

i) Non-renewable: Fuel oil, natural gas, diesel, kerosene, petrol, coal and coke, liquefied petroleum gas, etc.;
ii) Renewable: Biogas, biomass, solar thermal energy, etc.; and
iii) Secondary thermal energy generated from other sources such as electricity through cogeneration and trigeneration.

Study Finding 3: Results framework and activities for the comprehensive DSM study

The terms of reference given below under the framework for comprehensive study shall form the basis of request for proposal (RFP), which stipulates the objectives, scope of study, deliverables and development requirements agreed by the stakeholders to formulate the DSM Master Plan and policy.

A separate document of RFP comprising the following terms of reference for the DSM full study has been prepared under Outcome 3 as detailed in Section 7.2.3:

Task 1: Review existing programmes/projects that have been implemented since 2005, and existing institutional setup, regulatory framework pertaining to the rational use of thermal energy in industrial, commercial and residential sectors.

Task 2: Propose counter-measures for the following but not limited to the identified shortfalls and barriers.

Task 3: Develop comprehensive strategies and measures.

Task 4: Conduct Cost-Benefits Analysis.

Task 5: Identify and recommend collection and management of thermal energy data.

Task 6: Develop a comprehensive DSM policy for Malaysia to realise the benefits of DSM strategies and measures.

Transport Energy Use

Study Finding 1: Baseline study on DSM related initiatives.

Transportation sector consumes a major share of energy. Energy consumption in this sector is substantially rising as the number of vehicle on Malaysian roads continued to increase between 2005 and 2014 (from 14.82 to 25.10 million). The annual increase rate of the road transport is about 6.93%. Some key findings from this study are as follows:

i) The highest energy consumption for the transportation is in road transport, which accounts for 90.02% of the total energy consumption in 2014, while in 2005 this value was 88.73%;
ii) Among the road transport, car consumes highest share of fuel as well as energy. The percentage of energy consumption by car among all road transports is 67.73% in 2014 as compared to 63% in 2005;
iii) Road transportation accounts for the biggest CO_2 emission which is about 89.70% of the total CO_2 emission in the transportation sector in 2014, while in 2005, the value was 87.68%;
iv) Among the road transport, car emits the highest amount of CO_2 at 67.15% in 2014 as compared to 62.69% in 2005;
v) The use of electric vehicle (EV) has been increased, especially electric motorcycle which has increased rapidly from 270 (2011) to 1,179 (2014);
vi) EV is the most environment-friendly as it contributed only 0.001% of CO_2 emission; and

vii) The energy consumption in the total transportation sector is found to be comparable to that presented in NEB 2014 report.

Study Finding 2: Identification of focus and boundary setting

The types of transportation are classified as land (road and rail), air, and water. It is further categorised into types of vehicles such as motorcycles, private and commercial cars, buses, taxis, goods, electric vehicles, and other vehicles (road), LRT/MRT, passenger trains and freight trains (rail), airplanes and helicopters for domestic flights and water within the boundary of Malaysia. The population of vehicles identified is based on information obtained from the state and territory transport authorities and agencies for the period from 2005 to 2014 shall be used as baseline for this study.

The scope and boundary of the baseline study comprise all types of vehicles including land, water and air that were registered with the Department of Road Transport under MOT for vehicle road use, *Suruhanjaya Pengangkutan Awam Darat* (SPAD), Department of Civil Aviation (DCA), and other related transport agencies.

All kinds of moving transportation modes (private, public, mass, commercial, freight) will be considered except caravans, tractors, plants and equipment, airport ground handlers, vehicles belonging to the defence (military & police) services, infrastructure transport and vehicles with diplomatic or consular plates. Inactive vehicles, vintage/classic, scrapped or salvaged vehicles are also excluded from this study. Unregistered vehicles were not considered in the scope of this study as well.

Foreign transport that fuelled in Malaysia was considered in this study as they consume fuel designated for this country. The fuel consumption by foreign cars figure could be approximately offset by the same amount of fuel consumed by Malaysian vehicles that fuelled in those countries. Foreign transport i.e. ships, and airplanes (non-Malaysian registered vehicles) that refuelled in Malaysia were not be considered in this baseline study. Marine bunkers were also not included in the study since they were also categorised in a different category i.e. international consumption.

There were numerous boats (small tourist boats) used for transiting passengers from the mainland to islands for vacationing, snorkelling, sightseeing etc. It has been understood that these boats obtained their fuels from the normal petrol stations. These boats which might or might not fall within the purview of the port authorities, were not included in this baseline study since there were no specific data available and the amount of fuel consumption was small. This study would generate total transportation sector in Malaysia and individual classification of types of vehicle in the form of fuel of consumption (ktoe) and CO_2 emission (ktonne).

The proposed scope and boundary for the comprehensive study is to focus on land transportation only.

Study Finding 3: Results framework and activities for the comprehensive DSM study

The terms of reference given below under the framework for comprehensive study shall form the basis of RFP, which stipulates the objectives, scope of study, deliverables and development requirements agreed by the stakeholders to formulate the DSM Master Plan and policy.

A separate document of RFP comprising the following terms of reference for the DSM full study has been prepared under Outcome 3 as detailed in Section 7.3.4:

Task 1 (a): Review existing studies and programmes/projects that have been implemented since 2005 which were identified with rational use of energy in land transport sector and to conduct the following data mining tasks among others, for statistical analyses.

Task 1 (b): Review existing institutional setup, regulatory framework, legislation and financial mechanisms and resource allocation in Malaysia to achieve rational use of energy for transportation sector.

Task 2 (a): Identify shortfalls and barriers in land transport energy use that currently hinder the adoption of DSM initiatives in Malaysia and to propose mitigating measures and their impacts.

Task 2 (b): Identify examples of successful DSM land transport energy use efforts in selected model countries in the successful implementation of DSM transport energy use measures.

Task 3: Develop a comprehensive strategies and measures

Task 4: Conduct Cost-Benefits Analysis

Task 5: Develop a comprehensive DSM land transport energy use Policy for Malaysia to realise DSM transport energy use benefits in the country.

The holistic EE implementation under the DSM will contribute to the reduction of energy consumption for all targeted energy using sectors. The implementation proposed initiatives under the electrical energy sector and potentials initiatives to be proposed from the comprehensive DSM studies for thermal energy and transport energy use at the national will also help Malaysia to contribute to achieve the Sustainable Energy for All (SE4ALL) under the Sustainable Development Goal 7(SDG7).

The goals for the programme under United Nations is empower leaders to broker partnerships and unlock finance to achieve and secure universal access to affordable, reliable, sustainable and modern energy for all by 2030 and reducing the carbon intensity of energy in the same time and DSM could play significant roles in the programme.

1.0 INTRODUCTION

1.1 Overview

After gaining independence in 1957, Malaysia started its economic journey as an agriculture- and mining-based country but fast migrated to a middle-income country by virtue of our rapid industrialisation strategies. Malaysia was a commodity exporter of rubber, tin, palm oil, petroleum where the annual income rose about 6-7% from the years of 1970 until 2000. As a result, annual income rose about USD5,300 per capita in 2007 and become an upper-middle-income country (Yusof & Bhattasali, 2008). Table 1.1 shows that national level Gross Domestic Product (GDP) per capita rose from RM31,920 in 2012 to RM37,104 in 2015. The GDP level of which Federal Territory Kuala Lumpur topped the list with RM94,722.

Table 1.1 GDP per capita by state, 2012-2015 at current prices (RM)

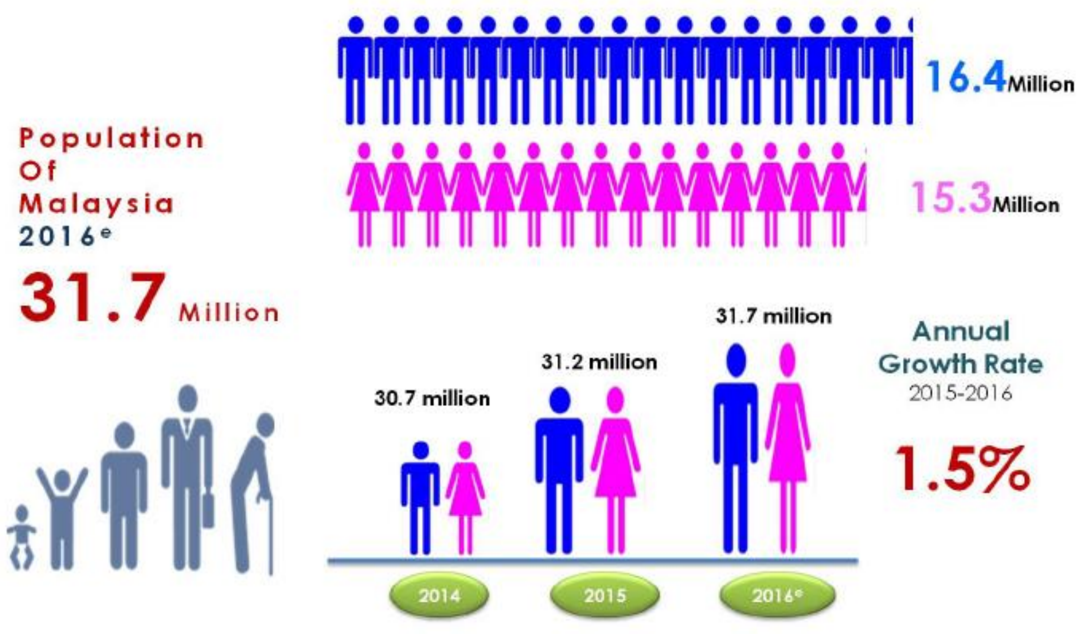
State	2012	2013	2014	2015
WP KL	74,579	79,752	90,464	94,722
WP Labuan	40,668	43,848	55,566	58,577
Sarawak	40,396	41,115	44,596	44,012
Pulau Pinang	36,787	38,356	42,130	44,847
Selangor	35,916	37,851	40,536	42,611
Melaka	33,623	34,109	38,656	39,853
Negeri Sembilan	32,545	33,033	35,865	36,699
Pahang	26,274	26,759	29,341	30,343
Johor	24,569	25,302	28,089	29,539
Terengganu	22,717	23,285	26,397	26,529
Perak	20,510	21,150	24,132	25,418
Sabah	18,713	18,603	19,723	19,734
Perlis	17,990	18,519	20,999	21,394
Kedah	15,777	16,316	17,329	18,249
Kelantan	10,568	10,677	11,748	12,075
Malaysia	**31,920**	**32,984**	**36,031**	**37,104**

Source: Department of Statistics Malaysia, 2015

Global Science and Innovation Advisory Council (GSIAC) stated that Malaysia's GDP per capita in 2014 exceeded the average of all countries worldwide. In a statement, the GSIAC said Malaysia's GDP per capita was at USD10,830 in 2014 while the average of all nations worldwide stood at USD10,804. By comparison, in 2010 national GDP per capita was USD8,752, some 8% below the then-world average of USD9,513 (Bernama, 2016).

Malaysia has achieved huge economic progress especially in the last three (3) decades and corresponding to this, the population has also increased. Figure 1.1 shows total population of Malaysia is estimated about 31.7 million for the year 2016, an increase of about 0.5 million as compared to 31.2 million in 2015.

Figure 1.1 Population of Malaysia, 2014 to 2016



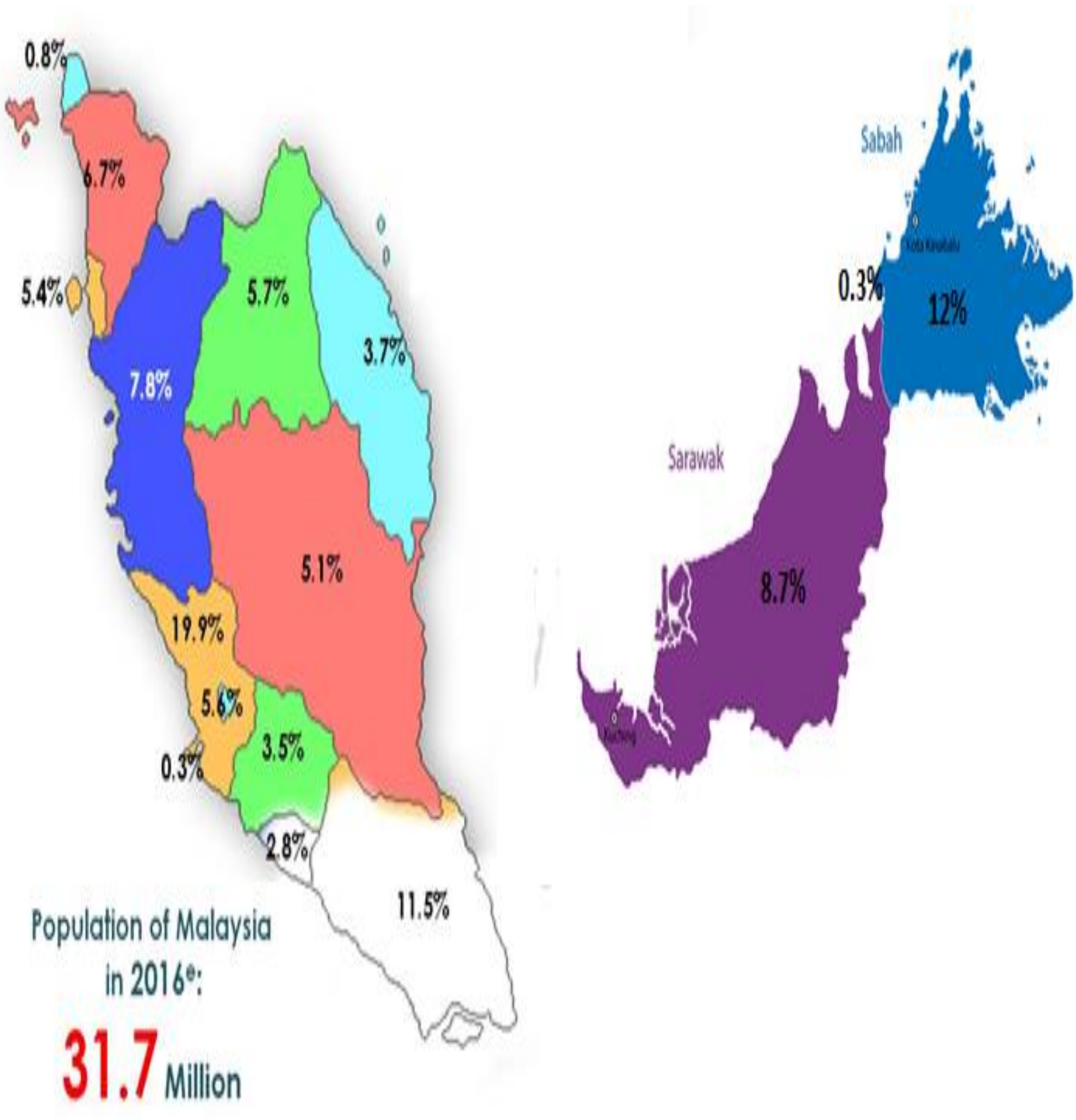
Source: Department of Statistics Malaysia, 2016

Figure 1.2 shows that Selangor recorded the highest percentage of population in 2016 (19.90%) followed by Sabah (12%) and Johor (11.50%). While Federal Territory Labuan and Federal Territory Putrajaya both recorded the smallest percentage of population with 0.30% each (DOSM, 2016).

As the population and GDP increases, energy consumption also increases. The demand for energy is fundamental for any development of the society for improving the living standards of the Malaysian population and the economic growth of the country. However, the use of energy must be rational and productive to avoid unnecessary wastage of depleting fossil fuel resources and harmful environmental impacts such as emission greenhouse gases (GHGs) and global warming effects.

In the past few decades, the growth in energy consumption in Malaysia has been phenomenal due to the expanding industrial sectors. Notwithstanding the importance of supply-side energy management, equal emphasis should also be given to demand side management.

Figure 1.2 Population distribution by state, Malaysia, 2016



Source: Department of Statistics Malaysia, 2016

1.2 Project Introduction

This report is prepared in accordance with the project document titled Preliminary Study on Demand Side Management (DSM) Project signed by United Nations Development Programme (UNDP) and The Government of Malaysia dated 26 May 2016. This project document covers the background information and methodology to be adopted by the project team along with the consultants throughout the study period from 1 June 2016 to 31 May 2017. The study findings of the preliminary project shall be based on the outcomes as follows:

- Outcome 1: Baseline Studies on DSM Related Initiatives;
- Outcome 2: Identification of Focus and Boundary Setting; and
- Outcome 3: Results Framework and Activities for Full Study.

The study findings of this preliminary study will provide the strategic directions and recommendations for a detailed DSM study in the thermal energy and transport energy use to be conducted later following the completion of this preliminary study.

For electrical energy, the expected outcomes will have more in-depth information on a holistic approach together with initiatives for potential targets to be achieved for each initiative. This is due to the availability of existing initiatives which the government has already approved, such as National Energy Efficiency Action Plan (NEEAP) and Building Sector Energy Efficiency Project (BSEEP). Other related studies and projects include National Energy Efficiency Master Plan (NEEMP) Study which was completed in 2011 by the Ministry of Energy, Green Technology and Water (KeTTHA) and Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) which was completed in 2005 by *Pusat Tenaga Malaysia* which was later transformed to become Malaysia Green Technology Corporation (MGTC).

All those studies and projects have been focused mainly on electrical energy and comprehensive engagements have already been made with key stakeholders in electrical energy sector. Their inputs of short, medium and long-term Energy Efficiency (EE) initiatives for Malaysia have been sought and documented in reports from those projects and studies.

The Malaysian government has also introduced various direct and indirect energy policies over the past three (3) decades to ensure efficient management of energy security and resources. Among the existing policies are:

The National Energy Policy (1979)

This policy was introduced to ensure adequacy, security and cost-effectiveness of energy supply, to promote efficient utilisation of energy and to minimise negative environmental impacts in the energy supply chain.

National Energy Policy, which was first formulated in 1979 and serves as the overall framework for the development of the energy sector, comprises three (3) principal objectives:

The Supply Objective:

- To ensure the provision of an adequate, secure and cost-effective supply of energy through the development of indigenous energy resources and diversification of energy supply from domestic and international sources.

The Utilisation Objective:

- To promote efficient utilisation of energy and to discourage wasteful and non-productive patterns of energy consumption.

The Environmental Objective:

- To minimise the negative impacts of energy production, transportation, conversion, utilisation and consumption on the environment.

The Four Fuel Diversification Policy (1981)

The policy was introduced in 1981 to prevent over dependence on oil as the main energy resource especially for electricity generation. The aim was to ensure reliability and security of energy supply by focusing on four (4) primary energy sources namely oil, gas, hydro and coal in the energy mix. In line with the policy, utilisation of gas in electricity generation increased from 67.80% in 1995 to 78.70% in year 2000. On the other hand, the contribution of oil in generation mix declined from 11% in 1995 to 5.3% in year 2000.

Because of the Four-Fuel Diversification Policy, natural gas became the major fuel for the electricity sector. About 75% of the fuel mix in the electricity sector for the year 2000 was from natural gas, followed by hydropower 10%, coal 9% and oil 6%. However, as seen from past experience, it is necessary to avoid over-dependence on any one (1) fuel. Thus, the percentage of all the different energy sources in the fuel mix is closely monitored to avoid over-dependence on any one (1) fuel and to allow further diversification in the fuel mix for power generation.

The Five Fuel Policy (2000)

In the year 2000, the Government introduced the Five Fuel Policy which identified Renewable Energy (RE) sources from biomass, biogas, municipal waste, solar and mini-hydro as additional sources of fuel for electricity generation besides the conventional sources oil, gas, hydro and coal. The policy also aims to encourage efficient utilisation of energy resources as well as reducing overdependence on conventional or fossil fuel.

The implementation of various energy policies in Malaysia has been carried out in different focus and strategies by the government. For the supply side of energy sector, it has achieved almost all its intended objectives and goals while in the demand side, well-defined policy directions are still needed to achieve the same success of implementation.

Despite the lack of holistic approach in the demand side of energy sector, several ad-hoc EE and DSM programmes and initiatives have been undertaken by various government, private and other organisations in recent years. However, these initiatives have mainly focused on electrical energy use and have been implemented on project-based approaches with their own objectives and targets such as follows:

- 2011 - 2013: Sustainability Achieved via EE programme, which gave rebates to buy new efficient refrigerators/air conditions for domestic and chillers for commercial building and industrial facilities, this programme is the Entry Point Project 9 under the Economic Transformation Programme (ETP) launched by the government in 2010 with the aim to mainstream EE industry as one (1) of the new source of economic growth for Malaysia to become a high-income nation by 2020;

- 2011- 2020: The Minimum Energy Performance Standard (MEPS) initiative was introduced by the Energy Commission (ST) through the enactment of Regulation 101A,101B and 101C. This was an enhancement to the initially voluntary “Star” labelling programme which were introduced to promote energy efficient domestic products. EC certifies selected products, which are rated from 1-5 stars as per their EE features;

- 2011 - 2020: The Voluntary Compliance with MS1525 (Code of Practice on EE and Use of RE for Non- Residential Buildings) was made mandatory through its incorporation under the Uniform Building Bye Law (UBBL) to create awareness on and development of EE buildings;

- 2012 - 2017: Industrial EE for Malaysian Manufacturing Sector - A Global Environment Facility (GEF) supported projects to promote the use of MS ISO 50001: Energy Management System (EnMS) to build capacity of SME in managing energy usage and incorporates EnMS to the industrial facilities;

- 2010 - 2017: BSEEP - A GEF-supported project and focused on EE for new and existing buildings. It is also a capacity building project for the government and the private sectors. The project shall develop/support necessary rating tools and standards and build capacity of public and private developers on building EE design and retrofitting;

- 2011 - 2020: Retrofitting measures for government buildings to be energy efficient. Amongst the retrofitted government buildings are the Economic Planning Unit (EPU) and the Ministry of Finance buildings which have return of investments (ROIs) of 1.6 and 4.7 years respectively. After the ROI years, all savings will be deemed profit for the owner of the buildings.

Among the main aim of these initiatives is to create and increase awareness on the importance of energy audit as one (1) of the key elements to identify EE potentials that can be implemented for large energy users in public and private sectors.

At the United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties - 15 (COP15) in Copenhagen in December 2009, Malaysia has pledged to voluntarily reduce carbon dioxide (CO_2) emission intensity of GDP up to 40% by 2020 as compared to 2005 levels, conditional on financial and technological assistance from developed countries (COP, 2009). In line with this pledge, the Government has introduced many renewable energy and EE initiatives, while enhancing the nation's energy security and sustainability. In November 2015, at the UN Climate Change Conference or COP 21 in Paris, Malaysia has also pledged the Intended Nationally Determined Contribution (INDC) global climate submission and set an ambitious higher goal of reducing its GHG emission intensity of GDP by 45% by 2030 relative to the emission intensity of GDP in 2005 as comparing to the COP 15 initial target to reduce its carbon dioxide emission intensity up to 40% by the year 2020 compared to the 2005 levels subject to assistance from developed countries. A target of a 35% reduction was set unconditionally while a further 10% reduction is contingent upon receiving sufficient climate change related financing, technology transfer and capacity building assistance from developed countries.

According to the International Energy Agency (IEA)'s Southeast Energy Outlook 2015 report, Malaysia's oil production has been falling steadily since peaking at around 830kb/d in 2003, mainly due to declining production in the mature basins located in the shallow waters offshore Peninsular Malaysia and Sarawak.

IEA forecasted that Malaysia's total oil production will decline gradually to around 600kb/d by 2040. However, Malaysia is richer in natural gas than in oil. Malaysia's gas production reached 69bcm in 2013, of which about half (34bcm) was exported as Liquefied Natural Gas (LNG), making it the world's second-largest LNG exporter after Qatar. Yet, the country is facing risk of shortages given the progressive decline of gas fields, which mainly serve demand in the industry and power sectors in Peninsular Malaysia.

Based on the Malaysia energy demand scenario development and global climate commitment above, the DSM plan approach is a better way to manage and control the rising demand of energy, delay the construction of new power plants, reduce GHG emission and prolong the depleting period of the countries' resources. Without the holistic DSM programme implementation, Malaysia can be a net importer of oil and gas in the future faster than initially forecasted because in February 2015, the Prime Minister of Malaysia announced that Malaysia has already become a net importer of petroleum products. This upcoming DSM programme plan now is vital to curtail the energy demand in 2035 under normal Business-As-Usual (BAU) scenario and fulfil the target of COP 21 commitment pledged by Malaysia to the global community.

From the above literature, it is found that electrical and thermal energy are substantially consumed. Therefore, it is important to include electrical and thermal energy in the DSM study as Government policies play a powerful role to determine the pace of growth and the degree to which GHG emission follow the same path. In the case of transportation sector, it is also found that most of the studies have given focus on sectoral energy consumption, transportation polices and emission. Some studies have been done on energy consumption on the new register vehicle. There is no comprehensive study on the energy consumption on specific types of vehicle, fuel types, energy consumption on state basis, year by year and cumulative over the specified period which will be addressed in this report.

In 2014 electricity generation fuel mix comprise of natural gas (43.90%), coal (43.20%), fuel oil and diesel oil (2.80%), hydro (8.70%) and renewables (0.50%) (ST, 2014). Total installed capacity as at the end of 2014 was 29,938MW (31,608ktoe), an increase of 0.60% from 29,748MW (24,970ktoe) in 2013 due to additional capacity in service. Table 1.2 shows the fuel mix generation type and concludes that natural gas and coal are still dominant in the power generation as supply capacity.

The grid-connected RE commenced as early as 2004 (Bio-Energy was connected to the SESB grid 2004) under the SREP (Small Renewable Energy Power) programme and subsequently in 2012 from biomass plants, mini hydro and solar PV generation because of the implementation of the Feed-In-Tariff (FiT) scheme under the RE Act 2011.

Table 1.2 Fuel mix of supply in Malaysia, 2010 to 2014

Sectors	2010 (ktoe)	2011 (ktoe)	2012 (ktoe)	2013 (ktoe)	2014 (ktoe)
Natural gas	16,996	10,974	11,525	13,309	**13,844**
Coal	12,956	13,013	14,261	7,616	**13,654**
Hydropower	1,571	1,843	2,165	2,847	**3,034**
Diesel	417	977	819	450	**633**
Fuel Oil	128	1,117	556	700	**285**
Renewables	0	0	59	25	**158**
Total ktoe	**32,068**	**27,924**	**29,252**	**24,970**	**31,608**

Source: Energy Commission, 2014

Electricity consumption increased to 128,330GWh at a growth rate of 4.30% from the previous year of 2013, with the highest share by the industrial sector at 45.90%, followed by the commercial sector at 32.30% and residential sector at 21.20%. In 2014, total final energy consumption was recorded at 52,209ktoe, manifesting an annual growth of 1.20% compared to 4.60% growth in 2013, due to increasing demand from all sectors. The domestic growth has been sustained by the manufacturing and services sectors. Electricity accounts for 11,042ktoe of the total final energy consumption, where the industrial sector has the highest consumption of 5,702ktoe, followed by the commercial sector of 3,566ktoe and the lowest consumption was residential sector at 2,346ktoe (ST, 2013).

Table 1.3 illustrates the overall growth rates of the electricity consumption from 2010 to 2014 for industrial, commercial and residential sectors. About 78% of the installed capacity is in Peninsular Malaysia, 14% in Sarawak and remaining 8% in Sabah as shown in Table 1.4. The highest peak demand for Peninsular Malaysia was recorded at 16,901MW on 6 June 2014, Sarawak at 2,306MW and Sabah Grid at 908MW for year 2014.

Table 1.3 Electricity consumption in industrial, residential and commercial sectors, 2010-2014

Sectors	2010 (ktoe)	2011 (ktoe)	2012 (ktoe)	2013 (ktoe)	2014 (ktoe)
Industrial	3,994	4,045	4,510	4,809	**5,702**
Commercial	3,020	3,172	3,325	3,466	**3,566**
Residential	1,937	1,974	2,126	2,262	**2,346**
Total	8,951	9,191	9,961	10,537	**11,042**
Difference	Base	+240	+770	+576	**+505**
ktoe growth %	**Base**	**+2.70%**	**+8.40%**	**+5.80%**	**+4.80%**
GDP %	***7.4%***	***5.3%***	***5.6%***	***4.7%***	***6.0%***

Source: Energy Commission, 2014

Table 1.4 Installed electricity generation capacity in Malaysia, 2010 to 2014

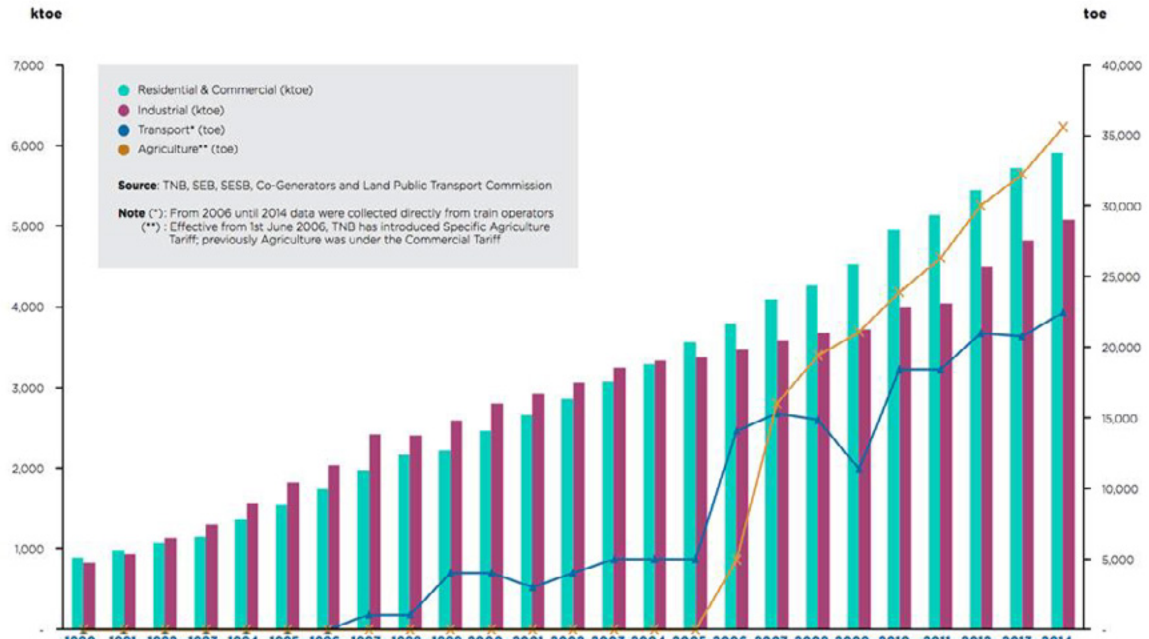
State	2010 (MW)	2011 (MW)	2012 (MW)	2013 (MW)	2014 (MW)
Peninsular	21,108	21,223	24,309	24,105	**23,394.50**
Sarawak	1,148	2,025	2,871	3,447	**4,342.90**
Sabah	1,014	1,123	1,963	2,196	**2,236.40**
Total	23,270	24,371	29,143	29,748	**29,973.80**

Source: Energy Commission, 2014

Under BAU scenario, Malaysia's final energy demand is projected to increase from 43.3Mtoe in 2010 to 68.9Mtoe in 2035, with an annual growth rate of 1.90%. Final energy demand of the industrial sector is projected to reach 27.6Mtoe in 2035. Under the BAU scenario, the industrial sector will surpass the transport sector and become dominant at 40.10% of national energy consumption in 2035. The share of commercial energy in the industrial sector in 2035 will be natural gas at 33.40%, electricity at 28.20% and oil at 28.10% (ST, 2016).

The total energy demand trend is escalating every year as shown in the Figure 1.3 with the calculated annual median positive growth rate of 2.70% from the sales forecast in the Figure 1.4. It is anticipated that this growth forecast will result in huge efforts to increase the electricity supply as a way to match the end-user demand capacity. This may lead to planting up of new power plants in order to meet the increasing demand.

Figure 1.3 Final energy demand by various sectors, 1990 to 2014

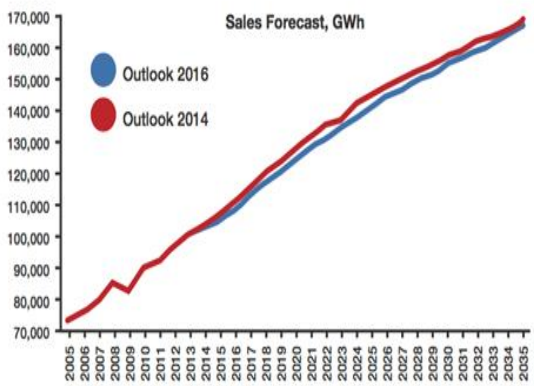


	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Residential & Commercial (ktoe)	885	988	1,081	1,147	1,365	1,549	1,747	1,961	2,165	2,220	2,453	2,660	2,859
Industrial (ktoe)	830	937	1,137	1,303	1,567	1,826	2,029	2,422	2,411	2,501	2,805	2,930	3,059
Transport* (toe)	-	-	-	-	-	-	-	1,000	1,000	4,000	4,000	3,000	4,000
Agriculture** (toe)	-	-	-	-	-	-	-	-	-	-	-	-	-

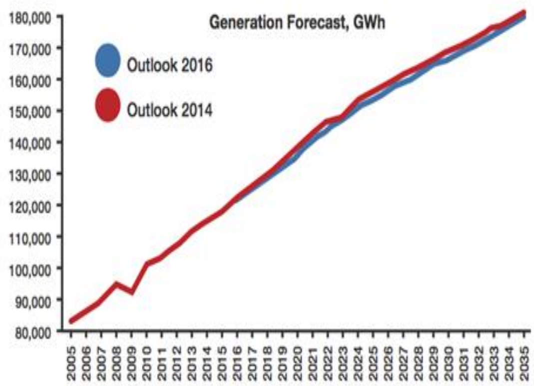
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Residential & Commercial (ktoe)	3,066	3,298	3,567	3,792	4,094	4,266	4,535	4,957	5,146	5,451	5,728	5,912
Industrial (ktoe)	3,242	3,340	3,371	3,475	3,587	3,687	3,719	3,904	4,045	4,509	4,818	5,072
Transport* (toe)	5,000	5,000	5,000	14,117	15,295	14,862	11,358	18,439	18,428	21,027	20,774	22,443
Agriculture** (toe)	-	-	-	4,886	15,991	19,393	21,080	23,920	26,312	30,014	32,240	35,578

Source: Energy Commission, 2014

Figure 1.4 Demand forecast growth rate, 2015 to 2035



Average period growth rates, % pa:	
2015 - 2020	3.4%
2015 - 2025	3.0%
2025 - 2035	1.7%



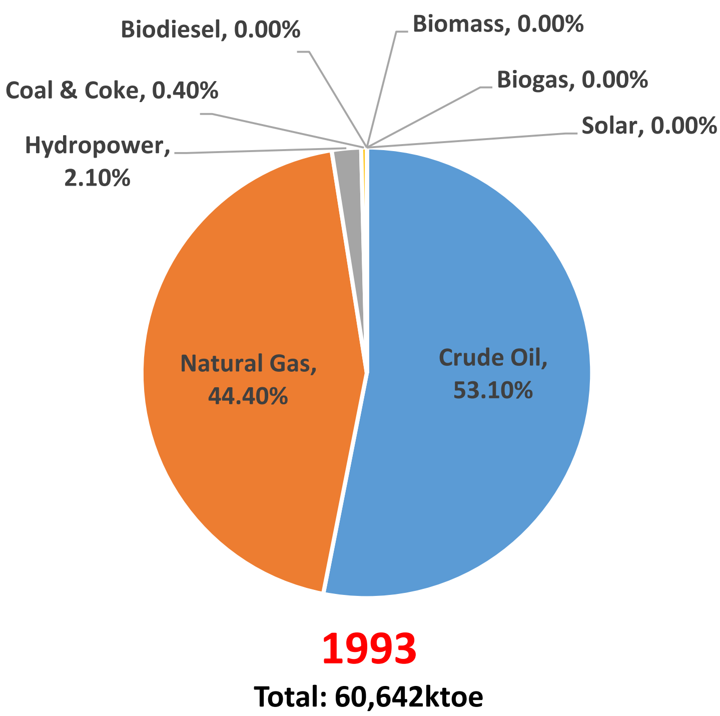
Average period growth rates, % pa:	
2015 - 2020	3.2%
2015 - 2025	2.8%
2025 - 2035	1.5%

Source: Energy Commission, 2016

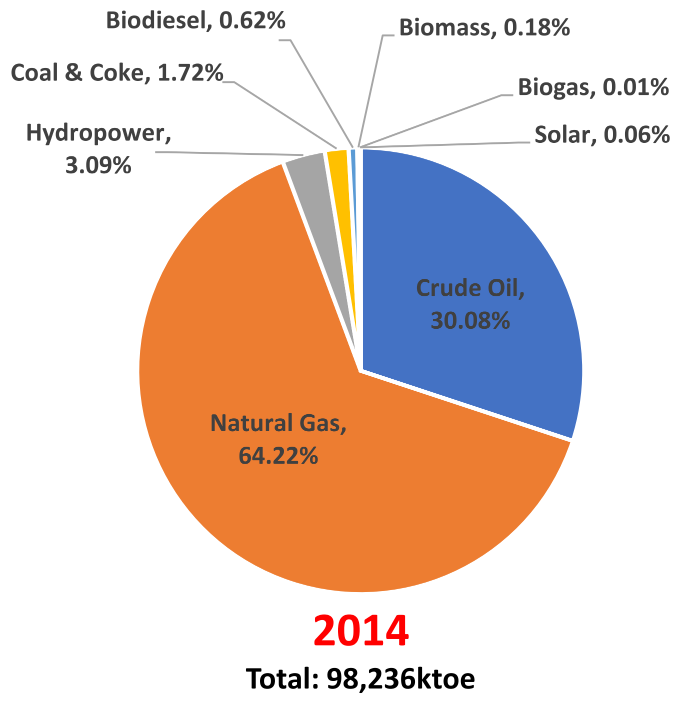
Based on the final energy consumption by sectors in the NEB 2014 and the thermal energy consumption data collected, the latter constitutes more than 80% of the total energy used by the industrial sector in 2014. It should be noted that thermal energy is substantially consumed in the industrial sector, which according to the Malaysian Economy in Figures (MEIF) 2016 contributes substantially.

Energy demands increase very quickly and most energy projections forecasted that present global energy sources mainly depend on fossil fuels (Borges Neto, Carvalho, Carioca, & CanafÃstula, 2010; Hasanuzzaman et al., 2012). According to Malaysia Energy Statistics Handbook (MESH), 2015 and NEB 2014, the Malaysia's energy sources depends largely on fossil fuels (mainly natural gas about 64.22% and crude oil 30.08%) as shown in Figure 1.5 (ST, 2014, 2015). This figure also shows that the total primary energy production by fuel type were 98,236ktoe in the year of 2014 compared to 60,642ktoe in 1993. Energy consumption significantly increased by about 61.99% for the last 21 years (i.e. from 1993 to 2014).

Figure 1.5 Primary production by fuel type, 1993 and 2014



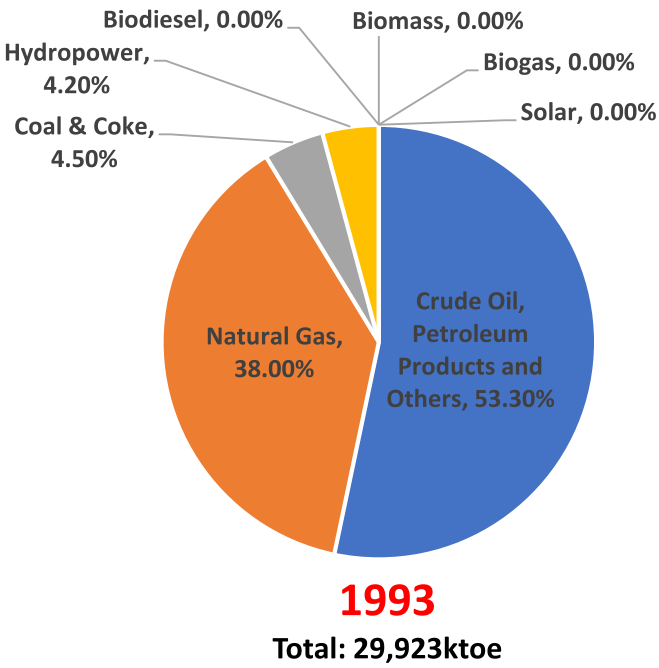
Source: Energy Commission, 2014

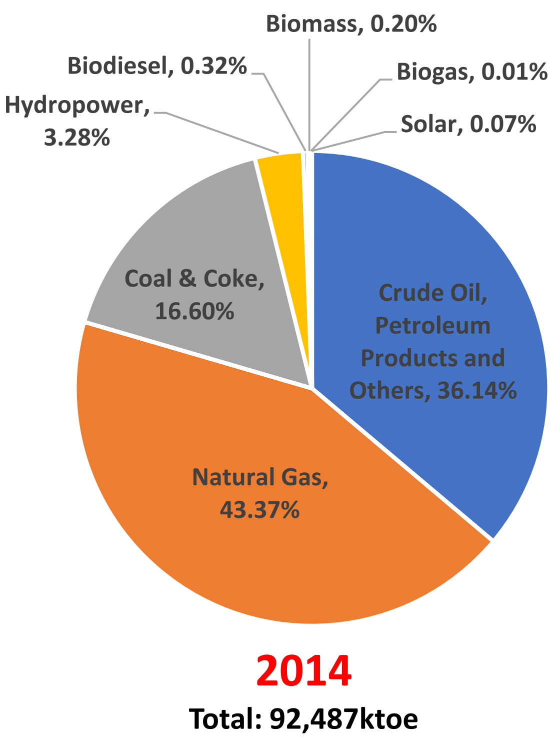


Source: Energy Commission, 2014

Figure 1.6 shows that the total primary energy supplies (TPES) by fuel type also depends largely on fossil fuels (e.g. natural gas 43.37%, crude oil 36.14%, coal and coke 16.60%) (ST, 2015). This figure also shows that the total energy supply was 92,487ktoe in the year of 2014 compared to 29,923ktoe in the year of 1993 in Malaysia. Energy supply increased about 209.08% for the last 21 years (i.e. from 1993 to 2014). Figure 1.7 shows the final energy consumption by fuel type (e.g. petroleum products 56.54%, natural gas 18.47%, coal and coke 3.27%) (ST, 2014, 2015). This figure also shows that the total energy consumption was 52,209ktoe in 2013 compared to 17,728ktoe in 1993. Obviously, energy consumption increased about 194.50% for the last 21 years (i.e. from 1993 to 2014).

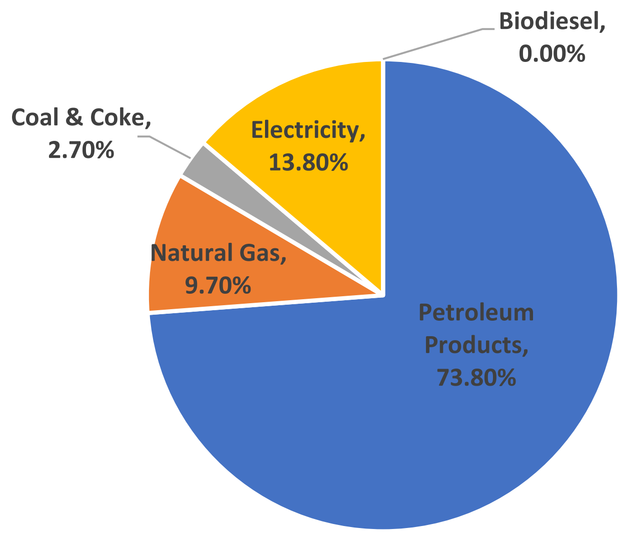
Figure 1.6 Total primary energy supplies by fuel type, 1993 and 2014



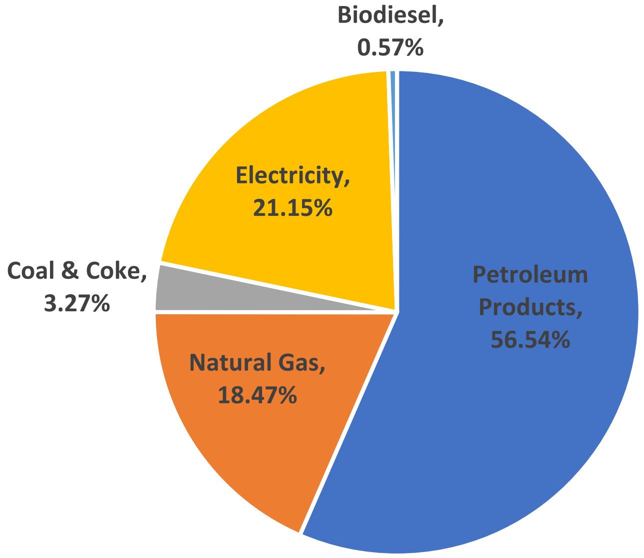


Source: Energy Commission, 2015

Figure 1.7 Final energy consumption by fuel type, 1993 and 2014



1993
Total: 17,728ktoe

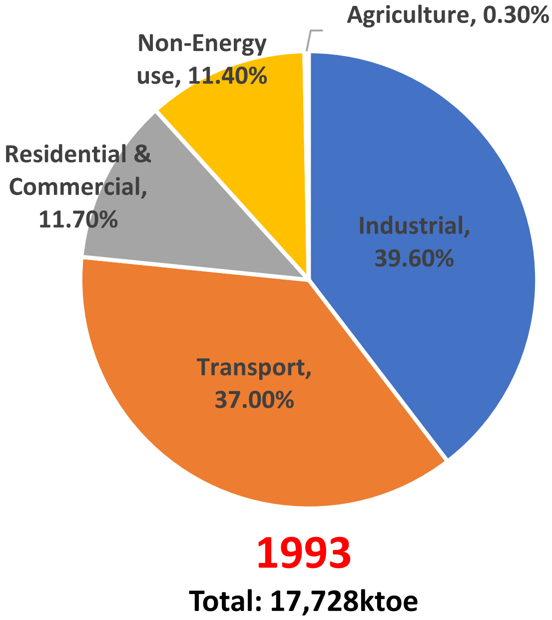


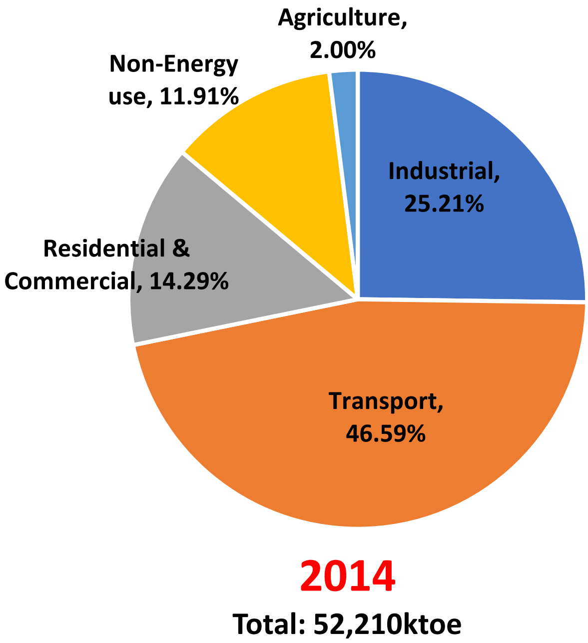
2014
Total: 52,209ktoe

Source: Energy Commission, 2015

Figure 1.8 shows the final energy consumption by sector (ST, 2014, 2015). Transportation sector is the major energy consumer in Malaysia that consume about 47% of total energy. This figure also shows that the energy consumption of transportation sector increases to 47% in 2014 compared to 37% in 1993.

Figure 1.8 Final energy consumption by different sectors, 1993 and 2014





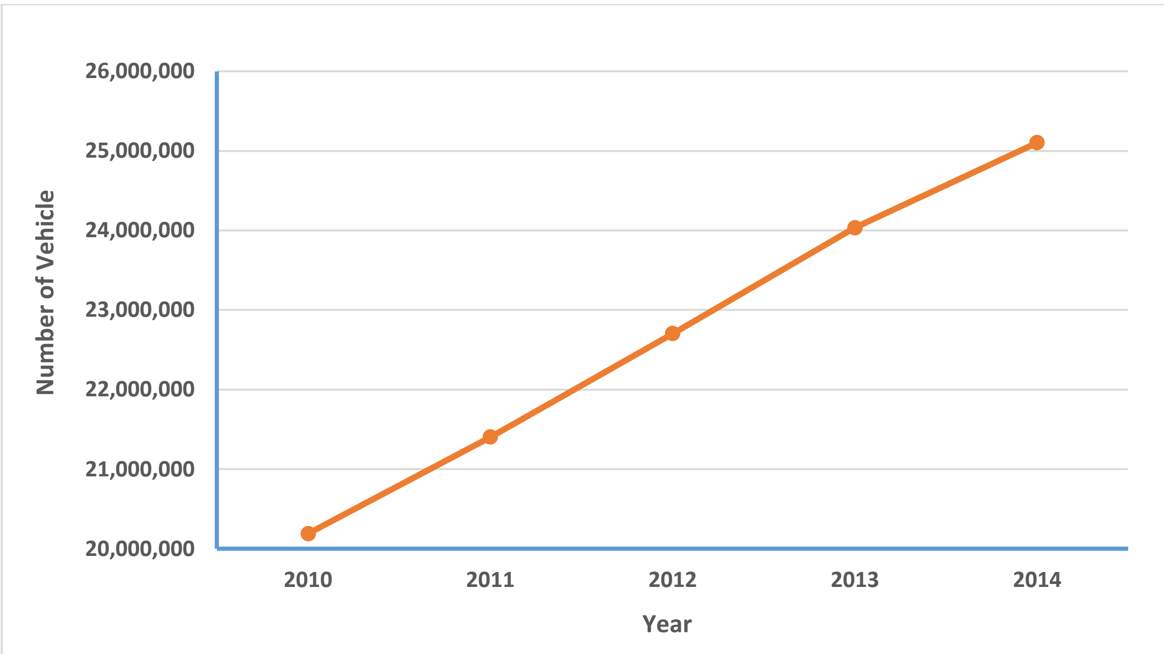
Source: Energy Commission, 2015

Figure 1.8 also shows that final energy consumption by transportation sector was about 46.59% in 2014. Academy of Sciences Malaysia (ASM) reported that the growth in transport sector and its energy usage are strongly dependant on the economic and population growth (ASM, 2014). The increase in both GDP and population are the main factors behind the increased number of vehicles, especially Light Duty Vehicles (LDVs) (Sabeen, Anwar, & Noor, 2012).

ASM in the report mentioned that transportation is an induced demand of the need to move people and goods from one (1) place to another to fulfil social and economic activities (Rahim *et al.,* 2014). Transportation forms one (1) of the backbones for economic growth as it enables trade while technological advancements in transportation play a major factor in globalisation. Although transportation trend can differ significantly between locations, a certain pattern can be seen between the social and economic growth, provision of transport infrastructure to accommodate this growth and the resulting preferred transportation choice of the general population.

The transportation and paved roads have narrowed the gap between rural and urban life as well as radically changed city life by accelerating the outward expansion of population into the suburbs (Colorado, 2016). The total length of roads in Malaysia was approximately 66,445km in 2000 and 155,427km in 2011 with the increase of 133%. That contributed to the increase of transport energy use (MNRE, 2016). Figure 1.9 shows the total number of vehicles on the road were 20,188,565 and 25,101,192 units for the year of 2010 and 2014 respectively where the annual increasing rate is about 5% (MOT, 2014).

Figure 1.9 Number of vehicles on the road in Malaysia, 2010 to 2014

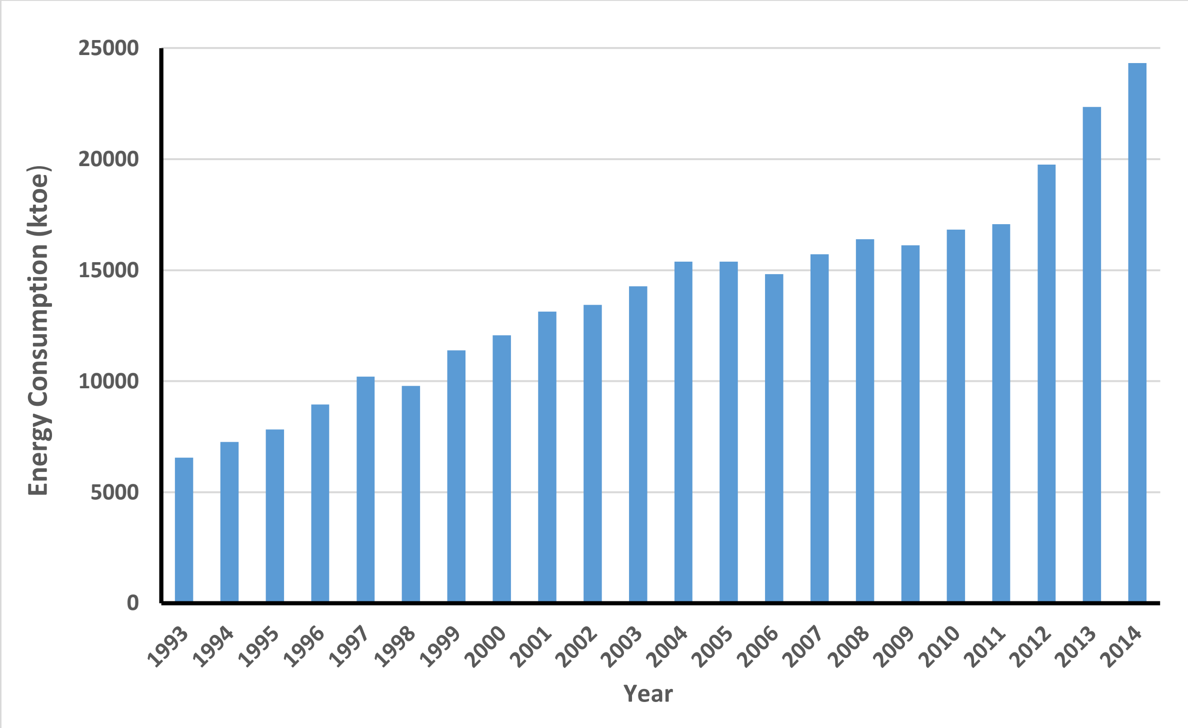


Source: Ministry of Transport Malaysia, 2014

The availability of reasonably priced vehicles by local manufacturers has also been major factor contributing towards the high rates of motorisation in Malaysia. The registration of vehicles (cars and motorcycles) has increased almost three-fold from 4.7 million in 1990 to 25.1 million in 2014 (MOT, 2014; SPAD, 2012). In 2014 there were 664,335 and 541,387 newly registered cars and motorcycles respectively.

Figure 1.10 shows the energy consumption for transportation sector in Malaysia from year 1993 to year 2014. In 2014, the final consumption of transportation sector was 24,327ktoe and this represents 46.60% of total final energy consumption.

Figure 1.10 Energy consumption by transportation sector in Malaysia, 1993 - 2014

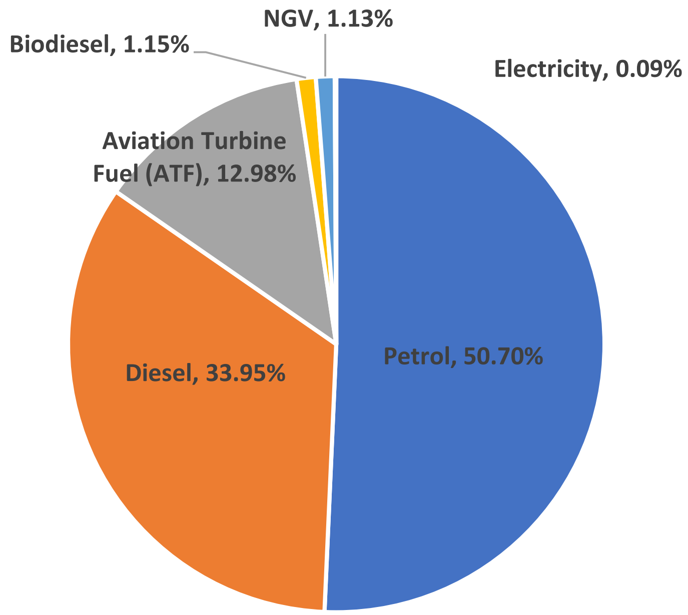


Source: Energy Commission, 2014

Figure 1.11 shows the transportation sector energy consumption by sources for 2014 (ST, 2014). The major source of energy use in the transportation sector are as follows:

- Petrol 50.70%
- Diesel 33.95%
- Aviation Turbine Fuel (ATF) 12.98%
- Biodiesel 1.15%
- NGV 1.13%
- Electricity 0.09%

Figure 1.11 Transportation sector energy consumption by sources, 2014

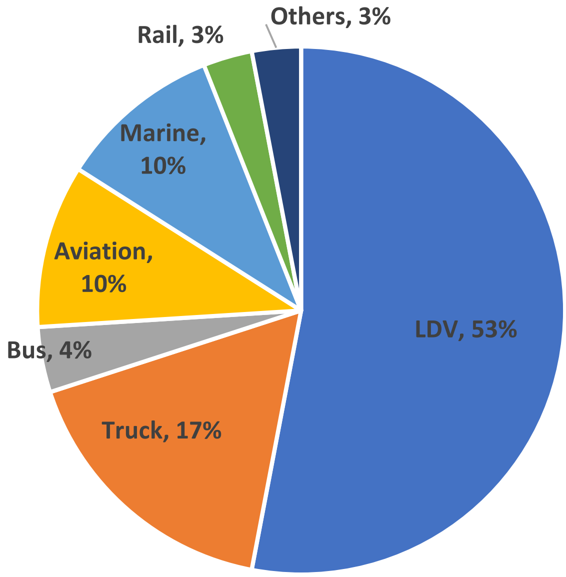


Source: Energy Commission, 2014

The sales of passenger and commercial vehicles in 2013 increased by 3.90% (i.e. from 627,753 in 2012 to 652,120 in 2013) due to economic growth between 4% to 5%, competitively priced models as well as increase of consumers' purchasing capability (MITI, 2014; ASM, 2014). The road transport is still the dominant mode of transport and carried about 94% of passengers and 96.40% of freight respectively (ASM, 2014).

The United Nations estimated the world's average annual population growth rate to be 0.90% and world's population will be at about 9.2 billion by 2050. The increase in both GDP and population growth resulted in the increase of vehicle's ownership particularly LDV and energy consumption in road transport. Figure 1.12 shows the transport energy consumption by mode for year 2010 whereby LDV is the major energy consumer for transportation sector with the total energy consumption of 53% (IEA, 2014b).

Figure 1.12 Transport energy consumption by mode, 2010



Source: International Energy Agency, 2014

The carbon dioxide (CO_2) emission shows an increasing trend for all the modes of transport with the increase of 184.90% over the last two (2) decades (ASM, 2014). Malaysia Airlines Bhd. (MAB) Group worked on the environmental impact and carbon footprint of 5.46 million tonne of CO_2 was found. This incorporated fuel burn for ground and groups aircraft energy consumption (diesel, electricity and gas etc.) at all the Malaysian centres of Group - Subang, KLIA, Miri, Penang, Kuching, and Kota Kinabalu (MASB, 2012).

The transport sector makes up about considerable amount of emission and demand of energy in Malaysia. Thus, the setup of public transport and initiatives is essential to reduce private vehicles usage on the highway and hence lessening pollutants. National Land Public Transport Master Plan (2012 - 2030) was introduced following the establishment of *Suruhanjaya Pengangkutan Awam Darat* (SPAD) for management of the rise of private vehicles and promotion of integrated planning of public transportation.

Biennial Update Report (BUR) aims at a 40% increase in the urban public transport share by 2030. The improvement of the public transport modal share was recorded as 16.90% in 2010 to 18.10% in 2014, whereas passenger ridership in the morning enhanced to number of 799,992 in 2014 in the area of Greater Kuala Lumpur/Klang Valley region (MNRE, 2016). According to the National Automotive Policy (NAP), the government intends to grow and enhance the competitiveness of the domestic automotive industry by handling structural concerns, for example low economies of scale, low utilisation of technologies, high production cost, human capital development and non-optimised supply chain that is not aligned to the requirement of the industry (MITI, 2014).

Furthermore, the government focuses to emerge as the regional hub for energy efficient vehicles (EEV) by means of proper investment strategies along with adaptation of innovative technology for domestic market and to penetrate regional and global markets by 2020. EEVs are able to meet the set of specifications such as fuel consumption (L/km) as well as carbon emission (CO_2/km), which is global practice. Vehicles such as hybrid, electric vehicles (EVs), fuel-efficient internal combustion engine (ICE) vehicles, and alternative fuelled vehicles such as Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Hydrogen, Biodiesel, Ethanol and Fuel Cell, are categorised as EEV vehicles. The EEV technical specification for fuel consumption is as in the following Tables 1.5 and 1.6 respectively.

The NAP 2014 was announced under targeted approach that focuses on EEVs. The focus on EEV will streamline the efforts of industry players, research institutes and government initiatives towards product and process technologies that are relevant to global trends of future power trains, fuel consumption patterns and emission requirement. The EEV penetration in Malaysia for 2014 was at 8.01% from overall Total Industry Volume (TIV) which represented 53,402 vehicles and 2015 was 32.60% (217,335 vehicles). The government strategy to introduce EEV and the gaining momentum in terms of the volume will directly reduce carbon and utilise lesser energy (MITI, 2016).

Table 1.5 Fuel consumption for passenger and commercial vehicles

Segment	Description	Car Weight (kg)	Fuel Consumption (L/100km)
A	Micro Car	<800	4.5
	City Car	800-1,000	5.0
B	Super Mini Car	1,001-1,250	6.0
C	Small Family Car	1,251-1,400	6.5
D	Large Family Car	1,401-1,550	7.0
	Compact Executive Car		

Segment	Description	Car Weight (kg)	Fuel Consumption (L/100km)
E	Executive Car	1,550-1,800	9.5
F	Luxury Car	1,801-2,050	11.0
J	Large 4*4	2,051-2,350	11.5
Others	Others	2,351-2,500	12.0

Source: Malaysia International Trade and Industry, 2014

Table 1.6 Fuel consumption for two (2) wheelers

Engine Size (cc)	Fuel Consumption (L/100km)
50-100	2.0
101-150	2.2
151-200	2.5
201-250	3.0

Source: Malaysia International Trade and Industry, 2014

The specific commitment of the government to use of EEVs for public transport was boosted by the reduction of 40.96ktonne CO_2eq emission achieved in 2013. Investing in public transport such as Mass Rapid Transit (MRT) in Greater Kuala Lumpur/Klang Valley and bus services in other state cities will be in the form of 40% public transport modal share in Greater Kuala Lumpur/Klang Valley and 20% in other cities. There is a need to improve inter-state and inter-city transport connections for reliability, convenience and availability (MNRE, 2016).

Kuala Lumpur, Penang and Johor will be targeted for expansion in the National Physical Plan 2 (NPP2), 2010. About six (6) million additional people will live in cities between 2010 and 2020 as estimated by The National Urbanisation Policy (NUP). NUP further indicates that 75% rate of urbanisation or 20.9 million people would occupy cities in 2020 that will further leverage the benefits of the public transport system. There should be proper connection between roads and railways for better multimodal transport which will form an integrated national transportation system. The incorporation of Bus Rapid Transit (BRT), Light Rapid Transit (LRT) and MRT routes must be undertaken in metropolitan areas such as Kuala Lumpur, Johor Bahru, Kuantan, George Town, Kuching and Kota Kinablau which connect stations to nearby areas for development of high-density residential and commercial markets.

The Government's plan to increase public transport modal share from its current 20% to 60% by 2020 is to reduce the dependence on private vehicles and congestion and to mitigate carbon emission from road transport. Malaysia has an extensive public transport network with over 173,000 vehicles and annually emitting about 7.07Mt CO_2. It is reported that about 65,000 diesel-fuelled buses also emit 5.8Mt CO_2 annually (The Star, 2016). To overcome this emission problem, the Government has overseen several projects to increase the effectiveness and sustainability of public transport, including restructuring bus routes, introducing novel ride sharing programmes, extending the LRT and Keretapi Tanah Melayu (KTM), Electric Train Service (ETS) lines as well as constructing the new fully electric MRT project, potentially reducing carbon emission by over 17,000tCO_2/100km.

2.0 PROJECT OVERVIEW

It has been recognised that DSM is a viable tool to manage and control the rising demand of energy, to delay the construction of new power plants, to reduce GHG emission and to prolong the depleting period of the resources. Such measures and initiatives have not been specific to energy use and are essentially on an ad-hoc basis.

2.1 Project Scope

2.1.1 Electrical Energy

The electrical energy is defined to cover electricity consumption by industrial, commercial and residential sectors. In this DSM master plan preparation, the electrical energy scope is confined to the following activities:

- To conduct preliminary energy baseline study on DSM via review and gap analysis against the NEEAP implementation document and other related documents; and
- To prepare a framework for the implementation of DSM initiatives with targets to be specified and effective measures for the implementation of a long-term DSM programme in Malaysia that is expected to be rolled out and covered in 12th and 13th Malaysia Plans.

The key activities to be executed throughout the study period are as follows:

- To conduct workshops with key stakeholders;
- To coordinate and facilitate the discussion with working group members, comprising major consumer groups representatives, and soliciting their feedbacks and inputs to this DSM study;
- To collect and validate the relevant statistical data from individual resource persons and other stakeholders.

2.1.2 Thermal Energy

The DSM preliminary study will investigate the current baselines in the national thermal energy consumption, identify scope and the relevant areas and finally to develop the comprehensive terms of references and consultancy document in the form of a complete tender document in line with the Government of Malaysia's format for the full DSM study to be conducted at a later stage.

The scope of the thermal energy sector in the DSM study shall cover the fuel energy and RE usage by the industrial and commercial sectors including but not limited to drying, heating and cooling purposes covering cogeneration and trigeneration, and their respective EE indicators where applicable.

2.1.3 Transport Energy Use

The DSM preliminary study will investigate the current baselines in the national transport energy consumption, identify scope and the relevant areas and finally to develop the comprehensive terms of references and consultancy document in the form of a complete tender document in line with the Government of Malaysia's format for the comprehensive DSM study to be conducted at a later stage.

The scope of the preliminary study covers land, water and air transportation that may include moving transportation system such as public transport, mass transport, commercial transport (for freight and logistics) and private vehicles but these are by no means exhaustive. However, the scope does not cover static and infrastructure transportation systems.

2.2 Project Objectives and Outcomes

The summary of overall project objectives and expected outcomes is outlined in the following Table 2.1

Table 2.1 DSM preliminary study objectives and outcomes

Outcome	Expected Output	Key Activities
Outcome 1: **Baseline Studies on DSM related initiatives**	• Stock take key findings and recommendations from past and existing studies, policies and roadmaps related to energy as well as energy policy planning and governance; • Analysis of Energy Demand and Supply: • Assess energy development in Malaysia through analysis on energy demand and supply by sectors and fuel type as well as other energy sources; • Review all existing national energy policies especially those with regards to DSM; • Review all existing national data monitoring, reporting and verification (MRV) system and identifying gaps for main DSM data requirements; and • Support to the strengthening UN's SE4ALL and SDG7 agenda.	• Workshops for the stock take and baseline setting and identifying current gaps and loopholes in policies and other existing energy related studies; • Workshops for demand/supply trends and consumptions patterns; • Workshops for data gathering • Individual resource person's data gathering activities and engagement with other stakeholders; and • Individual resource person's data gathering activities and engagement with other stakeholders.
Outcome 2: **Identification of Focus and Boundary Setting**	• Produce a preliminary study report that suggest scope of work in detail, disaggregated at the sectors and sub-sectors level; • Identification of focus areas disaggregated at the sectors and sub-sectors level; and • Set the boundaries for a comprehensive DSM study in Malaysia.	• Workshops for the sectors / sub-sectors scope of work and focus areas; and • Identify areas with data issues.

Outcome	Expected Output	Key Activities
Outcome 3: Results Framework and Activities for Full Study	• Mechanism and TOR for full DSM study • List of key stakeholders for full study • Preliminary institutional framework for main DSM study; • Timeline and milestones of execution of the main study; and • Tender document for the main study.	Conduct workshops to: • Design the TOR, framework and milestones for the main DSM study; • Identifying key stakeholders for the main DSM study; and • Prepare a proposed framework mechanism for the main DSM study.

2.2.1 Electrical Energy

The main deliverable of the study is a comprehensive and detailed report consisting of the proposed policy, action plan and its monitoring mechanism.

In addition to the above, this DSM study also take into consideration the above mentioned strategies to develop a comprehensive policy that will ultimately benefit the country socially and economically. Among the benefits are:

- Incentives that reflect acceptable costs;
- Establishment of appropriate institutional and regulatory frameworks;
- Use of complementary instruments (supporting measures);
- Regular collaboration between the public and private sectors;
- Good planning, regular review and strengthening and proper enforcement of regulations;
- Coordination at all government levels;
- Integration of EE concerns in other policies; and
- Post-evaluation of implemented measures and monitoring of their impacts.

The study findings and recommendations are further described in Section 7.1, Section 8.1.1, Section 8.2.1 and Section 9.1 of this report.

2.2.2 Thermal Energy

The project aims to provide a baseline understanding of the current state of energy demand side of Malaysia. The targeted outcomes are baseline studies on DSM initiatives, focus and boundary setting as well as detailed TOR and framework activities for a comprehensive DSM study. The study findings are further presented through the Outcome 1, Outcome 2 and an outline of the TORs for Outcome 3 in Section 7.2, Section 8.2.2 and Section 9.2 of this report.

2.2.3 Transport Energy Use

The project aims to provide a baseline understanding of the current state of energy demand side of Malaysia. The targeted outcomes are baseline studies on DSM initiatives, focus and boundary setting as well as detailed TOR and framework activities for a comprehensive DSM study. The study findings are further presented through the Outcome 1, Outcome 2 and an outline of the TORs for Outcome 3 in Section 7.3, Section 8.2.3 and Section 9.3 of this report.

3.0 PROJECT METHODOLOGY AND KEY ACTIVITIES

3.1 Project Methodology

The methodology to conduct this study is as follows:

- Similar approach has been adopted in data gathering from various agencies for electrical and thermal energy as well as transport energy use (i.e. workshops, direct engagement with agencies, data collections format/table, and desktop research).

- The identified organisations which are appointed as members in respective working group (WG) are listed in Appendix D. Members are to provide consultative inputs and recommendations related to energy data and other related matters to this DSM preliminary study. The working groups were led by the consultant appointed by UNDP and EPU for each group.

- The data collection covered the period 2005 to 2014 from various stakeholders for all three (3) sectors.

- A total of five (5) workshops with stakeholders have been conducted from the end of June 2016 until February 2017. Details of the workshop and participating stakeholders are provided in the attached Appendix D.

3.1.1 Electrical Energy

The methodology and activities conducted in the study are outlined as follows:

- To revisit and analyse key findings and recommendations from past and existing studies, policies and roadmaps related to electrical energy as well as energy related policy planning and governance and implementation such as the NEEMP Study document by KeTTHA (2009-2010), NEEAP, BSEEP, ETP etc.
- Consultations with related stakeholders involved with previous and existing studies and implementation programmes through workshops and meetings.
- To review all existing national electrical energy data, MRV system and identifying gaps for main DSM data requirements;

- To review strategic DSM initiatives development and implementation at model countries and based on recommended international practices for potential adoption with changes to meet the localised requirements;
- To analyse energy demand and supply growth trends for electrical energy;
- To assess energy development in Malaysia through analysis on electrical energy demand and supply by various sectors and fuel type as well as other energy sources;
- To stocktake and review existing legal provisions pertaining to the adoption of standards for best practices in industrial and building sectors; and
- To prepare a DSM implementation framework with the key thrusts, strategies, EE initiatives with energy consumption reduction target expected for each initiative.

3.1.2 Thermal Energy

The project methodology and activities conducted are summarised as follows:

- Conduct workshops to engage stakeholders for the following deliberations:
  - To identify key stakeholders and confirmation of TOR;
  - To establish the scope of the thermal energy;
  - To identify sectors and sub-sectors which consume thermal energy and consolidate the classification of industrial sub-sectors in accordance with the Malaysian Standard Industrial Classification 2008 (MSIC 2008) as recommended by DOSM;
  - To stocktake and baseline setting, and identifying current gaps and loopholes in policies;
  - To collect and review all existing thermal energy data MRV system and identifying gaps for main DSM data requirements;
  - To establish the boundary and focus areas of thermal energy;
  - To identify sources of thermal energy;
  - To establish data collection formats;
  - To identify potential providers of data;
  - To review and consolidate all data and information gathered; and
  - To conduct in-depth analysis of the aggregated data and information available.
- To conduct dialogue and briefings with industrial sector stakeholders such as manufacturers on data collection;
- To conduct survey in agencies/departments;
- To conduct joint review of data analysis with stakeholders;

- To share post-workshop information and materials with stakeholders.
- To propose a schedule of activities, milestones and deliverables to be conducted with the necessary details of topics, content, venue and time;
- To review strategic DSM initiatives, development and implementation in model countries for potential adoption to meet the localised requirements;
- To review all existing international and national energy policies related to thermal energy especially related to DSM; and
- To develop the baseline studies, scope & boundary, framework and activities for comprehensive study.

3.1.3 Transport Energy Use

The project methodology and activities conducted are summarised as follows:

- Conduct workshops to engage stakeholders for the following deliberations:
  - To identify key stakeholders and confirmation of TOR;
  - To identify transport classification, types and fuel use of transport sector, information and data requirements;
  - To review past and existing information, policies and roadmaps related to transport DSM;
  - To stocktake and baseline setting, and identifying current gaps and loopholes in policies;
  - To review all existing transport energy use data MRV system and identifying gaps for main DSM data requirements;
  - To establish the boundary and focus areas of transport energy use;
  - To establish data collection formats;
  - To identify potential providers of data;
  - To review and consolidate all data and information gathered; and
  - To conduct in-depth analysis of the aggregated data and information available.

- To conduct dialogue briefings with industrial sector stakeholders such as manufacturers on data collection;
- To conduct survey in agencies/departments;
- To conduct joint review of data analysis with stakeholders;
- To share post-workshop information and materials with stakeholders.

- To propose a schedule of activities, milestones and deliverables to be conducted with the necessary details of topics, content, venue and time;
- To review strategic DSM initiatives, development and implementation in model countries for potential adoption to meet the localised requirements;
- To analyse fuel consumption, CO_2 emission in various transport sectors and fuel type as well as other energy sources in Malaysia;
- To review all existing international and national energy policies related to transportation sector especially related to DSM; and
- To develop the baseline studies, scope and boundary, framework and activities for the full study.

The consultant for each sector has allocated research resources to identify and compile a list of relevant documents, working in close consultation with EPU and other stakeholders. The said list has been established and will obtain the listed documents with assistance from working group members as some of the documents lie with other agencies and/or ministry.

To enhance the effectiveness and successful review, the consultant has established the assessment focus and requirements based on the following criteria:

- Identify key findings from the various studies and reports;
- A structure and guideline to the analysis and assessment;
- A recognition of direct and indirect factors that have shaped certain development and performance of the study, i.e. the enabling factors;
- Identification and extraction/collection of primary and secondary data;
- Quality assurance of the analysis assessment; and
- Communication and engagement with all stakeholders in the study.

3.2 Deliverables

The project team and consultants have performed tasks based on expected outcomes and key activities that have been outlined in the project document approved by the Government of Malaysia and UNDP. There tasks are as stated below:

3.2.1 Electrical Energy

The main deliverable of the study is a framework for DSM programmes implementation and consisting of the proposed initiatives with goals and targets, action plan period and its MRV system. This shall incorporate at least the following:

- EE goals and targets with timeline for short, medium and long-term;
- Strategies and mechanisms to set and achieve EE targets;
- The assessment of selected strategies and plans to meet targets (revised, if necessary);
- Impacts from achieving EE goals and targets based on proposed programmes and initiatives;
- List of strategies and plans to achieve targets and their resource needs for prioritisation / short-listing (or acceptance);
- Proposed institutional framework for DSM implementation
- Legal and regulatory framework for effective EE initiatives implementation; and
- Proposed funding options and sourcing mechanisms.

3.2.2 Thermal Energy

Study Finding 1: Baseline studies on DSM related initiatives

- To gather information on the key findings and recommendations from past and existing studies, policies and roadmaps related to energy as well as energy policy planning and governance; Template as in Appendix B will be used for collecting baseline information;
- To conduct the analysis of energy demand and supply in Malaysia for the sector;
- To assess energy development in Malaysia through analysis on energy demand and supply by sectors and fuel type as well as other energy sources;
- To review all existing national energy related policies especially those with regards to DSM;
- To review all existing national data monitoring, reporting and verification system and identifying gaps for main DSM data requirements; and
- Support to the strengthening of United Nation's SE4ALL and SDG7 agenda.

Study Finding 2: Identification of focus and boundary setting

- Produce a preliminary study report that suggest scope of work in detail, disaggregated at the sectors and sub-sectors level; and
- Identification of focus areas disaggregated at the sectors and sub-sectors level and set the boundaries for a comprehensive DSM study in Malaysia.

Study Finding 3: Results framework and activities for the comprehensive and full DSM study

- Mechanism and Terms of Reference;
- List of key stakeholders;
- Preliminary institutional framework;
- Timeline and milestones for the execution; and
- The detailed tender document.

3.2.3 Transport Energy Use

Study Finding 1: Baseline studies on DSM related initiatives

- To gather information on the key findings and recommendations from past and existing studies, policies and roadmaps related to energy as well as energy policy planning and governance. Template as in Appendix B will be used for collecting baseline information;
- To conduct the analysis on energy demand and supply in Malaysia for the sector;
- To assess energy development in Malaysia through analysis on energy demand and supply by sectors and fuel type as well as other energy sources;
- To review all existing national energy related policies especially those with regards to DSM; and
- To review all existing national data monitoring, reporting and verification system and identifying gaps for main DSM data requirements.

Study Finding 2: Identification of focus and boundary setting

- Produce a preliminary study report that suggest scope of work in detail, disaggregated at the sectors and sub-sectors level; and
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Study Finding 3: Results framework and activities for the comprehensive and full DSM study

- Mechanism and Terms of Reference;
- List of key stakeholders;
- Preliminary institutional framework;
- Timeline and milestones for the execution; and
- The detailed tender document.

3.2.4 Project Report

The consultants submit reports as per the project schedule, as summarised in the table below:

Report	Submission	Content of Report
Contract Awarded	June - May 2017	Signing of contractual agreement between consultants and UNDP.
Inception report	30 June 2016	Methodology and timeframe of activities
Interim Report	14 October 2016	Progress report and preliminary findings
Draft Final Report	15 Feb 2017	Detailed recommendations.
Final Report	30 April 2017	Final recommendations based on the agreed scopes and intended objectives.
Detailed Tender Document	30 May 2017	Specifications for DSM detailed study for thermal energy and transport energy use.

The reports will also be submitted according to the format and other requirements of EPU and UNDP.

3.3 Key Activities

The key activities executed throughout the study period are as follows:

- To conduct workshops with key stakeholders for the working group formed for each sector
- To perform individual resource person's data gathering activities and engagements with other stakeholders; and
- To organise and invite DSM experts team from Japan, Thailand and Denmark through EPU to the workshops or seminars for information and experience sharing sessions.

4.0 LITERATURE REVIEW

4.1 Electrical Energy

In the past 10 years, many of EE initiatives had been undertaken by the Government of Malaysia. Some of these initiatives were supported by UNDP, Japan External Trade Organisation, Energy Conservation Centre of Japan (ECCJ) and the Danish International Development Agency. Those initiatives have led to capacity building in various aspects of EE in the country. It has also increased the awareness on EE among stakeholders, the private sector and energy users at large.

The benefits of DSM and Energy Efficiency and Conservation (EE&C) are paramount to the nation's economy and performance in tandem with the management of the environment. Improving EE will lead to significant cost savings and thereby improving competitiveness. EE&C activities will also help to conserve the usage and exploitation of the nation's limited natural resources while at the same time reduce the negative environmental impacts. The initiatives also paved the way for the enactment and formulation of EE regulatory instruments for some selected industries in the country.

From the past EE activities, there were two (2) important DSM initiatives plan that has been formulated and prepared to address the EE and utilisation issues for the nation. The initiatives plan are as follows:

4.1.1 Major past and current EE initiatives

i) The National Energy Efficiency Master Plan Study

The NEEMP study was commenced in 2009 and ended in 2010. The main objective of the study is to prepare the comprehensive master plan to optimise energy consumption against economic growth in three (3) main electrical energy using sectors namely industrial, commercial and residential. Based on the findings of the study, the NEEMP draft document prescribed a path towards improving the EE by pursuing the implementation of measures that are considered low hanging fruits and measures but require big capital investments, as they are viable for the nation as well as the end users.

The draft plan builds on the experiences from past projects and programmes, which have been implemented by various institutions and agencies, but are lacking a coherent framework to ensure sustainability in the longer term. It presents the instruments for a successful implementation of EE in Malaysia for the period between 2011 and 2020, which will address and mitigate barriers identified in the study.

Based on the findings of the study, there are several challenges which prevent a wide-spread adoption of energy efficient practices in the Malaysia which are:

- **Unavailability of Overall Policy and National Level Plan for EE Implementation for All Energy Using Sectors**

  EE has been a part of the every 5-year Malaysia development plan since the 8th Malaysia Plan (8MP) but there has not been any national road map or master plan for the implementation of EE policy. However, the selected EE activities are driven by relatively individual short-term projects, without a clear coordination among the activities and a clear medium and long-term objective.

  There is also no systematic and holistic approach in DSM and EE implementation in the country. Currently the aim to ensure sufficient supply in generation, resulting in continuous construction of new power plants to meet the increasing demand. Unfortunately, we have not integrated the potential impacts from DSM in the overall electricity capacity planning framework. This is not a wise strategy as many countries around the world have embarked seriously on DSM and benefits from such initiatives.

  Most of the time, the EE initiatives done as a stop gap measure and for short-term periods which are not sustainable in the long-term. Many initiatives are undertaken by various government agencies and associations and are not coordinated. Currently, the government when planning for power requirement for the country put a lot of concern on supply side management but very limited concern and resources for DSM.

- **Lack of Legal and Regulatory Framework for Energy Efficiency**

  The laws and regulations for the energy sector are mostly directed towards supply of electricity and safety in the use of electrical energy. Currently there are no overall laws or elements in the existing laws which demand EE to be considered within the electricity sector. The ST has enforced the Efficient Management of Electrical Energy Regulations (EMEER) 2008 as an initial start for efficient use of electrical energy. However, the regulations are limited to electrical energy only and for those installations which are using 3 million kWh and above in 6 months and are deemed as intensive energy users.

In the absence of thermal and transport energy regulations, users of thermal and transport energy have no legal obligation to comply with requirements for efficient utilisation of energy resources, and thus efforts to promote EE have therefore been confined to voluntary activities.

Since there is no legal framework to place the responsibility for EE within the government, there is also no avenue to provide the necessary powers to government agencies to implement mandatory EE initiatives.

- **Lack of Champion to Drive Energy Efficiency**

  EE has been implemented by many agencies and institutions on their own individual efforts. However, there has not been a clear authority to oversee ensuring EE play a pivotal role in the nation's energy planning. The supply planning is still very much based on meeting capacity requirements and thus other agenda like EE and DSM have not been given considerable attention.

  It is very important to have a dedicated and empowered entity to drive EE efforts in Malaysia. The entity would be tasked to enforce the laws and regulations relating to EE, engage all stakeholders and oversee all issues and activities related to EE in medium and long-term.

- **Low Energy Prices**

  The Malaysian electricity supply industry needs to ensure electricity prices are affordable to industrial, commercial and residential consumers and as such, the electricity and fuel prices have been kept below the actual cost of energy generation with the existing fuel subsidies. The total subsidy provided by the government for electricity generation in 2009 alone was at RM19 billion. The energy prices in Malaysia are relatively low compared to neighbouring countries such as the Philippines and Singapore where the prices are reflecting the market prices.

  Our energy prices are also relatively very low compared to developed countries where the energy prices are at the market prices and subjected to various taxes too. The low energy prices have prevented efforts on EE as energy users have been a less concerned about the energy costs. Therefore, many types of EE investments are not being seen viable as the returns in terms of energy cost savings are less attractive.

- **Lack of Sustainable Funding and Financing**

The funding for EE implementation by the government has been limited and mainly allocated for initiatives by respective ministry and agency or on project to project basis. Funding in terms of grants and rebates for energy efficient technologies will allow consumers to choose high efficient technologies to be adopted. There have been some fiscal incentives provided, however there have been very limited financial support from financial institutions for investments in large-scale EE projects implementation.

As energy, efficient technologies carry higher capital cost than inefficient technologies, this increases the investment burden for any party who is interested to do so. Coupled with relatively low electricity and energy prices, most of the energy users choose the least efficient technologies to avoid spending more.

There is no dedicated budget for a continuous promotion of EE and creating awareness at specified period where impacts can be monitored and assessed. The incentives given in the past are purely fiscal incentives in terms of tax and duty rebates and have proven to be quite cumbersome and difficult to obtain due to their long processes and involvement of multiple parties.

At the same time, there have been very limited financial institutions which are willing to provide loans to EE projects with conditions that suit the business models and nature of the industry players such as Energy Service Companies (ESCOs). The financial institutions currently are not in favour of financing EE businesses and therefore the dedicated financing for EE from commercial lending institutions need to be increased.

Loans for EE projects are normally given based on collaterals from the applying companies and not on the projects feasibility. Similarly, there are no loan schemes for EE for individual consumers, and the finance institutions will normally recommend traditional loan schemes such as term loans, credit card loans, if an individual wish to purchase energy efficient appliances.

The lack of understanding and awareness about investment potentials among decision makers in public and private sectors have been the major hurdles in EE implementation.

- **Lack of Consistency and Continuity in EE Programmes**

  Most of the efforts on promoting EE have been on project basis with limited time frame. Although, these projects have contributed to the capacity development in various institutions and some resulted in successful implementation of EE initiatives, however the activities have slowed down or discontinued after the project funding ended. The lack of a continuous annual government budget for EE activities has created a situation where activities have been fully dependent on funding availability. This has led to short-term initiatives which have been not sustainable

ii) The National Energy Efficiency Action Plan

The NEEAP document has been approved by the government in 2015, outlined the strategy for the implementation of EE measures in the industrial, commercial and residential sectors. This is expected to reduce energy consumption and economic savings for the consumers and the nation. The NEEAP also highlighted almost the identical barriers from the NEEMP study can be categorised as:

- Low energy prices;
- Lack of finance for EE;
- Lack of overall national plan for EE;
- Lack of champion to drive EE; and
- Lack of consistency in embarking on EE.

Therefore, the NEEAP presents the instruments for a comprehensive implementation of EE strategic initiatives for the period of 2016 to 2025. The Plan will address and mitigate identified barriers with sufficient funding allocated by the government. The lack of understanding and awareness about investment potentials among decision makers in public and private sectors have also been the major hurdles in EE implementation.

iii) The Building Sector Energy Efficiency Project

This is a national project, supported by UNDP and funded by GEF (in line with the its climate change strategic programme), with the Public Works Department (JKR), an agency under the Ministry of Works as the implementing entity of the project. The project is on Promoting EE in Residential and Commercial Buildings to reduce the growth rate of GHG emission from the building sector in Malaysia. It comprises of activities aimed at improving EE and promoting the widespread adoption of energy efficient building technologies and practices in the Malaysian commercial and residential sectors. The BSEEP project comprises five (5) specific Components to address EE for commercial and residential sector buildings as follows:

- Component 1: Institutional Capacity Development
- Component 2: Policy Development and Regulatory Frameworks
- Component 3: EE Financing Capacity Improvements
- Component 4: Information and Awareness Enhancement
- Component 5: Building EE Demonstrations

The expected outcomes of the BSEEP are as follows:

- Clear and effective system of monitoring and improving the energy performance of the buildings sector;
- Implementation of, and compliance with, favourable policies that encourage the application of EE technologies in the country's buildings sector;
- Availability of financial and institutional support for the adoption of initiatives on EE building technology applications;
- Enhanced awareness of the government, public and the buildings sector on EE building technology applications; and
- Improved confidence in the feasibility, performance, energy, environmental and economic benefits of EE building technology applications leading to the replication of the EE technology application demonstrations.

The BSEEP project is nearing its end (due in mid-2017) and is stated to have achieved most of its objectives, except for the completion of the "Demonstration Projects" under Component 5. Some of the projects have started physical construction but may not be ready before the project itself is completed.

iv) Electricity Supply Act 1990 and the Electricity Supply Act (Amendment) 2001

The main purpose of the Act is to regulate the electricity supply industry. The Act also has provisions on efficient use of electricity as follows:

- Section 23A: The Minister may, from time to time, prescribe the standards, specifications, practices and measures to be adopted and any other matters in respect of the efficient use of electricity;
- Section 23B: No person shall use or operate any installation unless the installation meets such requirements as may be prescribed in respect of the efficient use of electricity; and

- Section 23C: No person shall manufacture, import, sell or offer for sale or lease any equipment unless the equipment meets such requirements as may be prescribed in respect of the efficient use of electricity.

v) Centre for Education and Training in Renewable Energy, Energy Efficiency and Green Technology

Centre for Education and Training in Renewable Energy, Energy Efficiency and Green Technology (CETREE&GT) is in the campus of Universiti Sains Malaysia, Pulau Pinang which primarily focuses to increase awareness on EE and RE among school children and students. The centre has developed curricula for primary and secondary schools and assisted universities in incorporating EE into courses. The centre has organised events for schools on EE and RE and reached out to their targeted groups through exhibition vans and bus visits to schools all over Malaysia. The projects that have been carried out so far are as follows:

- Empowering master teachers in the methodology and implementation of RE and EE across curriculum through action research;
- Working closely with state education department in equipping teachers to roll out the RE & EE curriculum programmes;
- Incorporating RE and EE modules and materials in mathematics, languages and science;
- Producing the refined modules and aids for use in 8,500 primary schools in Malaysia; and
- Pre and post survey to selected primary school teachers on knowledge, attitude and practice (KAP) as feedback mechanism.

vi) Malaysian Industrial EE Improvement Project (2000 - 2007)

This project was aimed at promoting EE within the industrial sector. The project focused on energy auditing of industrial facilities, demonstration projects, rating of high efficient equipment and increase awareness among industrial consumers on EE. This project started in 2000 and was officially completed in 2007. Initially, this project only focused on eight (8) energy intensive industries namely wood, rubber, food, ceramics, glass, pulp and paper, iron and steel and cement. During project implementation, another three (3) sub-sectors namely plastics, textile and oleo-chemical industries were added. It was expected at the end of the project that Malaysia will have a good foundation for continuous efforts to capture EE potentials within the industrial sector. In addition, a total of 54 energy audits were also completed for energy intensive industrial facilities to identify EE investment potentials for Malaysia then.

The project also produced two (2) manuals on EE and conservation guidelines for Malaysian industries which were:

- Part 1: Electrical Energy-Use Equipment; and
- Part 2: Thermal Energy-Use Equipment.

Despite the low energy prices, the MIEEIP had, to a certain extent, managed to demonstrate the feasibility of energy saving measures and convince decision makers in industrial sector as well as financial institutions to get involved in EE&C projects.

vii) Energy Efficient Demonstration Buildings

The government has constructed three (3) energy efficient buildings to serve as model buildings which could be replicated by the construction industry. The buildings are:

- Low Energy Office (LEO) – first public building with EE features integrated into the building design. This building which houses KeTTHA has a Building Energy Index (BEI) of 100kWh/m^2 a year;

- Green Energy Office (GEO) – the building where the MGTC is located is a demonstration building designed with energy efficient features, generating RE from photovoltaic PV systems and utilising water from a rainwater harvesting system. The building is designed to have BEI as low as 65kWh/m^2 a year. GEO Building is the first building to be certified using the Green Building Index (GBI) rating tool; and

- Diamond Building – the building that houses ST is the sequel to LEO and GEO with greater efficiency and green features. It is the state-of-the-art green building and has a BEI of 85kWh/m^2 a year. This building has obtained the GBI Platinum and Green Mark Platinum certifications.

viii) The Green Technology Financing Scheme

In January 2010, the government launched the Green Technology Financing Scheme (GTFS) with the allocation of RM1.5 billion to support investment in green technology projects in Malaysia which includes EE initiatives. Through the scheme, the Government will bear 2% of the total interest rate. In addition, the Government will provide a guarantee of 60% on the financing amount via Credit Guarantee Corporation Malaysia Bhd, with the remaining 40% financing risk to be borne by participating financial institutions. The scheme should benefit companies who are producers and users of green technology. This fund has been extended to the allocation of RM5 billion as announced by the government in March 2017.

ix) Fiscal Incentives for EE and Green Buildings

The government has introduced several fiscal incentives since early 2000s to promote EE projects and the purchase of energy efficient equipment by businesses as follows:

Companies providing energy conservation services

- Pioneer Status (PS) with tax exemption of 100% of statutory income for 10 years; and
- Investment Tax Allowance (ITA) of 100% on qualifying capital expenditure incurred within a period of five (5) years.

Companies which incur capital expenditure for energy conservation for own consumption

- ITA of 100% on qualifying capital for expenditure incurred in energy conservation projects implemented within a period of five (5) years.

Companies importing energy efficient equipment for third party usage

- Import duty and sales tax exemption on energy efficient equipment such as high efficiency motors and insulation materials to importers including authorised agents approved by ST.

Sales tax exemption

- Sales tax exemption on the purchase of locally manufactured energy efficient consumer goods such as refrigerators, air conditioners, lightings, fans and televisions.

Owners of buildings awarded with the Green Building Index certificate

- Tax exemption equivalent to 100% of the additional capital expenditure incurred to obtain the GBI certificate.

Buyers of buildings and residential properties awarded with the GBI certificate bought from real property developers

- Stamp duty exemption on instruments of transfer of ownership for GBI-rated buildings.

x) Efficient Management of Electrical Energy Regulations 2008

The Regulation was gazetted on 15 December 2008. This has been an initial legal instrument being enforced to ensure management of energy intensive installations are in place. The Regulation requires the owner of any installation consuming three (3) million kWh or more over a period of six (6) consecutive months to appoint a Registered Electrical Energy Manager (REEM) and to submit reports to ST on their efficient energy management programmes in every six (6) months.

xi) Introduction of Minimum Energy Performance Standard and Mandatory Star Rating Energy Label

MEPS and Star Energy Label were introduced by ST for refrigerators in 2005 on voluntary basis through a nation-wide promotion campaign. Subsequently rating and labelling have been extended to fans, televisions, air conditioners, refrigerators and lamps. This labelling programme is now mandatory for these appliances.

Industrial equipment such as high efficiency motors have also been rated and labelled under the same programme. Appliances were labelled in a scale of 1-to-5 stars where the greater value of star it gets, the better it is in terms of EE. Appliances which qualify for 5-star will be endorsed with an endorsement label.

xii) Energy Audit Conditional Grant for Government, Commercial and Industrial Buildings

Under the 11th Malaysia Plan (11MP): Malaysia allocated RM165 million for the duration of the 11MP to provide Energy Audit Grants for the following specific initiatives:

- Energy Audit and Management for Industrial Sector (Energy Audit Conditional Grant);
- Energy Audit and Management for Commercial Sector (Energy Audit Conditional Grant); and
- Energy Audit, Management and Retrofit for Government Sector.

SEDA and ST as the implementing agencies have embarked on the energy audit conditional grant activities for commercial buildings under 11MP. The project duration takes three (3) years to complete and to commence from 2016 to 2018. This energy audit is a systematic process to understand how and where the energy being used, explore on how to manage it and identify the energy cost savings potential. The grant is opened to any commercial buildings which are using electricity more than 100,000kWh per month.

4.1.2 Energy Efficiency Initiatives in Developing Countries

For countries in Southeast Asia, ASEAN Centre for Energy (ACE) was setup in 1986 to address the energy issues within ASEAN region. It has viewed EE as the most cost-effective way of enhancing energy security and in addressing climate change and promoting competitiveness in energy usage. ASEAN Member States have been following a deliberate policy of diversifying primary energy resources and using energy sources efficiently. The Energy Efficiency and Conservation Sub Sector Network is responsible for the coordination of ASEAN's collective efforts on EE towards its target of reduction in energy intensity. Some outcome based programme strategies have been carried out as follows:

- Harmonisation and promotion of EE standards and labelling on various kinds of energy-related products especially targeted products of air conditioning and lighting;
- Enhancing private sector participation including ESCOs for EE&C promotion;
- Developing green building codes which support the use of high energy efficient products; and
- Enhance the participation of financial institutions in EE&C development.

During the 32nd ASEAN Ministers on Energy Meeting held on 23rd September 2014 in Vientiane, Lao PDR, endorsed the theme of the new ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 as *"Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability for All"*. Under this ASEAN Plan, energy efficiency and conservation is one of the focus area for continually leading the efforts in the efforts in the region to achieve the aspirational goal of reducing energy intensity in ASEAN by 20% by 2020 as a medium-term target and 30% by 2025 as a long-term target based on the 2005 levels.

For Malaysia, the total final energy consumption was 49.68Mtoe and the electricity generation of 147.461TWh with installed capacity of 29.76GW for year 2014 under ACE Energy Database System. Some research also has been carried out in other countries on development in the DSM implementation area by EE research group under Copenhagen

Centre on EE: Accelerating EE: Initiatives and Opportunities - Southeast Asia and the outcomes are summarised as follows:

(i) Indonesia

Initiative	Title	Details	Sectoral Coverage
Policies	Instruction on Central and Regional Government to implement EE&C 10/2005	Implementing EE in government offices (lighting, air conditioning, electrical equipment, official vehicles) and buildings.	Building
	Procedure for EE&C Implementation	Regulating EE measures in government offices, households, commercial buildings, industries, transportation and other activities.	All Sectors
	National Action Plan for Reducing Green- house Gas Emission (RAN-GRK) 61/2011	The plan aims to achieve a 26% reduction in GHG emission below the BAU level by 2020, based on unilateral actions, and a further reduction of up to 41% below BAU if adequate international support were made available to the government. The activities to reduce GHG emission will include, among others, the conservation and efficient management of energy.	All Sectors
	National Energy Policy (2003-2020)	This policy includes an action plan targeting EE&C e.g. increasing use of energy-saving appliances and equipment standards and labelling in the household and commercial sectors; promoting co- generation and introducing DSM in industry; and applying EE standards to motor vehicles.	Industrial, Commercial and domestic
	Energy Conservation (30/2007)	This stipulates that EE&C is the responsibility of all energy users and that incentives will be offered to efficient users and to producers of efficient appliances	All Sectors
Programmes	Environmental Support Programme	Supported by Denmark's Development Co-operation (DANIDA), this programme is in its third phase. It has three (3) main components that	All Sectors

Initiative	Title	Details	Sectoral Coverage
		target improving the environmental performance of the country. Measures include support to the national and regional levels of government in implementing and monitoring EE, energy conservation and RE.	
	Public–Private Partnership (PPP) Programme on Energy Conservation	This programme is a government-funded energy audit programme that is available to industries and commercial buildings. Participating industries and commercial buildings are required to implement the recommended energy-saving measures identified in the energy audit.	Building, Commercial and industries
	Energy-efficient lighting programme in the residential sector	This is primarily a DSM building, programme. This programme provides subsidies, residential and in certain cases, free Compact Fluorescent Light (CFLs) to eligible households.	Building, residential
	Sustainable Tourism through EE with Adaptation and Mitigation Measures (STREAM).	This project aims to strengthen local structures for the sustainability of Pangandaran, a popular tourist destination in Indonesia. Measures include, among others, the adoption of an EE approach in all tourist services.	Commercial
	Promoting EE in the Industries through System Optimisation and Energy Management Standards	Supported by UNIDO, this programme targets four (4) priority industrial sectors, i.e. textiles and garments, pulp and paper, foods and beverages, and chemicals. The programme aims to achieve EE in the industrial sector through capacity- building in both skills development and improvements in financial capacity.	Industrial

Source: Copenhagen Centre on Energy Efficiency, 2015

(ii) Vietnam

Initiative	Title	Details	Sectoral Coverage
Policies	Vietnam Power Development Plan (2011-2020)	The Vietnam Power Development Plan (Power Master Plan VII) 2011 - 2020 provides a clear and measurable target for a 2030 vision for country's power development. It sets out six (6) directions and four (4) targets and the plan puts strong emphasis on energy security, EE, RE development and power market liberalisation. The targets, in relation to improving EE, include reducing the average energy elasticity ratio from the current 2.0 to 1.5 in 2015 and 1.0 in 2020.	All Sectors
	National Energy Efficiency Programme	The Vietnam Energy Efficiency Programme (VNEEP) is a ten (10) year programme, approved in April 2006 by the Prime Minister of the Socialist Republic of Viet Nam. It is a targeted national programme and the first-ever comprehensive plan to implement measures for improving EE and conservation across all sectors of the Vietnamese economy. The overall aim of the programme is to make initial savings of 3–5% in 2006–2010 and a further 5–8% in 2011–2015.	All Sectors
Programmes	EE Promotion in the Building Sector	The United States Agency for Industrial Development (USAID) Vietnam Clean Energy Programme - Energy Efficiency Promotion in the Building Sector supports the Government of Vietnam's (GVN) Green Growth Strategy and related action plan. The project collaborates with the Ministry of Construction (MOC) to reduce electricity consumption in the country	Building

Initiative	Title	Details	Sectoral Coverage
		through improved EE in the building sector by implementing the Vietnam EE Building Code (VEEBC) and promoting a green building programme.	
	Vietnam Energy Efficiency Energy Efficiency and Cleaner Production Financing	Funded by the International Finance Corporation, the Vietnam Energy Efficiency and Cleaner Production (EECP) Financing Programme aims to reduce greenhouse gas emission and improve resource utilisation by increasing the financing available for cleaner production and energy EE investments. The project works with selected commercial banks to build market strategies and tailored financial products, and targets enterprises looking to upgrade their production systems and technologies to achieve greater energy EE, cost savings, productivity, and environmental performance.	Industry
	EE improvement project by World Bank (WB)	The State Bank of Vietnam and the WB signed a USD500 million loan for a USD731.25 million operations in support of Vietnam's energy sector. The investment will fund the construction of over 1,000 kilometres of transmission lines and implement smart grid technologies to improve the reliability and quality of electricity supply.	Power Sector

Source: Copenhagen Centre on Energy Efficiency, 201

(iii) Thailand

Initiative	Title	Details	Sectoral Coverage
Policies	High EE standard for equipment and machinery	This policy requires the supply market to offer energy efficient equipment and machinery through the implementation of standards and labelling programmes	Commercial
	Energy management in designated buildings in factories	About 2,800 buildings and 5,400 factories have Industrial been designated that are required to implement EE measures and submit an annual report to Department of Alternative Energy Development and Efficiency (DEDE) to demonstrate on-going improvement in EE.	Industrial
	Persons Responsible for Energy (PRE)	All companies that meet an energy consumption threshold are required to appoint staff to oversee commercial the development and management of EE programmes	Industrial and commercial
	Building energy code (upcoming)	This policy aims to introduce special building codes for new buildings to ensure efficient energy use. This policy is currently being developed.	Building
	Tax incentives	DEDE works with the Revenue Department to facilitate tax incentives for the purchase of EE products. It also cooperates with the Board of Investment (BOI) to exempt corporate income tax and import duties for EE purposes. This is done on *ad hoc* basis, and there is no on-going support.	Industry and commercial

Initiative	Title	Details	Sectoral Coverage
Programmes	Technical Assistance	The government provides support, through the Energy Conservation Promotion Fund, to a range of capacity-building activities, including seminar and training, demonstration projects on advanced technologies, in-depth energy audits for buildings and industries, establishing an energy display centre, and a practical training centre.	All Sectors
	Energy Efficiency Networking	Through a voluntary agreement with major corporates (such as the Thai Chamber of Commerce, the Federation of Thai Industry, commercial banks, etc.), the government develops PPP to strengthen EE promotional activities.	All Sectors
	Revolving fund	This fund supports energy investors concerning capital investments in EE and encourages commercial banks to include EE in their list of financial products. Following the success in creating a sustainable market, DEDE has now exited from this programme.	All Sectors
	Energy Management Audit	The government aims to develop an accreditation process for energy auditors to provide EE services to all sectors. This policy is currently being developed.	All Sectors
	Government co-investment programme - ESCO fund	The ESCO fund was created to allow access to financing for smaller businesses, which would otherwise be unable to obtain funding from commercial banks. Thailand now has an ESCO Association that allows networking among ESCOs.	Industrial

Source: Copenhagen Centre on Energy Efficiency, 2015

4.1.3 Energy Efficiency Initiatives in Developed Countries

i) Japan

Japan is one (1) of the most successful countries in implementing EE&C activities. In addition to having the lowest CO_2 emission in the world, Japan's EE&C efforts have been making a steady progress over the past 35 years. According to their Agency for Natural Resources and Energy, since 1973 the GDP of the nation has almost tripled (at the current point in time) while maintaining a monotonous trend in terms of its energy consumption in the industrial sector. This has aided in cementing Japan's leadership in setting EE&C trends for the rest of the world.

The Japanese have developed their own Energy Conservation Law (concerning the Rational Use of Energy) which offers specific criterion for business operators on using energy rationally. The Law also provides the necessary guidelines in preparing medium and long-term plans as well as the necessary criteria for construction and specific building industries on using energy rationally. They have also developed a "Top Runner" programme which details the criteria for specific equipment in pursuit of having more energy efficient electrical products in the market.

In terms of EE, measures are aimed at improving EE by more than 30% from early 70s to later 90s as well as to reduce the oil dependence level by less than 40% from of 50% over the same time frame. Both measures form the basis of the New National Energy Strategy for Japan.

In addition, Japan has market-based energy pricing policy. In terms of successful outcomes, Japan has could achieve a zero increase in energy consumption during the past 40 years, and currently has the lowest GDP energy intensity (primary energy supply per GDP) in the world and it is also a country with the lowest energy intensity in the various industrial sub-sectors in the world.

To promote the rational use of energy, Japan established the ECCJ. The ECCJ acts as a resource for technical advice to local governments. The ECCJ has also adopted a list of policies entitled the Fundamental Policies for Rational Use of Energy, which outlines various measures for builders, owners and local governments to encourage adoption of EE measures.

ECCJ undertake many of the administrative and management functions for the residential sector programmes in Japan, with responsibilities for:

- Energy conservation audits services for buildings;
- Ranking catalogue for energy efficient appliances;
- Promotion of energy labelling system;
- International Energy Star programme implementation; and
- Energy education at primary and middle schools.

In summary, it should be noted that thanks to the unique culture of Japan in traditional awareness for eliminating waste and desire to be internationally competitive due to poor mineral and oil resources in the country, EE&C measures were implemented quite voluntarily by industrialists without many disincentives. Japan's success stories encompass the enhancement of energy management at work site, wide and deep dissemination of EE equipment in industrial sector. The key success factors and mechanisms also cover the follows:

- Legislation of Energy Conservation Law and its progressive amendments to meet social needs;
- The provision of mandatory EE standards and criteria for factory operation and voluntary EE target reduction by 1% per annum under the EC&C law;
- Solid financial supporting system for EE equipment introduction and EE investments.
- Voluntary efforts by enterprises for enhanced energy management by introducing Total Quality Control, Total Productive Maintenance, Kaizen, Small Group Area, etc.; and
- Support by implementing agencies and institutions for people awareness and dissemination activities on EE&C.

ii) Denmark

Denmark's energy policy has targeted to reduce total energy consumption by 2% in 2011 and by 4% in 2020 compared with 2006 consumption and to increase the use of RE to 20% of gross energy consumption in 2011.

To ensure that the policy is adhered to, Denmark has put into place several legislative acts. The Finance Act has imposed an energy saving target on state owned institutions and aims to reduce energy consumption by 10% in 2011 as compared to 2006. Denmark's Design of

Energy Using Products Law covers standby and off modes for a range of products as well as introducing standards for appliances.

In terms of EE measures, Denmark has produced purchasing guidelines by the Danish Electricity Trust and this covers the purchasing of new equipment and components. Denmark has also developed an action plan for renewed energy conservation which aims for verifiable energy savings corresponding to an average of 2 billion kWh per year over the period 2006 - 2013. The country has also developed an EnMS which is a method to secure a constant improvement of the EE in a company as well as employing energy efficient design which ensures investments in new production facilities are optimised based on a total assessment of price and operating costs.

The EE measures employed by Denmark has had its success through the Green Town project where 6000 CFLs were installed in 600 homes resulting in saving the average household approximately USD730 over the life of the bulbs and reducing electricity consumption equivalent to providing enough power for 20 more homes. This effort has could reduce greenhouse gas emission equal to taking approximately 700 cars off the road for a year.

Denmark is one (1) of the biggest performers in Combined Heat and Power (CHP) production where about 50% of electricity is produced through CHP. Energy Investment Deduction (EID) which is a mechanism of tax deductible investment (up to 40% of investments) for energy efficient CHP installation.

In summary, due to the small industrial scale of the country, most of its EE efforts remain focused on the residential and commercial sectors such as in the Green Town Project highlighted above. In addition, there has been some mention of the Danish Energy Agency, the National Agency for Enterprise and Construction, The Electricity Savings Trust are among the main organisations in Denmark responsible for EE activities.

In Denmark, the relevant legislation is Promotion of Savings in Energy Consumption (Act no. 450 of 31 May 2000). The objective of the Act is to promote energy savings by consumers in accordance with environmental and economic considerations. The Act ensures energy-saving activities are prioritised, promotes cooperation and coordination in the implementation of the activities and further ensure consumers receive efficient and user-friendly advice concerning energy savings.

The Act is applicable towards enhancing efficiency and reduction of the use of energy in products, installations, processes and buildings, including installations for the buildings' own supply of energy. It is also applicable to means of transport to the extent that this appears from the Act or from rules laid down by the Minister for the Environment and Energy pursuant to the Act.

The Danish regulatory framework is supported by several organisations. These organisations are intended to support a market-oriented strategy and the initiatives described in their EE action plan. Some of the main organisations and its responsibilities are:

a. Danish Energy Authority

This agency is responsible for official tasks in all aspects of energy conservation. It is also responsible for legislation and regulation in this sector and for negotiations within the European Union (EU) including implementation and monitoring of EU directives on labelling and standards, research and development and several operational duties, such as about the energy labelling of buildings. Its official duties also include the setting up of a framework and the monitoring of the activities of electricity supply companies and the Electricity Savings Trust.

b. National Agency for Enterprise and Construction

The agency is responsible for several official, energy-related tasks in the construction sector. These duties include the energy provisions of the Building Regulations, regulations on individual metering of electricity, gas, water and heat, and regulations on efficiency in heat-producing systems.

c. The Electricity Savings Trust

The Electricity Savings Trust was established in 1996. It is mandated with efforts related to electric-heating conversion and the promotion of efficient electrical appliances etc., in households and in the public sector. As far as electric-heating conversion is concerned, the Trust awards grants and negotiates price agreements, etc. About the promotion of efficient electrical appliances, the Trust conducts campaigns, market influencing, voluntary agreements and transparency of electricity consumption.

d. Grid and distribution companies (electricity, gas and heat)

The companies are also entrusted with the responsibility to promote energy conservation among their consumers.

4.1.4 Southeast Asia Region: Common Identified EE Implementation Barriers

The Copenhagen Centre on EE based in Jakarta, Indonesia conducted an EE study in 2015 titled as Accelerating Energy Efficiency: Initiatives and Opportunities - Southeast Asia (UNEP, 2015). It identified similar common barriers to EE interventions which have been observed throughout Southeast Asia countries and covered a wide spectrum, including policy, institutional, technical, financial and social aspects. Two (2) barriers that have been found to be common in all countries area lack of interest by the top management of companies and factories to agree on EE investment and a lack of awareness about EE technologies and the benefits they can offer. While both issues are somewhat interconnected, the first one (1) is mainly due to the lack of knowledge that EE investment can make a good business case. Some barriers are country or industry specific, including:

- The low energy price (e.g. in Indonesia, Malaysia and Thailand) is a disincentive for the industries and companies to undertake EE measures;
- The lack of a regulatory framework (e.g. the Philippines) inhibits the wider implementation of EE measures;
- The absence of an appropriate institutional mechanism (e.g. the Philippines) to provide long-term support for EE implementation;
- Insufficient capacity of governments and private sectors (e.g. in Indonesia) to deliver EE projects and services;
- The lack of financial support to offset high capital investment for smaller companies (e.g. in Indonesia, the Philippines and Vietnam) to undertake EE measures; and
- The lack of quality testing infrastructures, (e.g. appliance and equipment testing laboratories in Indonesia and the Philippines) to implement standards and labelling programmes effectively.

To address the above barriers that have been identified and to reap the opportunities that exist in the priority sectors in the selected countries, the following actions were recommended:

- Provide targeted capacity-building for the top management;
- Support the development of a targeted, long-term and result-driven awareness programmes to increase knowledge about EE;
- Provide technical assistance with demonstrations projects of energy-efficient technologies;
- Support capacity building programmes to develop energy managers and energy auditors;

- Deliver capacity-building programmes for ESCOs;
- Provide financial support for EE projects implementation with capital investment;
- Provide capacity development for government employees;
- Establish quality testing infrastructures;
- Develop an enabling environment through supportive policy;
- Create a central repository entity of energy data and information on EE; and
- Develop holistic EE programmes for the commercial, industrial and residential sectors.

Based on the Asia Pacific Economic Cooperation (APEC) Energy Demand and Supply Outlook, sixth (6th) edition study in May 2016, Malaysia will reduce its energy intensity by 41% in 2035 under the BAU energy consumption, contributing to the APEC's-overall goal of 45% reduction in energy intensity. It could achieve a further 4.60% reduction under the DSM initiatives. Over the next five (5) years, setting a DSM master plan is a high priority for the government; this will further reduce energy intensity in the longer term.

Under the 11MP, the government has set various strategies and initiatives to improve the energy supply and demand portfolio. Executing such plans could be challenging, particularly if the plan lacks support from the sectors or if existing market distortions for energy is not addressed.

4.1.5 Outcomes of Sharing Experiences with Model Countries

The model countries like Denmark, Japan and Thailand, who have all successfully adopted EE and DSM measures for efficient management of their energy needs that they shared at the experience sharing workshop on 17th and 18th January 2017.

i) Common features of optimal electrical energy utilisation

A common feature reflected from the info sharing exercise is the impact & influence of some key institutional framework developments in the 3 countries concerned. These includes: -

- Absence of energy subsidies in the countries involved;
- Formulation of legislative enactments to manage & control all forms of energy use in the countries involved;
- Adequate, even 'lucrative' funding mechanisms to support the EE&C initiatives covered by the legislative framework;

- Finite assignment of responsibility to dedicated implementing agencies, according to the functions & regulatory management for the different energy use applications; and
- Apparently unrestricted "empowerment" of the implementing agencies concerned to access the required resources needed, in respect of competent personnel, necessary tools & relevant, even emerging, technologies required.

ii) Energy costs to consumers

Denmark

Denmark is a "resource-deprived" country, as regards its indigenous energy resources. It countered the energy cost escalation due to the 'oil shock' of the 1970s by pursuing fuel substitution, intensive EE&C initiatives and enhancing taxes on energy to discourage energy waste. Denmark also promoted diverse energy conservation, energy substitution and EE initiatives for all forms of energy use by supporting the consumers' investments with capital grants of up to 30%. The average electricity tariff to retail consumers is heavily taxed, and is about RM1.40 per kWh; hence any investment in EE initiatives becomes financially attractive to the users.

Japan

Like Denmark, Japan is an energy poor country about its indigenous energy resources and has not subsidised energy for its citizens. Japan was significantly affected by the economic impact of the 'oil shocks' of the 1970s, and this compelled it to pursue efficient use of energy (EE) to mitigate the energy cost burden on its economy. This resulted in the enactment of its "Act on the Rational Use of Energy".

Denmark and Japan also promoted energy conservation, energy substitution and EE initiatives for all forms of energy use by supporting the consumers' investments with substantial capital grants on capital investments by the consumers. Moreover, Japanese legislation mandates specified energy saving targets on "designated consumers" of 1% per annum on a moving 3-year basis.

The average electricity tariff to retail consumers is stated to be above RM1.00 per kWh; hence any investment in EE initiatives becomes financially attractive to the users.

Thailand

In Thailand, the Electricity Generating Authority of Thailand (EGAT) had executed the government policies relating to electricity use in the country. EGAT generates and transmits the electricity and distributes it to the consumers through the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).

EGAT was generally the government's policy implementing agency when it needed to pursue EE&C initiatives to counter the harsh economic impact of the oil shocks of the 1970s and 1980s. Electricity tariffs in Thailand were similar to those of its neighbours in ASEAN, unlike those of Japan or Denmark.

iii) Energy efficiency legislation and funding

Denmark

In Denmark, the Danish Energy Regulatory Authority (DERA) is independent of the government and discharges its responsibilities as stipulated in the supply acts for electricity, natural gas and heat, while the Danish Energy Agency (DEA) has been responsible for implementing the EE and related climate initiatives, among other tasks that it is responsible for.

The existing legislation provides for the allocation of funds for the operation of the agencies to discharge their obligations and permits DERA and DEA to implement the national aspirations for efficient use of energy in all fields. This includes the acquisition of the relevant energy use statistics for monitoring and assessment of their success with respect to the set targets.

The funding has been used successfully to promote the adoption of a wide range of EE&C initiatives that has contributed to Denmark having decoupled its GDP growth from its energy use, so much so that its GDP has grown by about 40% since 1990 while its energy use has reduced by about 8% and its GHG emission have reduced by about 33% during that period.

Japan

The serious economic impact of the 'oil shocks' of the 1970s compelled Japan to pursue efficient use of energy (EE) to mitigate the energy cost burden on its economy. This resulted in the enactment of its “Act on the Rational Use of Energy”, which has formed the bedrock of its policies and strategies for rational use of energy in all forms, i.e. for electricity, thermal energy and energy used for transport.

The act included defining “designated entities”, based on their overall energy use above a set value (including electricity and thermal energy) which were compelled to adopt EE&C measures through specific investments in EE machinery and appliances. These compulsory measures were supported with government grants and rebates of the order of 30% of the capital investment involved.

Since the first oil shock of the 1970s, Japan has managed to improve its overall EE by approximately 40% through effective actions by both the public and private sectors. Japan is currently one (1) of the most energy efficient countries in terms of energy intensity (i.e. the energy used to produce a unit of GDP).

Thailand

Thailand's legislation to reduce its import of energy resulted in the establishment of several independent regulatory agencies to promote EE&C in support of its DSM initiatives. The regulatory agencies established and empowered to discharge their specific functions include:

- EPPO – the Energy Policy and Planning Office;
- DEDE – the Department of Alternative Energy Development and Efficiency; and
- TISI – Thai Industrial Standards Institute.

Thailand developed policies & strategies for the adoption of EE&C initiatives from the early 1990s to develop and implement its First Demand Side Management (DSM) programme covering the period 1993 to 2000, with a budget of USD189 million. This was facilitated by the financial assistance it received from the Global Environment Facility (GEF) and the Government of Australia (GOA) in the form of a grant of USD15.5 million, and a concession loan from the Japan Bank for International Cooperation (JBIC) of USD25 million.

Thailand's legislation included the establishment of an “Energy Conservation (ENCON) Fund” on its petroleum product sales. Thailand used this fund, said to amount to about USD200 million a year, to finance its EE initiatives. This support included capital grants of up to 30% of the capital costs involved.

An additional, common incentive in all three (3) countries has been their governments' financial support to the “designated entities” to lessen the capital investment burden for the consumers' implementation of EE initiatives with rebates or grants of up to about a third of the capital cost for those initiatives.

iv) Dedicated implementing agencies

All three (3) countries that shared their experience had established dedicated implementing agencies that were made responsible for discharging their obligations in accordance with the legislative framework in the respective countries.

The agencies were independent of outside influence, but constrained by the legal provisions under which they operated. Their adequate and assured funding gave them the flexibility to plan, prioritise and implement the respective EE initiatives according to their cost-effectiveness in the disbursement of the public funds they are allocated.

The legislative foundation and the funding provisions enabled them to effectively adopt a "carrot and stick" mechanism to ensure achievement of their objectives. The grants and rebates that they could allocate made the implementation of the EE initiatives viable for the consumers concerned, thus giving the national economy a "competitive advantage" while also giving them bragging rights for their emission reductions.

A key element for their success was also the extensive awareness raising and technical advice to assist the designated consumers, as well as the public, to readily adopt the promotion efforts as they were seen to be practical and financially viable.

They had achieved substantial successes and had could monitor and report on their activities and the degree of success achieved. Such successes, and the cost-effectiveness of the initiatives implemented, had garnered sufficient confidence for the funding to be sustained.

It is assumed that the references to the legislative framework, sustained funding mechanism and the assignment of responsibility to a competent dedicated agency are taken "as a given". Malaysia has embarked on some ad-hoc EE&C activities and has taken specific actions over at least the last half decade.

These initiatives can be further strengthened by emulating activities as indicated by Denmark, Japan and Thailand. Among the key actions that can bring about 'quick successes' are:

- Promote cogeneration or trigeneration by eliminating the existing administrative constraints to its wider adoption to maximise the benefits from primary energy use, especially natural gas, for the larger industrial and commercial consumers;

- Expedite the extension of MEPS for a wider section of industrial equipment and consumer appliances. This should include the proposed HEPS (High Efficiency Performance Standards). Malaysia currently has only five (5) categories of appliances under MEPS, compared with 22 electrical appliances and 3 building materials that have an impact on electricity use for Japan, while Thailand has a total of 28 categories of equipment and appliances under MEPS or EE Labelling mechanism. Malaysia can consider adopting the Thai approved standards and labelling performance values for the appliances that have yet to be evaluated for Malaysia, as a move to expedite these rating criteria, as the appliances may be a part of ASEAN common standards in future, under the “ASEAN SHINE” proposal presented by the Thai Speaker at the DSM Workshop;

- Expedite the currently “protracted negotiations” to formalise standard EPC (Energy Service Performance Contracting) agreements for wider adoption of the EPC business in the country for both the public and private sectors. Currently, apparently only the Ministry of Health facilities have implemented EPC with MAESCO (Malaysian Association of ESCOs) member companies. The private sector entities are apparently reluctant to enter such EPC agreements as they are still uncertain of the legal issues on risks and responsibilities involved and would prefer to use standardised government approved agreements;

- Enable the designated implementing agency to develop 'Human Capital' and technical competency in the related technical fields for energy management and energy audits, not only to satisfy the regulatory requirements under EMEER, but also to create a talent pool for the larger users to call upon for preliminary or detailed audits and advice. Denmark, Japan and Thailand appear to have established “well-oiled” mechanisms to assist their 'designated entities' to get credible and authoritative advises for assessing the technical and financial viability of their prospective EE initiatives;

- Establish a more credible and interactive public sector – industry stakeholder engagement mechanism to emulate the successful Japanese mechanism to promote its “Top Runner” programme to achieve the desired efficiency enhancement targets for HEPS / MEPS or labelling of appliances. This engagement can help to establish a concrete roadmap for enhancing the target efficiency standards for such equipment over time. Nominally such standards need to be reviewed at least once every five (5) years to determine more challenging performance standards; and

- Establish not just adequate building codes, but also enforce those codes via all Local Authorities throughout the country. The UNDP/GEF supported BSEEP project has developed guidelines for passive EE building design, while the UBBL has now incorporated the provisions of the latest MS1525, but enforcement of their compliance is far from adequate. It must be noted that the building sector (both commercial and residential) consumes a significant share of electricity, with a large share for cooling, while the existing building stock has not been designed for adequate passive EE performance. This warrant intensive promotion of retro-fits for the enhancement of passive design in the existing building stock, even with capital grants or rebates to the extent that these incentives are cost-effective in themselves.

4.1.6 Key Lessons Learned

Based on above literature review and experiences shared by selected model countries, the following conclusions can be drawn:

- The findings from the NEEMP study, the NEEAP document and other studies and initiatives have been reviewed and almost the same barriers have been identified;
- Many EE initiatives that have been implemented successfully reduced the final energy consumption in three (3) sectors, commercial, industrial and residential;
- Southeast Asia countries have been facing the same common barriers identified as above and Malaysia has also encountered almost similar barriers; and
- Through the support of EE&C Law in place and dedicated EE&C agency to manage the EE activities with proper funding mechanisms in developing countries like Thailand and developed countries like Japan and Denmark are successful in implementing DSM.

4.2 Thermal Energy

Thermal energy consumption has not been monitored in details in Malaysia until 2013 when ST conducted a survey with 520 manufacturing companies in Peninsular Malaysia. This survey could provide an understanding of energy consumption (including thermal energy) pattern of the industrial sector but this survey was a one-time exercise for the 5-year period from 2010 till 2014. Therefore, information pertaining to DSM in thermal energy in Malaysia is limited, and lacks continuous monitoring, reporting and verification (MRV) programme.

Literature review on thermal energy would serve to provide background information of thermal energy scenarios both in Malaysia as well as other parts of the world. Literature review also provides an appreciation of potential low-carbon thermal energy technologies and applications, which can be explored further in the detailed DSM study.

4.2.1 World Energy Outlook 2015

The IEA's World Energy Outlook (WEO) 2015 report (IEA, 2015) emphasised on the energy sector transition that moves towards global action in tackling climate change. The central scenario of WEO 2015 (the New Policies Scenarios) contains cautious implementation of new and announced policies including the energy sector components of the climate pledges, which supports the greater adoption of low-carbon technologies and improved EE. EE improvements have helped restrain the growth in final energy demand in 2014 to just one-third of the level it would otherwise have been. The coverage of EE regulations in industry, buildings and transport has nearly doubled, rising from 14% of the world's energy consumption in 2005 to 27% in 2014.

4.2.2 Southeast Asia Outlook 2015

The IEA's Southeast Asia Outlook 2015 report (IEA, 2015) highlighted that it is important for Southeast Asia to focus on efficiency, accelerated removal of fossil-fuel subsidies and deployment of low-carbon technologies as these strategies can curb the rise in energy demand and GHG emission while delivering energy and environmental benefits without harming economic prospects. The report also highlighted the on-going changes for Malaysia's energy sector.

Malaysia's energy demand will almost double between 2013 and 2040, with rising contributions from all energy sources. The report also elaborated on Malaysia's role in international market shifts as the country becomes increasingly dependent on oil and coal imports, while natural gas exports fall back. Growing domestic needs and flattening production are set to reduce Malaysia's gas exports, which should decline to less than 10bcm by 2040. Malaysia's continued development will hinge on the strategic direction of its energy policy.

4.2.3 Cogeneration and District Energy

Cogeneration and district energy systems are sustainable energy technologies according to an IEA report (IEA, 2009). Cogeneration is also known as CHP and district energy systems represent a proven, cost-effective and clean solution for delivering electricity, heating and cooling. CHP and district energy can be used as a tool to meet broader energy and environmental objectives. Since more than 70% of fuel energy is consumed in the industrial processes in Malaysia, CHP and district heating and cooling (DHC) could be the potential technologies to be explored for greater adoption as a strategic measure to benefit from such proven technologies. However, it is recognised that there are barriers in the country for these technologies to be widely adopted. The key to unlocking this potential lies in the thorough investigation, development and implementation of effective policies.

It is noted that district cooling is more applicable to the hot and humid climate in the country but for industrial applications, heating may be a common requirement depending on the types of industrial processes. Nevertheless, CHP and DHC represent a series of proven, reliable and cost-effective technologies which are known to have been making an important contribution to meeting heat and electricity demand in many countries in the world. Due to their enhanced energy supply efficiency and use of waste heat and low-carbon RE sources, CHP and DHC are already important parts of many national and regional GHG emission reduction strategies. IEA have highlighted the energy, economic and environmental benefits of CHP and DHC. This report also provided the "best practice" CHP policy development pathway. Refer to Appendix H for the illustration diagram of CHP policy development pathway.

Cogeneration for the convenience of classification may be subdivided into two (2) generic groups:

- Combined Heat and Power (CHP), and
- Combined Cooling and Power (CCP)

A third generic cogeneration group, which is a combination of the above two (2) classifications, is Combined Heat, Cooling and Power (CHCP), otherwise known as trigeneration.

4.2.4 Energy outlook and energy saving potential in East Asia 2016

The Economic Research Institute for ASEAN and East Asia (ERIA) published some findings (Kimura & Phoumin, 2016) of the Working Group members from the East Asia Summit (EAS) countries, which comprise of the ten (10) ASEAN member countries, viz. Brunei, Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam, and six (6) other countries, viz. Australia, China, India, Japan, South Korea and New Zealand. In the Summit, Malaysia was represented by ST. According to this report, fossil fuel energy consisting of coal, oil and gas will still be dominant in 2040 and its share under the BAU will be 84%. If EAS countries remain dedicated to implementing their EE and conservation policies and increase low-carbon energy technologies under the alternative policy scenario (APS), the EAS region could achieve fossil fuel savings of 23% and the fossil fuel share could fall to 76%. CO_2 emission would be reduced significantly thus.

The report also stated that under the BAU scenario, Malaysia's final energy consumption will increase from 55.29Mtoe in 2013 to 157.37Mtoe in 2040. The report also stated that oil will still dominate with 51.40% in 2040, followed by natural gas and electricity, both at 22.50% each in 2040.

Malaysia is endowed with abundant sunshine throughout the year. On the other hand, due to the hot and humid climatic conditions, urbanisation and improvement in the standard of living in Malaysia, the demand for thermal comfort is ever increasing. Thus, energy consumption for air conditioning in buildings takes up the largest share in the energy requirements in buildings.

This ERIA publication reports some interesting findings of a technical and economic study on solar thermal cooling that has been conducted. This study explores the indicative viability of harnessing solar energy to supplement generation of chilled water through both solar thermal and solar PV hybrid chiller systems.

Solar energy is harnessed in essentially two (2) ways for useful applications, namely 1) capturing light rays of solar energy through solar PV panels for electricity generation; 2) harnessing solar thermal energy through solar collectors to produce hot water for heating purposes and alternatively, for the generation of chilled water through absorption chillers for air-conditioning purposes. Solar PV electricity generation has been promoted and implemented in the region. Production of hot water through solar collectors for process heating and shower purposes has been well established in the region. However, production of hot water for generating chilled water for the air-conditioning systems in buildings has yet to be nurtured into market acceptance.

By comparison, solar PV electricity generation is relatively more straight-forward but only about 35% of the available solar energy is harnessed for the conversion to electricity while the remaining 65% is converted to the non-useful heating of the solar PV panels. On the other hand, solar thermal cooling system is capable of absorbing more than 95% of incident solar radiation, depending on the medium used in the system (WEC, 2007). Therefore, it may be worthwhile to consider harnessing solar thermal energy for the generation of chilled water.

In hot and humid climate, air-conditioning takes up the largest share of energy use in buildings. Solar air-conditioning facilities can reduce the peak load demand for electricity and this certainly reduces considerably the infrastructure costs, otherwise the transmission and distribution assets need to be sized to cater for the greater peak electricity demand. This will also result in significant reduction in GHG emission.

4.3 Transport Energy Use

4.3.1 International Energy Agency

International Energy Agency (IEA) has released an annual series of Global Fuel Economy Initiative (GFEI) working papers investigating the global fuel economy of newly registered light duty vehicles over time: the international Comparison of LDV Fuel Economy. The report included time-series of sales-weighted average, fuel-weighted average fuel economies for the years 2005 to 2013 for twenty-five (25) countries including, China, France, Germany, Japan, Malaysia, Thailand, United States etc.

This report covers information on economic and demographic characteristics, i.e. average income, geographic situation of each country under consideration, as well as information on the fuel economy policies and monitoring, changes in the average fuel economy with respect to country-specific LDV market structures, focusing in particular at vehicle specifications such as segmentation, weight, footprint, as well as engine and drive train technologies (IEA, 2016b).

The growth of fuel consumption and other characteristics of LDV vehicle dimensions, weight, fuel type, engine power, and displacement for new vehicle registrations from 2005 to 2013 for more than 20 countries have been studied in this report. This analysis gives insights on the points that influenced this evolution, accounting for the influence of the policy context (e.g. the presence of fuel economy regulations, vehicle and fuel taxation schemes) and average national income level.

Table 4.1 shows the summary of country-specified LDV market characteristics and fuel Economy Trends. The best measures of fuel economy and CO_2 emission can be found in France since it has stringent fuel economy regulations in place. France provides monetary incentives to buy fuel-efficient vehicles in the form of fee rebate schemes or vehicle taxation based on CO_2 emission per km. It also imposes high taxes on automotive fuels. The combination of these measures has effectively resulted in consumers choosing more fuel-efficient vehicles in each size class.

Table 4.1 Summary of country-specified LDV market characteristics and fuel economy trends

Country	France	Turkey	Germany	India	Japan	Thailand	South Africa	Brazil	Indonesia	Chile	China	Mexico	Russia	United States
Fuel Consumption (L/100 km)	5.5	5.8	6.3	6.3	6.3	7.7	7.9	8.2	8.2	8.3	8.5	8.7	8.6	9.4
CO_2 Emission ($g\ CO_2/km$)	<120	142	150	150	143	189	182	190	191	200	197	201	201	219

Source: International Energy Agency, 2016

Table 4.2 shows an overview of the impacts of methodological changes on global fuel economy developments from 2005 to 2013. The impacts of methodology changes on global fuel economy are markedly different between the OECD and non-OECD. The values are divided into without Light Commercial Vehicles (LCVs) based on New European Driving

Cycle (NEDC) and with LCVs based on WLTC. Without LCVs, in the OECD, the average annual improvement rate is -2.6%, compared with -0.2% for non-OECD. With LCVs, the average annual improvement rate is -2.2%, compared with -0.5% for non-OECD (IEA, 2016b).

Table 4.2 Impacts of methodological changes on global fuel economy developments, 2005 to 2013

			2005		2008		2011		2013	
Values published in IEA, 2014 with no LCVs, based on NEDC	OECD Average	average fuel economy (Lge/100 km)	8.6		7.9		7.3		6.9	
		annual improvement rate (% per year)		-2.7%		-2.6%		-2.6%		
						-2.6%				
	Non-OECD Average	average fuel economy (Lge/100 km)	7.3		7.4		7.3		7.2	
		annual improvement rate (% per year)		0.5%		-0.4%		-0.9%		
						-0.2%				
	Global Average	average fuel economy (Lge/100 km)	7.3		7.4		7.3		7.2	
		annual improvement rate (% per year)		-2.3%		-1.9%		-1.8%		
						-2.0%				
	GFEI target	average fuel economy (Lge/100 km)	**8.3**							**4.2**
		required annual improvement rate (% per year) 2005 base year					**-2.7%**			
		2014 base year					**-3.1%**			
			2005		2008		2011		2013	
Values published in Global Fuel Economy Developments including all LCVs, based on WLTC	OECD Average	average fuel economy (Lge/100 km)	8.9		8.4		7.8		7.5	
		annual improvement rate (% per year)		-2.1%		-2.5%		-1.9%		
						-2.2%				
	Non-OECD Average	average fuel economy (Lge/100 km)	8.5		8.5		8.4		8.2	
				- 0.1%		-0.4%		-1.2%		
		annual improvement rate (% per year)				**-0.5%**				
	Global Average	average fuel economy (Lge/100 km)	8.8		8.4		8.0		7.8	
		annual improvement rate (% per year)		-1.7%		-1.6%		-1.4%		
						-1.6%				
	GFEI target	average fuel economy (Lge/100 km)	**8.8**							**4.4**
		required annual improvement rate (% per year) 2005 base year					**-2.7%**			
		2014 base year					**-3.3%**			

Source: International Energy Agency, 2016.

Table 4.3 shows an average new LDV fuel economy by country normalised to the WLTC, 2005 to 2013. It reflects the standard inclusion of light commercial vehicles and pick-up trucks for 25 countries. The average engine power of new LDV sold in 2013 was 110kW. India had the lowest average engine power of 57kW while U.S average engines have almost three (3) times more power than India. For engine displacement, global average was almost 2.0 litres (L), the average Japanese car had an engine displacement slightly above 1.3L while U.S has an average of more than 3.0L.

Table 4.3 Average new LDV fuel economy by country normalised to the WLTC

Country	Average fuel economy 2013 (Lge/100 km, NEDC)	Average fuel economy 2013 (Lge/100 km, WLTC)	Average power 2013 (kW)	Average displacement 2013 (cm^2)	Average empty weight 2013 (kg)	Average footprint 2013 (m^2)
Argentina	7.1	7.9	-	1,689	1,285	3.9
Australia	8.0	8.8	128	2,344	1,570	4.2
Brazil	7.3	8.2	80	1,508	1,168	3.8
Canada	9.0	10.2	129	2,164	1,715	4.8
Chile	7.6	8.3	94	1,845	1,402	4.0
China	7.5	8.5	94	1,709	1,440	4.0
Egypt	7.4	8.2	62	1,639	1,337	4.1
France	5.1	5.4	80	1,592	1,352	4.1
Germany	5.8	6.3	100	1,754	1,453	4.2
India	5.8	6.3	57	1,355	1,110	3.5
Indonesia	7.4	8.3	78	1,568	1,237	3.8
Italy	5.3	5.7	76	1,507	1,281	3.9
Japan	5.5	6.1	73	1,311	1,167	3.5
Korea	5.7	6.3	120	1,936	1,517	4.2
Malaysia	6.9	7.7	-	1,606	1,228	3.9
Mexico	7.7	8.7	95	1,796	1,402	4.0
Peru	7.3	8.2	-	-	1,417	4.0
Philippines	8.0	9.1	-	-	1,527	4.1
Russia Federation	7.7	8.6	94	1,865	1,384	4.0
South Africa	7.0	7.7	96	1,899	1,491	4.1
Thailand	7.4	7.9	88	2,004	1,529	4.3
Turkey	5.5	5.8	79	1,546	1,356	4.1
Ukraine	7.1	7.8	-	1,796	1,411	4.0
United Kingdom	5.6	6.0	92	1,683	1,401	4.1
United States	8.4	9.4	173	3,069	1,812	4.5
OECD	6.7	7.5	128	2,283	1,559	4.2
Non-OECD	7.3	8.2	89	1,680	1,362	3.9
World	7.0	7.8	110	1,993	1,470	4.1

Source: International Energy Agency, 2016

Notes: Most efficient Light Duty Vehicle (< 6.0 L/100km), least efficient Light Duty Vehicle (≥ 8.0 L/100km)

Regional average engine power and displacement are markedly different between the OECD and non-OECD. In the non-OECD, the average new LDV engine is about 30% less powerful and 26% smaller in capacity than those in OECD. In terms of average weight and size, vehicles sold in non-OECD were about 12% lighter and 6% smaller compared to OECD countries.

4.3.2 Canadian's Vehicle Survey

Canadian Vehicle Survey was conducted in year 2008 by Natural Resources Canada (CNR, 2009). The working papers included the investigation on the average fuel consumption rate of newly registered LDV over time. The survey population consists of all motor vehicles such as light vehicles (car, vans, station wagon, Sport Utility Vehicles (SUV) and pickup truck), medium trucks (gross vehicle weight between 4.5 and 15ton) and heavy trucks (gross vehicle weight of 15ton and more) registered in Canada at any time in 2008 that have not been scrapped or salvaged. Buses (since 2004), motorcycles, off-road vehicles (e.g. snowmobiles) and special equipment (e.g. cranes, snowploughs) are excluded. The study covered age of vehicles, vehicle kilometres travelled, fuel consumption, geographic analysis, and types of vehicles.

4.3.3 Australia's Survey of motor vehicle use

In Australia, a study was conducted based on estimates from the 2014 Survey of Motor Vehicle Use (SMVU) that includes the statistics of passenger vehicles, motorcycles, trucks and buses (ABS, 2016). The data was collected by the Australian Bureau of Statistics (ABS) over the period from 1 November 2013 to 31 October 2014 which covers 8 states in Australia. The population is identified using information obtained from the State and Territory motor vehicle registration authorities, as a part of the annual ABS Motor Vehicle Census (MVC). Estimates from each of these samples are aggregated and adjusted for new motor vehicles and re-registrations of vehicles to produce an annual estimate.

Vehicles in scope of the SMVU are all vehicles that were registered with a motor vehicle registration authority for road use along the 12 months ending 30 June 2016. The SMVU did not consider caravans, trailers, tractors, plant and equipment, defence services vehicles, and vehicles with diplomatic or consular plates. Vehicles registered as vintage and veteran cars were also excluded. The SMVU gave estimates for total distance travelled, tonne-kilometres and total fuel consumption. Tonne-kilometres is the industry measure for the freight task. SMVU calculates this data using laden distance travelled for work purposes and average load weights as reported by respondents (ABS, 2016).

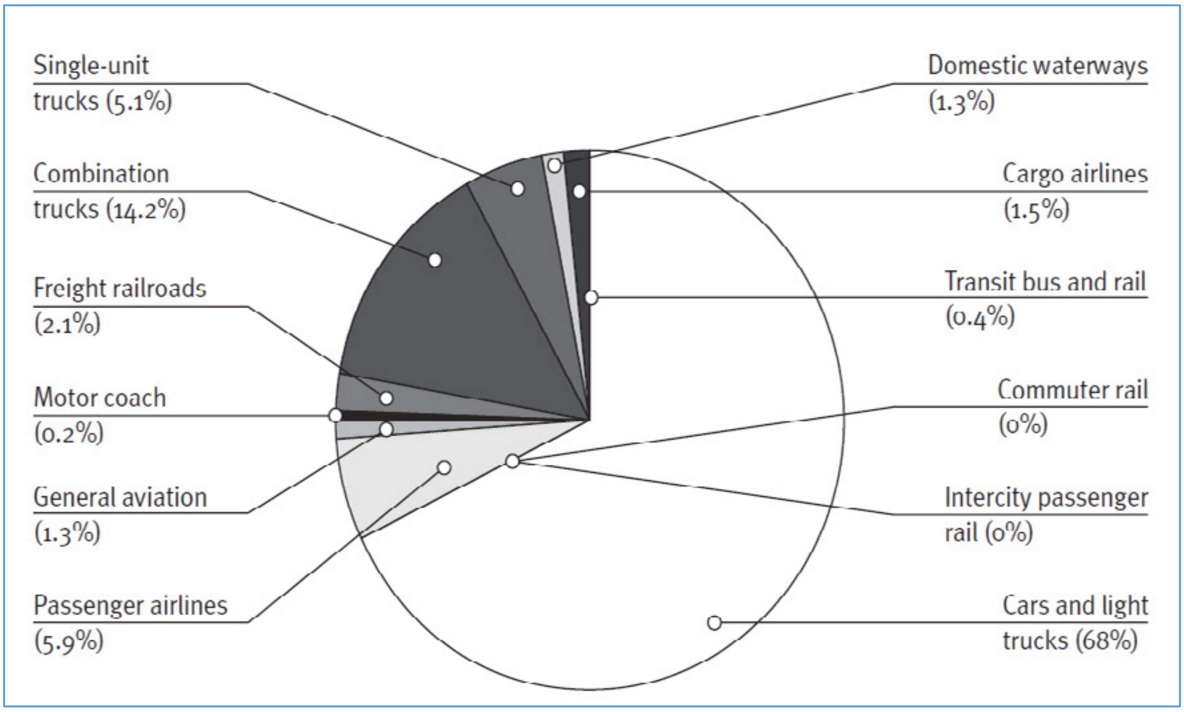
4.3.4 USA's Transportation Research Board

In U.S.A, transportation is the country's largest user of fuel since it claims more than two-thirds of the fuel consumed in the United States. In 2007, a study on potential strategies for reducing energy use and GHG emission from the private vehicle and freight transportation systems conducted by Transportation Research Board (TRB) examined on cars and light trucks, medium and heavy trucks, and commercial airliners.

Figure 4.1 shows share of petroleum fuel consumption by U.S.A domestic transportation mode, 2007. Percentage shares by mode were calculated based on various government and industry data sources. Fuel used during the transmission and distribution of commodities by pipeline is excluded from the totals.

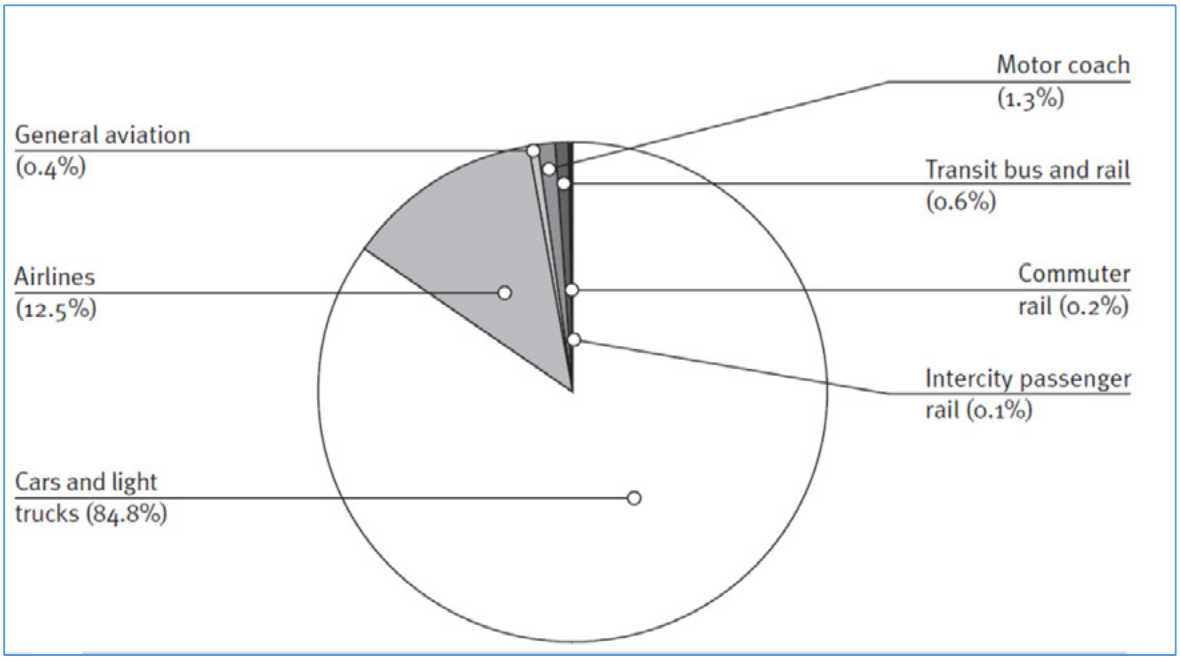
Figure 4.2 shows the share of U.S. domestic passenger miles by mode, 2007 (TRB, 2011). Cars and light trucks account for 85% of all passenger distance travelled, while airlines account for 12%.

Figure 4.1 Share of petroleum fuel consumption by U.S.A domestic transportation mode, 2007



Source: Special Report 307, Transportation Research Board U.S, 2011

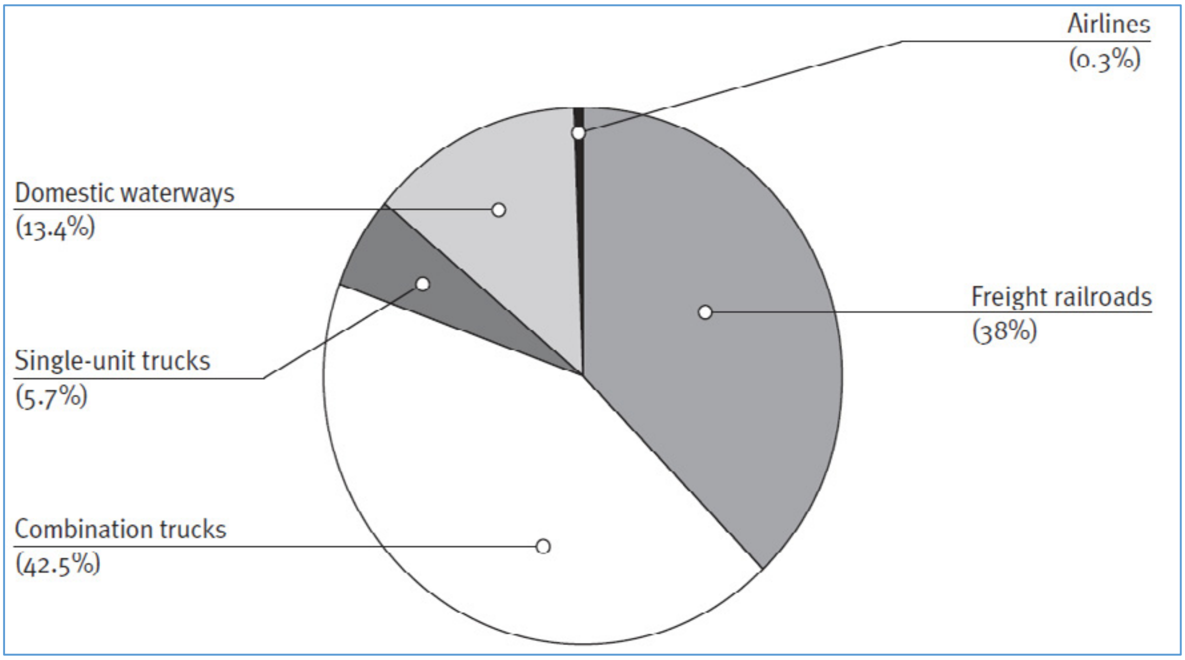
Figure 4.2 Share of U.S.A domestic passenger mile by mode, 2007



Source: Special Report 307, Transportation Research Board U.S, 2011

In figure 4.3 is shown the share of U.S. domestic freight ton-miles by mode, 2007 (TRB, 2011). It may be noticed that combination trucks and freight railroads claim the two (2) major share of the in the mix with airlines having the least share.

Figure 4.3 Share of U.S.A domestic freight ton-mile by mode, 2007

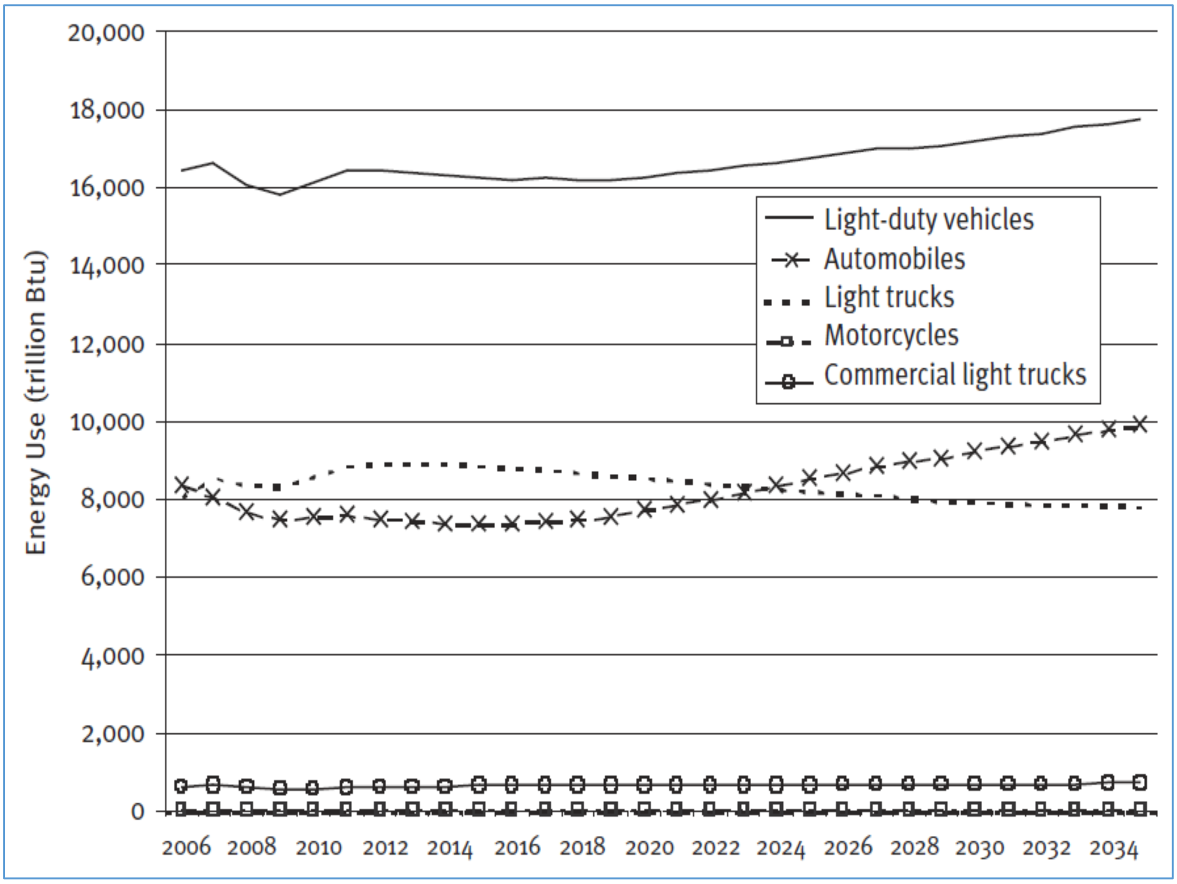


Source: Special Report 307, Transportation Research Board U.S, 2011

4.3.5 USA's Annual Energy Outlook

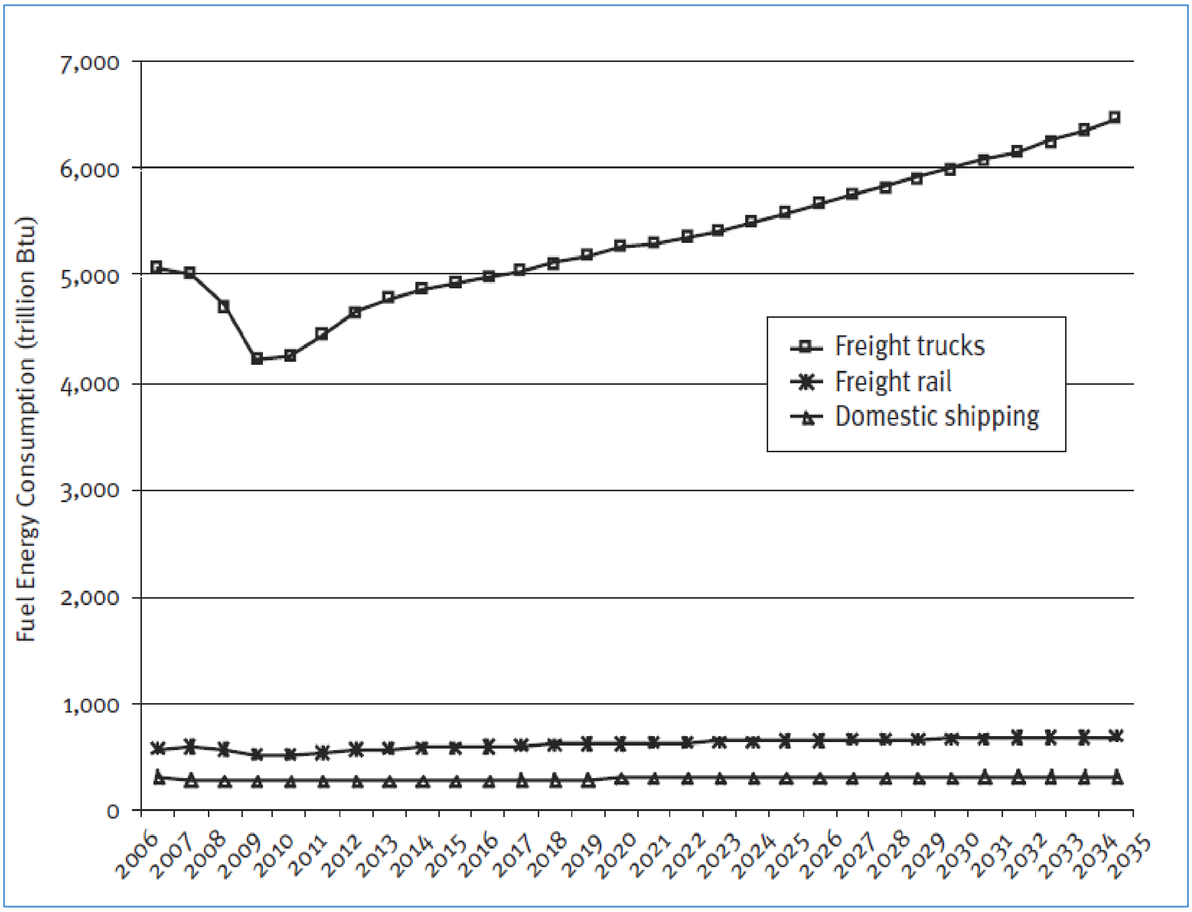
Figure 4.4 shows the reference case projection of energy use by light-duty vehicles was issued by Annual Energy Outlook (AEO) in 2010. In this case, EIA assumes that cars and light trucks remains major means of personal transportation in United States. National Agency Modelling System (NEMS) projected growth in transportation energy use is expected to come from freight trucks as shown in Figure 4.5. NEMS assumes that trucks like all other vehicles, will become more energy efficient overtime. However, the growth in freight demand from an expanding economy is the cause of increase in fuel consumption (AEO, 2010).

Figure 4.4 Reference case projections of energy use by light-duty vehicles to 2035



Source: Energy Information Administration, 2010

Figure 4.5 Reference case projections of energy use by major domestic freight modes through 2035



Source: Energy Information Administration, 2010

Table 4.4 gives the existing and proposed vehicle fuel and GHG efficiency standards in the United States and some other countries including Canada, Australia, Japan, EU, China and South Korea. It may be noticed that most of the countries have adopted the weight-based corporate average structure to formulate their standard. The minimum GHG emission limit has been set by EU which is 130g of CO_2/km.

Table 4.4 Existing and proposed vehicle fuel and GHG efficiency standards in the U.S.A and other countries

Country of region	Model year effective	Standard type	Unadjusted fleet target or measure	Structure	Targeted fleet
United States	2016	Fuel economy, GHG	34.1mpg (14.5km/L) or 250g of CO_2/mile (155g of CO_2/km)	Footprint-based corporate average	Cars, light trucks
Canada (Proposal)	2016	GHG	155g of CO_2/km	Footprint-based corporate average	Cars, light trucks
European Union	2015	GHG	130g of CO_2/km	Weight-based corporate average	Cars, light trucks
Australia	2010	GHG	222g of CO_2/km	Single average	Cars, light trucks
Japan	2015	Fuel economy	16.8km/L	Weight-based corporate average	Cars
China (Proposal)	2015	Fuel economy	14.2km/L	Weight-based per vehicle and corporate average	Cars, light trucks
South Korea (Proposal)	2015	Fuel economy	17km/L or 222g of CO_2/km	Weight-based corporate average	Cars, light trucks

Source: Energy Information Administration, 2010

4.3.6 Japan’s Top Runner Programme

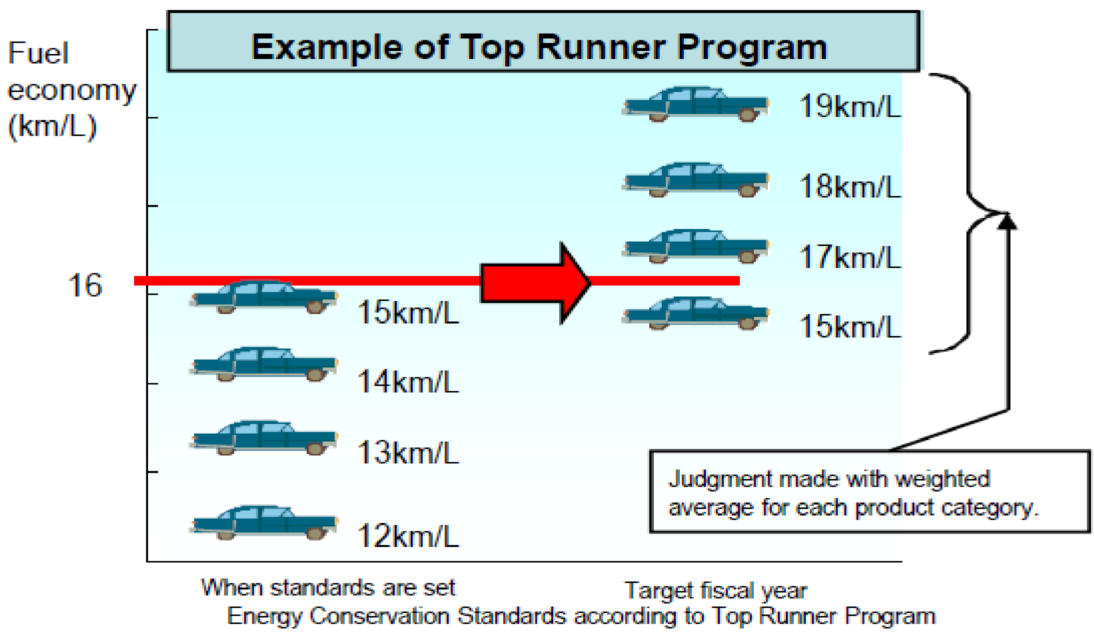
For automobiles, the fuel efficiency consumption standards using the Top Runner Method were introduced in 1999 under Ministry of Economy, Trade and Industry Agency (METI). Japan’s Top Runner Programme is to promote energy conservation and reduce CO_2 emission for passenger vehicle and freight vehicles with a gross vehicle weight of 2.5tons or less, followed by the fuel efficiency consumption standards for passenger vehicles using liquefied petroleum gas introduced in 2003 setting fiscal year (FY) 2010 as its target FY. The fuel efficiency consumption standards for heavy-weight freight vehicles with a gross vehicle weight exceeding 3.5tons were introduced in 2006 and freight vehicles with a gross vehicle weight of 32.5tons or less, the fuel efficiency consumption standards were introduced in 2007 setting FY2015 as its target FY (METI, 2011).

The Top Runner Programme is a mandatory programme for companies (manufacturers and importers), to fulfil the efficiency targets within 3 to 10 years, which encourages competition and innovation among the companies. Companies make efforts toward those goals, so the programme has contributed in improving EE of automobiles (passenger vehicles) consumers in Japan. Vehicle fuel efficiency standards are mandated to vehicle manufacturers by Law Regarding the Rationalization of Energy Use. The standards are developed based on the “Top-Runner” vehicle at that time as well as the prospect of future technical improvement by the targeted FY (METI, 2015).

Figure 4.6 shows the energy conservation standards according to Top Runner Programme. For setting FY, fuel economy standards are set at the actual levels of 12km/L to 15km/L, and it is expected that for the target FY an improvement levels of 15km/L to 19km/L can be achieved.

Figure 4.7 shows the fuel economy standards according to Top Runner Programme. In the case of passenger vehicles, fuel economy for the target FY 2020 would improve by 24.10% over the actual levels of petrol passenger vehicles in FY2009. Light Duty Commercial Vehicle (LDCV) fuel economy increased by 26.10% from FY2012 to FY2022 and Heavy duty vehicle (HDV) fuel economy increased by an average of 11.45% from FY2002 to FY2015.

Figure 4.6 Energy conservation standards according to Top Runner Programme



Source: METI Japan, 2017

Figure 4.7 Fuel economy standards according to Top Runner Programme

FE Standard for PVs (Target year FY2020)

	Standard (km/L)	Prospected Average [FY2009 Record → FY2020]
	10.6 ~ 24.6	16.3 km/L → 20.3 km/L +24.1%

FE Standard for LDCV (Target year FY2022)

	Standard (km/L)	Prospected Average [FY2012 Record → FY2022]
	10.2~ 28.1	14.2km/L → 17.9km/L +26.1%

FE Standard for HDVs(Target year FY2015)

	Standard (km/L)	Prospected Average [FY2002 Record → FY2015]
Route Bus 	4.23 ~ 6.97	4.51 km/L → 5.01 km/L +11.1%
General Bus 	3.57 ~ 9.04	6.19 km/L → 6.98 km/L +12.8%
Truck 	4.04 ~ 10.83	6.56 km/L → 7.36 km/L +12.2%
Tractor 	2.01 ~ 3.09	2.67 km/L → 2.93 km/L +9.7%

Source: METI Japan, 2017

4.3.7 Thailand's Energy Efficiency Developments in Transport Sector

In the early stage of environmentally sustainable transportation system planning, policies were carried out in the Developments of National, Bangkok and Regional City Transport Master Plans. Studies on Traffic and Transport Master Plan for Regional covering Nong Khai City was supported by the Office of Commissioning for Management of Land Traffic (OCMLT, formerly known as OTP in 2001). The model was developed by using Transportation Regional Improvement Projects and Survey (TRIPS) programme and applying the Traditional 4-Step Transportation Planning Model for forecasting travel demand in horizon years. The master plan is more focused on road network developments and effects on travel time and speed of traffic in cities regardless the environmental impact and energy consumption. It also covers the development of baseline setting approach for transportation sector clean development mechanism (CDM) projects that includes baseline setting, calculation of CO_2 reduction, identifying vehicle types, technology and network (OCMLT, 2001).

Study on Energy Efficiency R&D Roadmap for Thailand (MoE, Thailand, 2012), supported by Energy Policy and Planning Office under Ministry of Energy covers:

- Modal Shift (private cars to public transport): Includes Mass transit system and feeders in big cities and infrastructure development guideline for mass rapid transit system and transportation demand management to promote public transport;

- Rail-based freight transport: Includes data and related factors to energy intensity by transport modes, mechanism and measures to promote railway freight transport and reform the development of railway infrastructure;

- Sustainable low-carbon transport system for regional cities: Covers best practices to develop infrastructure of public transport and non-motorized mode in regional cities; and

- Vehicle EE standard and labelling: Covers classification of vehicles for setting fuel economy standards, energy consumption, fuel economy, vehicle kilometres travelled (VKT) data by vehicle type, high EE vehicles (e.g., electric motorcycle, EV, Light-duty diesel vehicles)

A 20-year Energy Efficiency Development Plan (EEDP 2011-2030) Thailand Action Plan has been developed by the Ministry of Energy, focusing on transportation, industrial, service & household sectors, by setting EE standards of electrical appliances & buildings and supporting development of mass public transportation and rail systems. In the transport sector, Thailand has established various EE measures for improving end-user EE such as, promoting high efficient standard vehicles and EE labelling (CO_2 taxation and car EE labelling), increasing EE in trucks and buses by using management system and financial incentives (Eco driving financial incentive) and developing infrastructure and fuel policy (Modal shift, double track railway and EV) (MoE, Thailand 2011).

4.3.8 Malaysia's Energy Usage and EE in Transportation

In Malaysia, study has been carried out by ASM on energy usage and EE in transportation. This report provides an overview on the energy usage and EE summarises the current status and recommends the next actions for improving energy practice in transportation and energy efficient transport in Malaysia. The findings are divided into three (3) sections, namely environment, policy and technology. The environment section outlines the impact of transport energy usage and EE on the environment, while the recommendations for mitigation actions are given under the policy and technology sections.

From this report, it is concluded that actions must be taken via the adoption of new policies and development of new technologies to improve the current energy usage pattern in the transportation sector. In terms of policy, a master transport policy that consider energy usage and EE is recommended, alongside with policies for fuel and emission standards, incentives for phasing our inefficient vehicles as well as energy usage and fuel efficiency labelling policy for vehicles.

At the same time, policies to support future vehicle technologies, particularly policies for internet of vehicles, electric vehicles and biofuel productions are also suggested. From the technology's perspective, this report highlights the needs to develop technologies for EVs together with EEVs. The development of enabling technologies for EVs, and alternative fuels namely biofuels and hydrogen fuels are recommended as the technological steps for improving transport energy usage and EE (ASM, 2014; Rahim *et al*., 2014).

5.0 ENERGY RELATED DATA REQUIREMENTS

5.1 Electrical Energy

5.1.1 Classification of the electrical sector

The electrical energy data and information required for this study are categorised into three (3) main sectors namely industrial, commercial and residential. They are mainly sourced from sources that have been already published such as the NEB reports and at the online portal Malaysia Energy Information Hub produced by key stakeholders such as ST and from electricity supply companies such as Tenaga Nasional Bhd. (TNB), Sabah Electricity Sdn. Bhd. (SESB) and Sarawak Energy Bhd. (SEB).

Meanwhile, the targeted energy measures saving projection information are updating and data on the NEEAP is sourced directly from key personnel involved in the preparation of the plan from ST.

5.2 Thermal Energy

5.2.1 Classification of the thermal energy sector

Similar to the electrical sector, the thermal energy data and information required for this study are categorised into three (3) main sectors namely industrial, commercial and residential in accordance with the NEB reporting. For the building sector, the data are classified under commercial and residential sectors instead of the classifications discussed with stakeholders such as shopping malls, hotels (including restaurants), office complexes, airports, hospitals, universities, and townships (district cooling plants).

Due to the diverse and extensive nature of the industrial activities, the classification of the industrial sub-sectors was deliberated at length with the stakeholders in three (3) WG sessions. The details are discussed in Section 5.2.2 below.

5.2.2 Classification of the industrial sub-sectors

The initial classification of the industrial sub-sectors presented for the WG discussion in the first two (2) workshops were based on the MIDA's listed manufacturing industries and the eight (8) manufacturing sectors in Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP). However, on recommendation by DOSM during the second WG workshop, a list of fifteen (15) industrial sub-sectors was consolidated in accordance with the MSIC classification as recommended by DOSM where possible as some sub-sectors such as food, beverages, tobacco products, textiles and leather products are combined as listed in Table 5.1 below.

However, the final analysis of data presented at the final workshop was based on ST's survey conducted with 520 manufacturing companies in Peninsular Malaysia in 2013. This set of data has some different classifications of the manufacturing industry sub-sectors, which are in accordance with the breakdown of the manufacturing sub-sectors based on the IEA and APEC format of classification of the industrial sub-sectors. The difference between this set of classifications and the MSIC classification as recommended by DOSM during the second workshop is shown in Table 5.1 below.

Table 5.1 Tabulation of Industrial Sub-Sectors Classification according to MSIC and IEA

MSIC Classification		IEA Classification		Remarks
1	Food, beverages and tobacco products	**1**	Food, beverages and tobacco	Similar classification; include processing, preserving and manufacture of food, beverages and tobacco products (excludes preliminary processing of tobacco).
2	Textiles and leather products	**2**	Textiles and leather	Similar classification; include the preparatory operations and manufacture of textiles (including wearing apparel), and leather and related products.
3	Wood and wood products and furniture	**3**	Wood and wood products	Similar classification; include the processing and manufacture of wood products and furniture.

MSIC Classification		IEA Classification		Remarks
4	Paper and paper products	**4**	Pulp, paper and printing	Similar classification; include the processing and manufacture of pulp, paper and paperboard, other paper products, and printing.
5	Chemicals and chemical products	**5**	Chemical	Similar but IEA includes petrochemical in chemical sub-sector
6	Non-metallic mineral products	**6**	Non-metallic mineral products	Similar classification; include manufacture of glass and glass products, ceramic products, cement and plaster, and intermediate and final products from mined or quarried non-metallic minerals e.g. sand, gravel, stone or clay.
7	Basic metals	**7**	Iron and steel	MSIC's basic metals include: – Iron & steel – Precious & non-ferrous metals IEA's iron & steel include: – Iron & steel Casting of metals
8	Machinery and equipment	**8**	Machinery	IEA's machinery includes fabricated metal products; computers, electronic & optical products; electrical equipment; and machinery.
9	Motor vehicles, trailers, semi-trailers and other transport equipment	**9**	Transportation equipment	Similar classification; include manufacture of motor vehicles, trailers and semi-trailers, and parts and accessories.
10	Rubber and plastic products			Not listed in IEA classification
11	Computer, electronic and optical products			Listed in IEA under machinery
12	Electrical equipment			Listed in IEA under machinery

MSIC Classification		IEA Classification		Remarks
13	Coke and refined petroleum products			Listed in IEA under chemical
14	Pharmaceutical products			Not listed in IEA classification
15	Fabricated metal products			Listed in IEA under machinery
		10	Non-ferrous metals	Listed in MSIC under basic metals
		11	Not elsewhere specified	Not listed in MSIC classification

It should be noted that the “Not elsewhere specified” under the IEA classification is for fuel consumption that does not correspond to any of the classification given under IEA classification in Table 5.1 above.

5.2.3 Data requirements for Energy Efficiency Indicators

The concept of EE indicators is based on international methodology adopted by the IEA, which is the reference for the study (IEA, 2014a). This preliminary study has abled to establish thermal energy consumption indicators by sectors and sub-sectors, expressed in percentage, i.e. share of the sectors or sub-sectors in the overall thermal energy consumption by the industrial, commercial and residential sectors. However, for the establishment of EE indicators, some levels of difficulties were encountered since not all activities and production data could be obtained due to non-obligation to disclose such data by the industries. Therefore, the priority has been given to gather energy consumption data for the sectors and sub-sectors listed in the above. It is suggested that the methodology for the sourcing of the complete set of activities and production data should be explored in the detailed study.

It was learned from the seminar on DSM Programmes and Best Practices of Model Countries on 17 and 18 January 2017 organised by EPU that Japan has only established and published industrial EE benchmark indices in 2009 although the enactment of the Energy Conservation (EC) Act with mandatory rational use of energy was carried out in 1979. Japan’s industrial EE benchmark indices covered only six (6) target industries as detailed in Table 5.2 below. It can be seen from this table that Japan has developed meticulous methodology and data collection programme, and only six (6) sectors and sub-sectors have established EE indicators. Japan's experience shows that EE indicators can be established but it does require a lot of efforts from both the public and private sectors and systematic data reporting and collection, which is a requirement under the Japanese EC Act. It was learned that these six (6) industries were given the priority in stipulating the target levels of EEIs as these industries are energy-intensive. The industries in Japan have statutory obligations to comply with the target levels as shown in Table 5.2.

It could also be observed that Japan's EE policy and activities are well managed by the Agency for Natural Resources and Energy under the Ministry of Economy, Trade and Industry (METI), Japan through the Energy Conservation and Renewable Energy Department on the statutory requirements. The implementation of EE activities in terms of assistance and guidance to the industries is well supported by organisations such as the Energy Conservation Centre, Japan (ECCJ), which has in-house experts with industrial experiences.

Table 5.2 Japan's Benchmark Index for Designated Industries

Target Sector		**Benchmark Index Calculation Methodology**	**Target Level**
Iron & Steel (medium and long-term target Level 1)	Iron manufacturing using blast furnaces	$\frac{\text{Energy consumption}}{\text{Amount of crude steel}}$	≤ 0.531 kL / t
	Common steel manufacturing using electrical arc furnaces	$\frac{\text{Energy consumption in in the process of manufacturing crude steel}}{\text{Amount of crude steel}} + \frac{\text{Energy consumption rolling process and onward process}}{\text{Amount of rolled steel}}$	≤ 0.143 kL / t
	Special steel manufacturing using electrical arc furnaces	$\frac{\text{Energy consumption in in the process of manufacturing crude steel}}{\text{Amount of crude steel}} + \frac{\text{Energy consumption rolling process and onward process}}{\text{Amount of shipped steel}}$	≤ 0.36 kL / t
Utility/Power Generation (medium and long-term target Level 1)		[1] Thermal efficiency standardised index $\frac{\text{Thermal efficiency at power generation side obtained by a performance test of rated output}}{\text{Designed efficiency of the rated output}}$ [2] Thermal electric power generation efficiency	[1] ≥100.3% [2] None
Pulp & Paper	Paper mfg.	$\frac{\text{Energy consumption}}{\text{Production volume}}$	≤ 8532 MJ / t
	Paper board mfg.	$\frac{\text{Energy consumption}}{\text{Production volume}}$	≤ 4944 MJ / t

Target Sector		Benchmark Index Calculation Methodology	Target Level
(medium and long-term target Level 2)			
Chemical (medium and long-term target Level 2)	Petrochemical Industry	Energy consumption in the process to manufacture ethylene / Production volume of ethylene etc. (Products: ethylene, propylene, butadiene, benzene, etc.)	≤ 11.9 GJ / t
	Soda Chemical Industry	Energy consumption in the electrolytic process / Weight of sodium hydroxide from electrolytic cell + Heat quantity of steam usage in concentration process / Weight of liquid sodium hydroxide	≤ 3.45 GJ / t
Oil Refining Industry (medium and long-term target Level 3)		Energy consumption in the petroleum refining process / Sum of { Coefficient recognised as appropriate based on the world average etc. of each plant in petroleum refining process } x { Oil throughput of each plant in petroleum refining process }	≤ 0.876 No dimension i.e. kL (total energy consumption / kL (total equivalent oil throughput)
Cement Manufacturing (medium and long-term target Level 3)		Energy consumption in raw material process / Production volume in raw material part (clinker equivalent) + Energy consumption in pyroprocess / Production volume in pyroprocess part (clinker) + Energy consumption in finishing process / Production volume in the finishing part (Portland cement Equivalent) + Energy consumption in shipping process / Shipping volume (a variety of cement and clinker)	≤ 3891 MJ / t

Source: METI Japan, 2009

Consultations with WG members pointed out that thermal energy should be clearly defined at the beginning, otherwise the data collection might not be effective and would in fact cause confusion in the process. The thermal energy in this DSM study covers the following categories of fuels:

i) Non-RE: Fuel oil, diesel, natural gas, kerosene, petrol, liquefied petroleum gas, coal and coke, etc.;
ii) RE: Biogas, biomass and solar thermal energy; and
iii) Secondary thermal energy generated from other sources such as electricity through cogeneration and trigeneration.

Data collection formats were prepared and deliberated with stakeholders' inputs before they were sent out to all identified potential data providers. A briefing session was conducted with Federation of Malaysian Manufacturers (FMM) members. These formats are appended in Appendix B. The data collection templates were sent to the following:

i) Energy Commission;
ii) Department of Statistics Malaysia;
iii) Gas Malaysia Bhd;
iv) Federation of Malaysian Manufacturers;
v) Petroliam Nasional Berhad;
vi) Shell Malaysia;
vii) Malaysian Gas Association;
viii) Cement and Concrete Industry Association; and
ix) Malaysian Rubber Glove Manufacturers Association.

There were two (2) templates for data collection as shown in Appendix B; one (1) is based on the industrial sub-sectors, the other format is based on the fuel types, i.e. fuel oil, diesel, natural gas, LPG, coal, etc. Table 5.3 shows the sources and types of data obtained.

Table 5.3 Sources and types of data obtained

Fuel Type	Energy Commission	Gas Malaysia	Cement Industries (4 companies)	FMM members (7 companies)
Fuel oil	✓	NA	✓	✓ (light fuel oil)
Natural Gas	✓	✓	NA	✓
LPG	✓	NA	NA	✓
Kerosene	✓	NA	NA	NA
Petrol	✓	NA	NA	NA
Diesel	✓	NA	✓	✓
Coal and coke	✓	NA	✓	NA

Fuel Type	Energy Commission	Gas Malaysia	Cement Industries (4 companies)	FMM members (7 companies)
Biomass (saw dust, empty fruit bunch (EFB), paddy husk, sludge)	NA	NA	✓	NA
Biogas	NA	NA	NA	✓
Carbon black	NA	NA	✓	NA

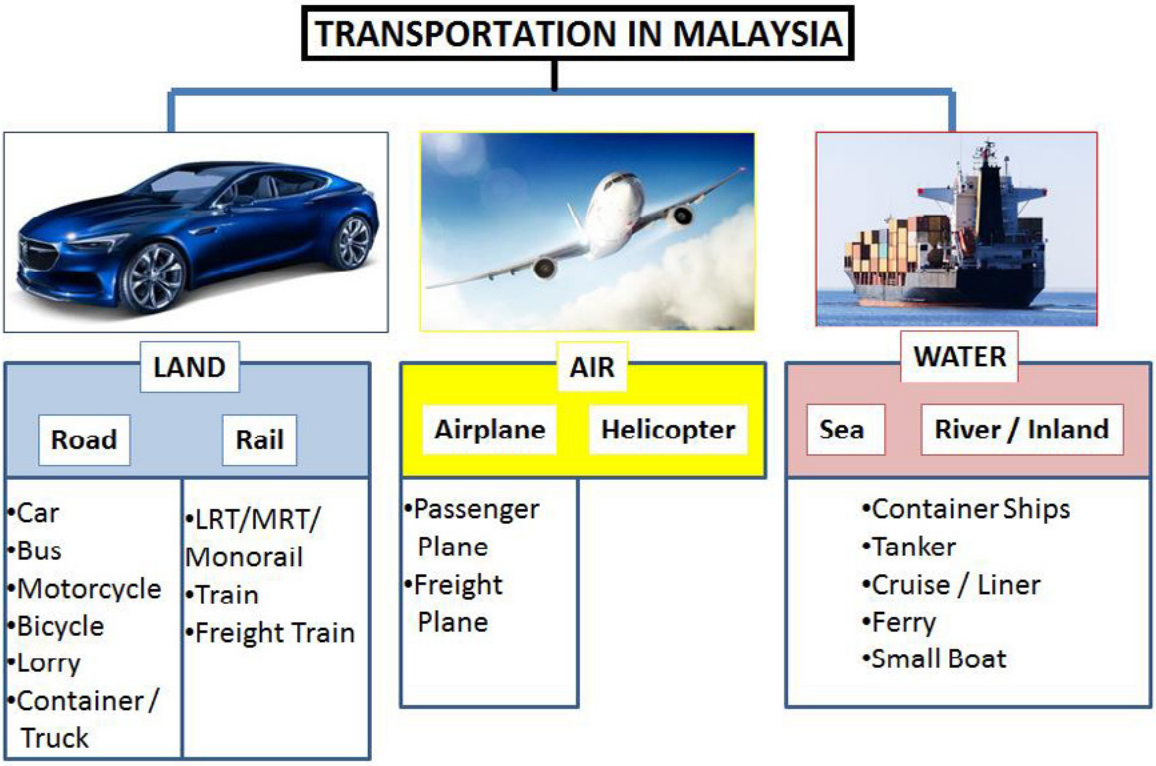
5.3 Transport Energy Use

Transportation sector is related to land development, economic structure, energy policies, and environmental quality (Fedra, 2004). Transport is a complex social, technical and economic system that interacts with urban and regional planning decisions, logistics, energy use, economics, engineering advancements and environmental impacts.

5.3.1 Classification of Types of Transport

Transportation is a network that includes several components: infrastructure, urban planning, vehicles and instruments, information and communication technologies (ICT) applications related to the infrastructure and on-board network services, and operational and administrative procedures (Rahim *et al.*, 2014). Mega Science Transportation Sector Team clarified mainly into three (3) categories as: (i) Land, (ii) Air and (iii) Water as shown in Figure 5.1.

Figure 5.1 Types of transportation in Malaysia



Source: Academy of Sciences Malaysia, 2014

This report gives more focus on the energy consumption and emission for the transportation sector in Malaysia. To calculate the energy consumption, need more details information of type of transport, usage behaviours, fuel types, distance travel etc. Figures 5.2 to 5.13 show Malaysia's current transportation network, routes and links.

Figure 5.2 Main expressways in Peninsular Malaysia

Source: PLUS, Malaysia Bhd, 2014

Figure 5.2 shows the current transportation network, routes and links that encompass Peninsular Malaysia. *Bukit Kayu Hitam (Up-north) of Peninsular Malaysia* is connected *to Johor Bahru (South of Peninsular Malaysia)* by the North-South Expressway. It is the longest highway and acts as the backbone of land transport in Peninsular Malaysia.

Main roads in Sabah is linked in most parts of the state (except for central districts of Nabawan and Kota Kinabatangan) as shown in Figure 5.3. These networks are majority developed near the South China Sea and Sulu Sea between year 2006 to 2010 extending from 17,246km to 21,934km (BORNEO POST online, 2017).

Sarawak is the largest state in Malaysia situated in the eastern part. The main road network is mostly at the coastal side of the South China Sea which covers about 77% of the area in the state as shown in Figure 5.4. The main road network is almost 30,000km in length and two-third of it is paved.

Figure 5.3 Main roads in Sabah

Source: Public Works Department, Sabah 2014

Figure 5.4 Main roads in Sarawak

Source: Public Works Department, Sarawak, 2014

The railway network of Peninsular Malaysia is shown in Figure 5.5. The network covers interconnection from Thailand's railway network in the north down to Singapore's railway in the south. By 2010, *Keretapi Tanah Melayu Bhd* (KTMB) established 1,658km long railways in the Peninsular Malaysia.

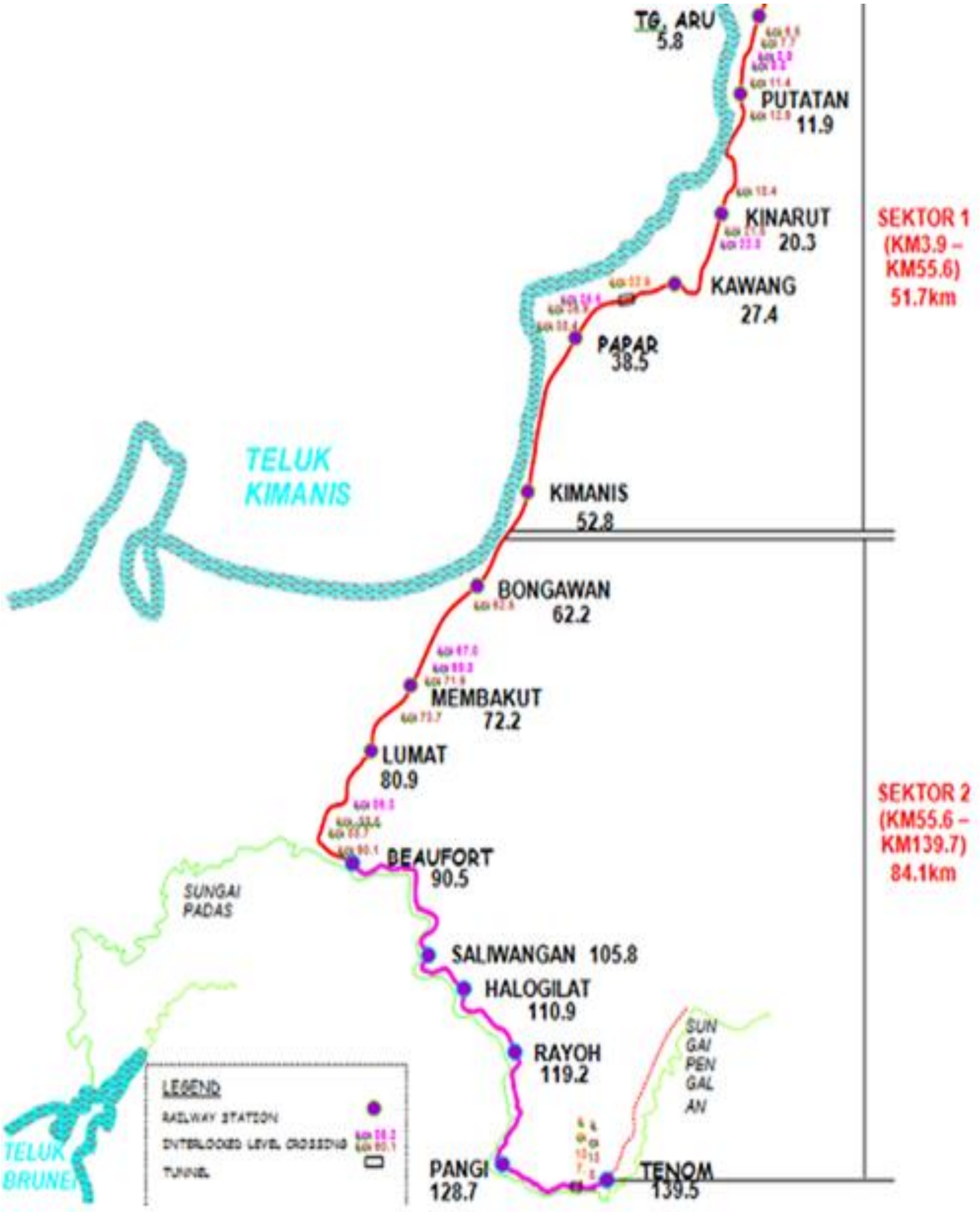
Sabah has a 134km long railway network connecting *Tanjung Aru near Kota Kinabalu to Tenom* as in Figure 5.6. The rail transport in Sabah mainly consists of diesel multiple unit, rail bus, railcar and carriage & wagon.

Figure 5.5 Rail transport network in Peninsular Malaysia

Source: Ministry of Transport, 2014

Notes: DTP – Double Track Project

Figure 5.6 Rail transport network in Sabah



Source: Sabah State Railway Department, 2016

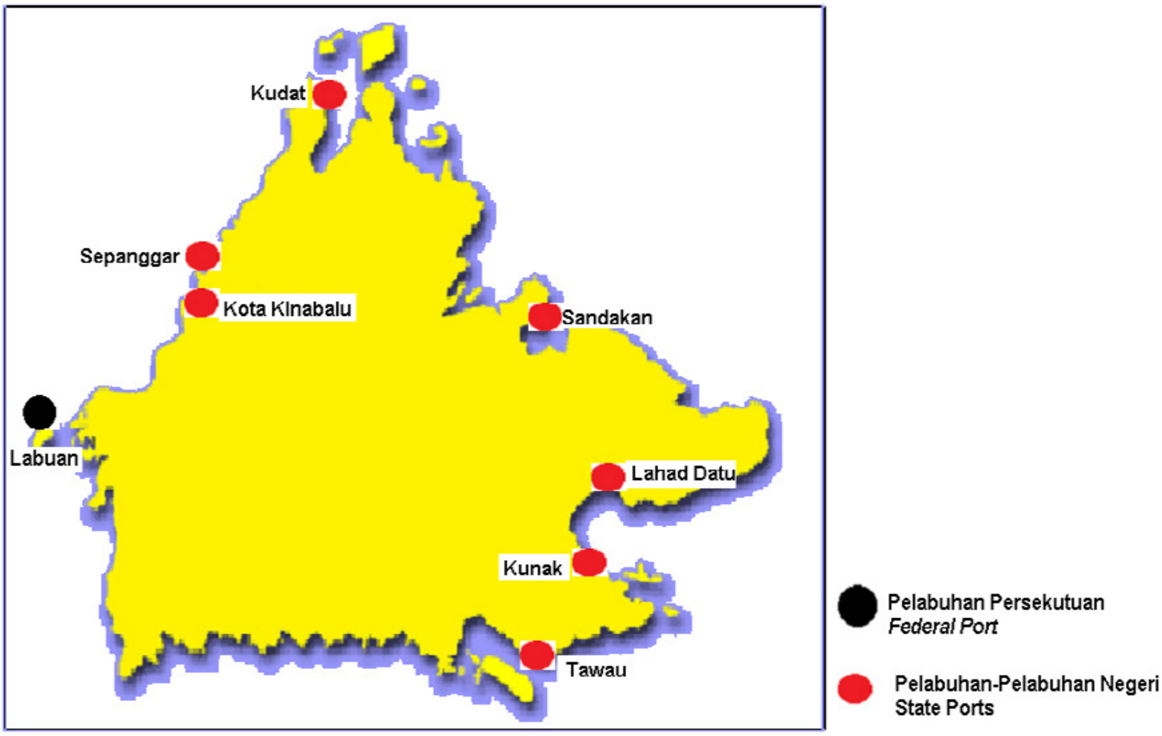
Malaysia's ports operate under two (2) separate authorities. Federal ports as indicated in Figure 5.7, operates directly under the Ministry of Transport (MOT) and State ports operates by respective port authority.

Figure 5.7 Federal ports in Peninsular Malaysia

Source: Department of Statistics, 2014

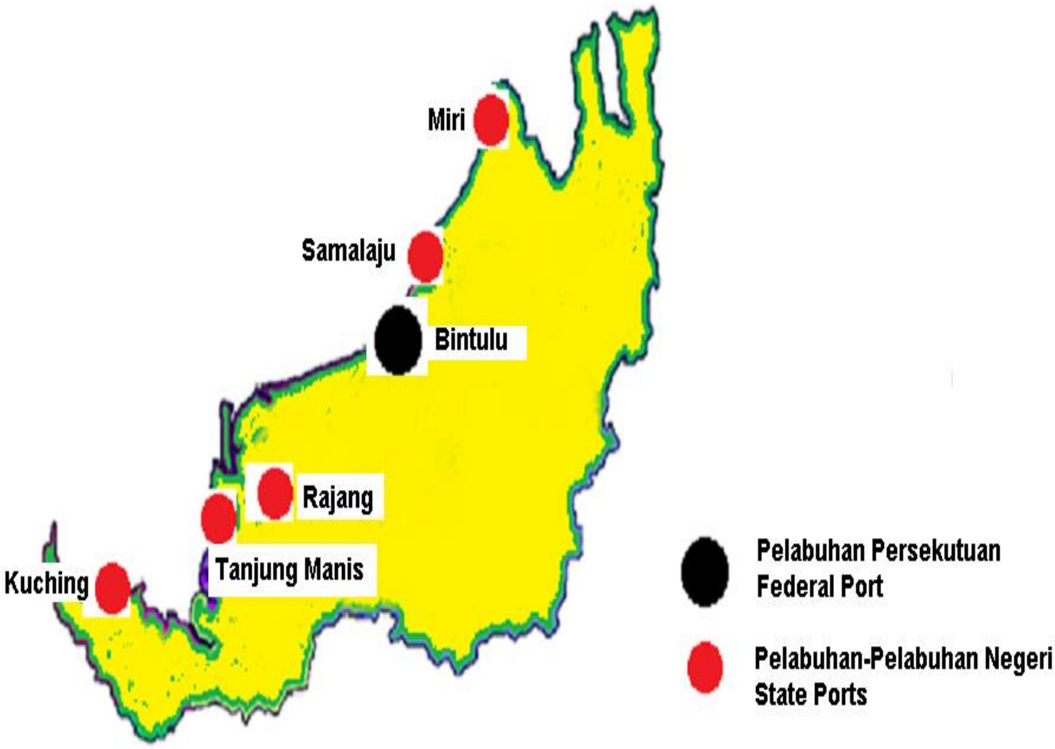
Ports in Sabah and Sarawak are mainly under State Statutory Bodies except for two (2) ports which are under Federal control, *Labuan* Port (Sabah) and *Bintulu* port (Sarawak) as shown in Figure 5.8 and Figure 5.9 respectively.

Figure 5.8 State and Federal ports in Sabah



Source: Department of Statistics, 2014

Figure 5.9 State and Federal ports in Sarawak



Source: Department of Statistics, 2014

Malaysia has three (3) types of airports (as indicated in Figures 5.10 to 5.12), namely International Airport, Domestic Airport and Airstrips. The majority of the airports are operated by Malaysia Airport Holding Bhd. (MAHB) and the national flagship airliner is Malaysia Airlines Bhd. (MAB).

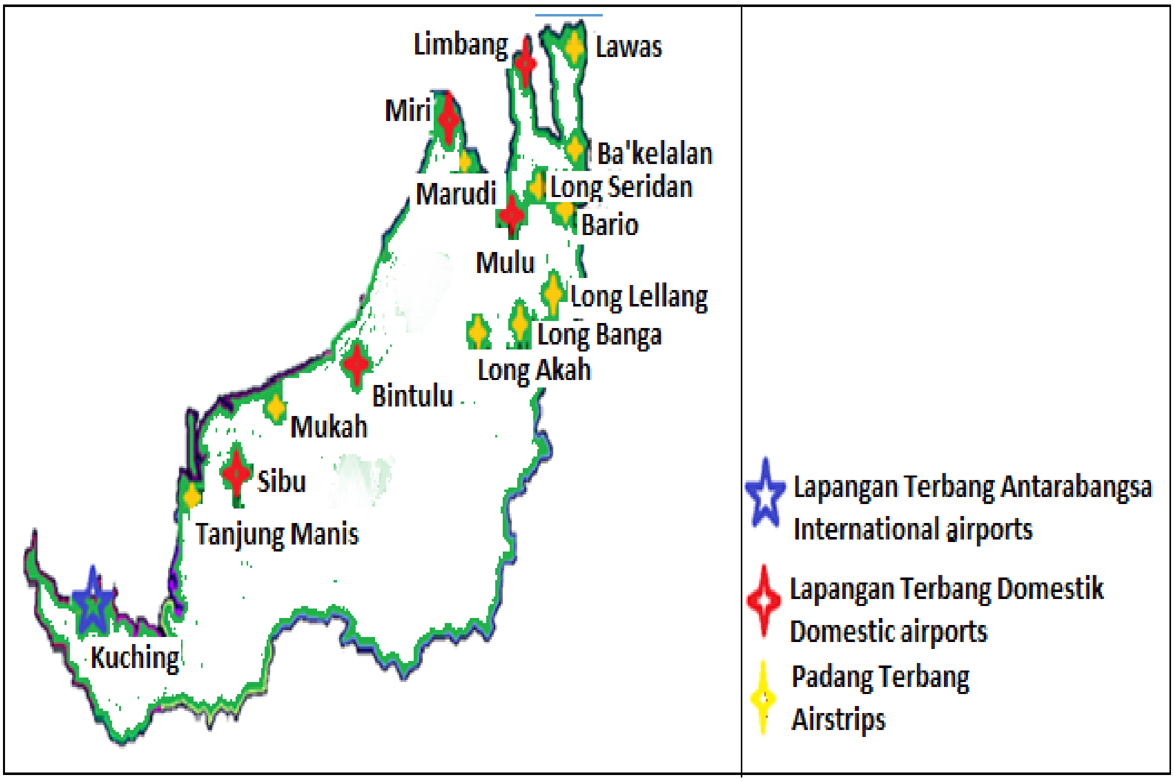
Figure 5.10 Airport locations in Peninsular Malaysia

Source: Department of Statistics, 2014

Figure 5.11 Airport locations in Sabah

Source: Department of Statistics, 2014

Figure 5.12 Airport locations in Sarawak



Source: Department of Statistics, 2014

Malaysia has a strong and multiple access transit rail networks in the core business and commercial areas which includes LRT, MRT and Monorail as shown in Figure 5.13. These lines are under the jurisdiction of SPAD.

Figure 5.13 Transit rail transport network of Klang Valley

Source: Land Public Transport Commission, 2016

6.0 DATA COLLECTION AND ANALYSES

6.1 Electrical Energy

6.1.1 Data from Energy Commission

Table 6.1 shows the total electrical energy consumption for the whole Malaysia country in year 2014. The Peninsular Malaysia is being the largest energy consumption of 108,259GWh (84%), Sarawak accounted for 15,152GWh (12%) and Sabah accounted for 4,919GWh (4%) from the total Malaysia energy consumption demand 2014.

In 2014, the industrial sectors were the largest consumers in Peninsular Malaysia & Sarawak, while the commercial sector was the largest consumer in Sabah, as shown in the Figure 6.1, Figure 6.2 and Figure 6.3 for Peninsular Malaysia, Sabah and Sarawak respectively.

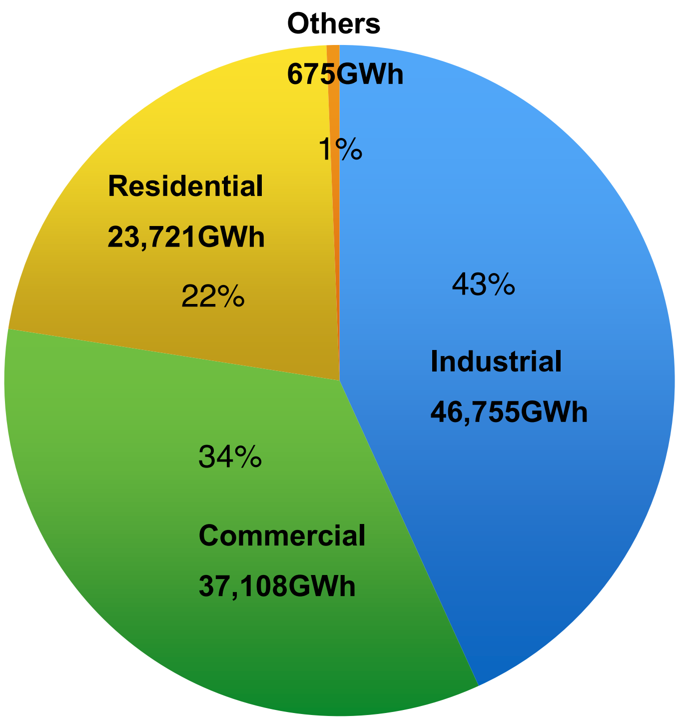
Table 6.1 Total electrical energy consumption demand, 2014

Region	Industry		Commercial		Residential		Transport		Agriculture		Total
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh
Peninsular Malaysia	46,735	79.3	37,708	89.5	23,721	87.0	261	100.0	413.5	100.0	108,259
Sabah	1,230	2.1	2,043	4.9	1,647	6.0	-	-	-	-	4,919
Sarawak	10,966	18.6	2,290	5.5	1,896	7.0	-	-	-	-	15,152
Total	**58,951**	**100.0**	**41,441**	**100.0**	**27,264**	**100.0**	**261**	**100.0**	**414**	**100.0**	**128,330**

Source: Energy Commission, 2014

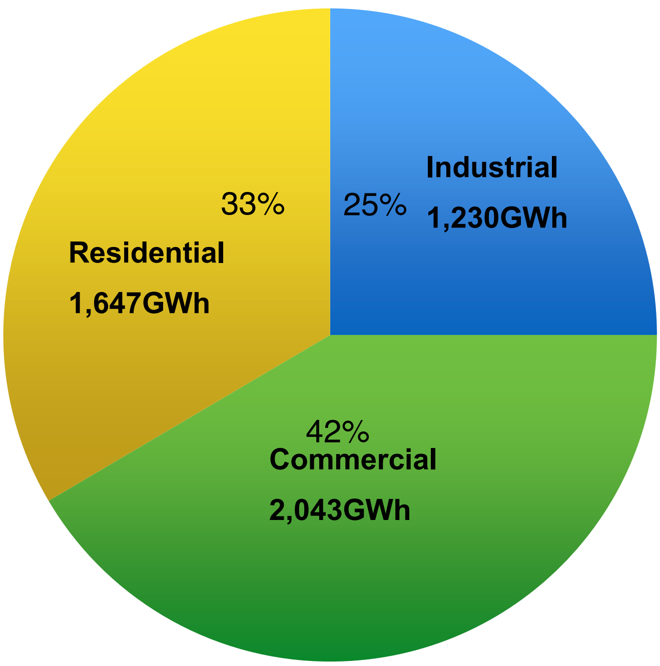
Based on the above energy consumption analysis for Malaysia as a whole, it is noticed the industrial sector is the dominant energy consumption sector for Peninsular Malaysia and Sarawak while the commercial sector is the highest energy consumption sector for Sabah as shown in the sub-section for Peninsular Malaysia, Sabah and Sarawak.

Figure 6.1 Peninsular Malaysia energy consumption distribution by sector



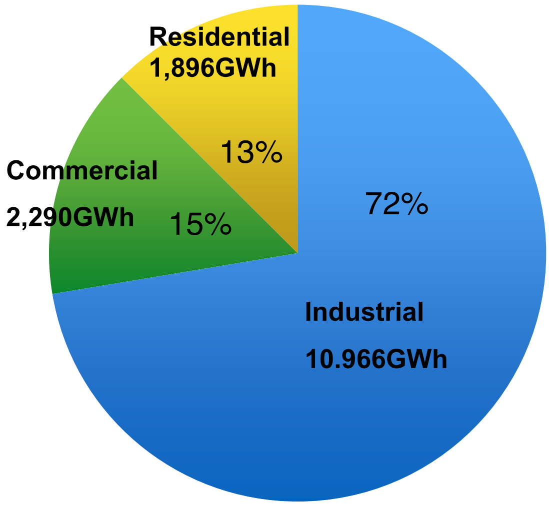
Source: Energy Commission, 2014

Figure 6.2 Sabah energy consumption distribution by sector



Source: Energy Commission, 2014

Figure 6.3 Sarawak energy consumption distribution by sector

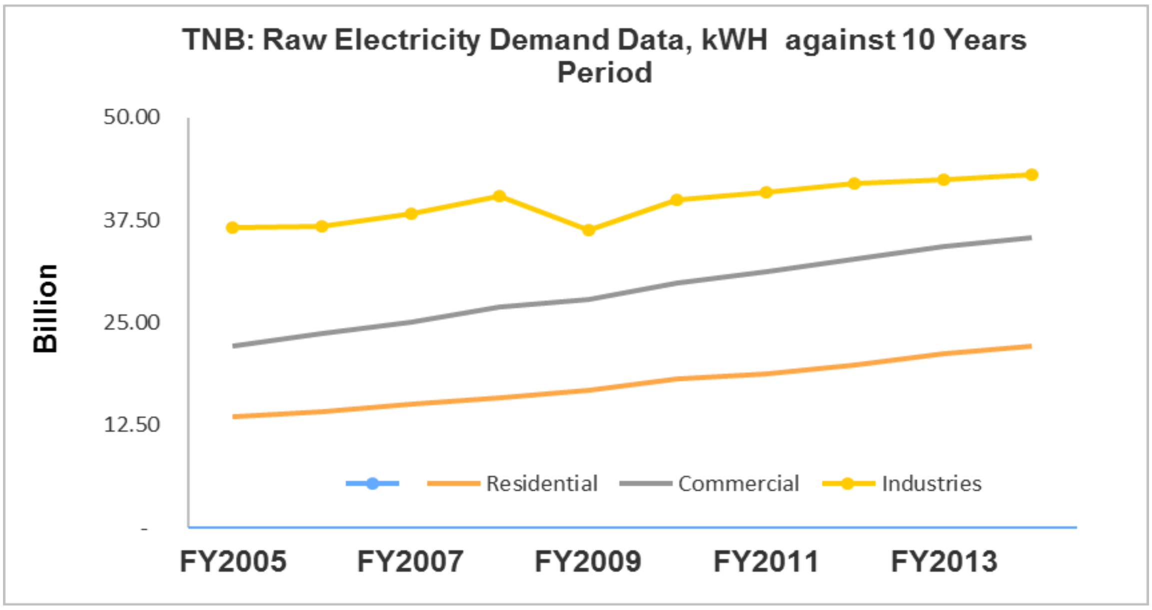


Source: Energy Commission, 2014

6.1.2 Data from Tenaga Nasional Bhd

Figure 6.4 shows the TNB electricity consumption trends for all the three (3) sectors in this DSM plan study. The industrial sector is the largest energy consumption sector followed by commercial and residential sectors. The industrial sector energy consumption declined in 2009 due to the global economic crisis when the GDP growth rate was affected. In general, the energy consumption trends for the three (3) sectors show positive growth from 2010 onwards.

Figure 6.4 TNB electrical demand trends, 2005 to 2014

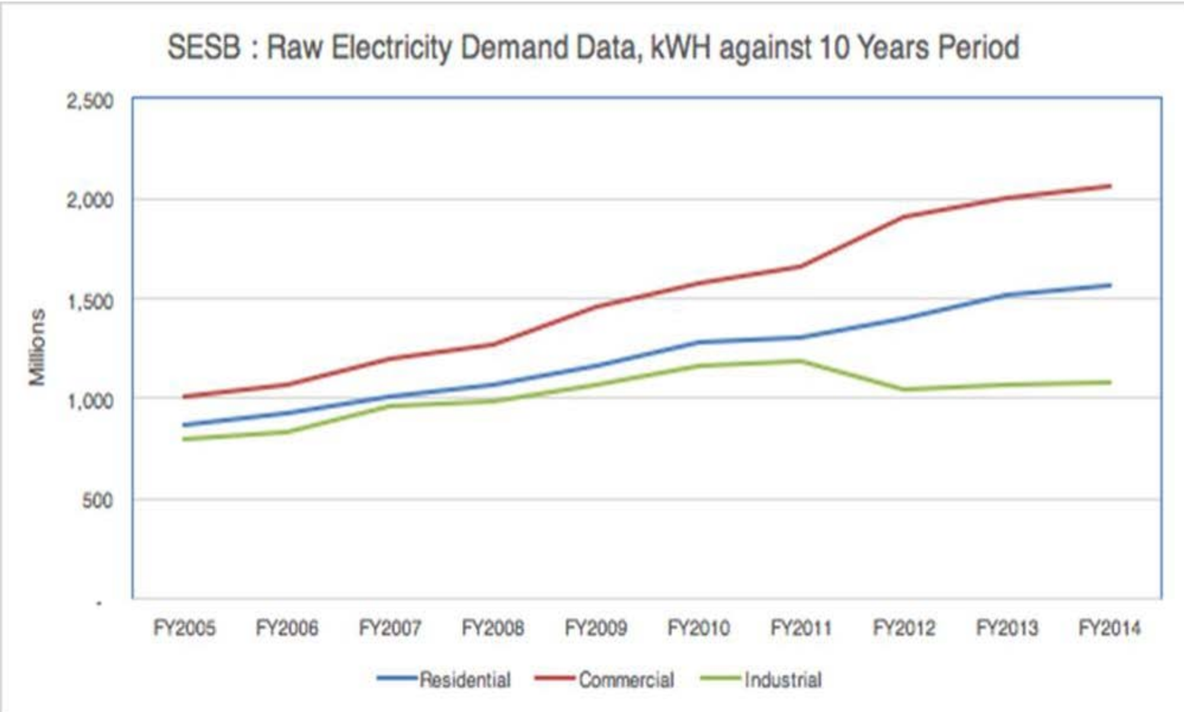


Source: Tenaga Nasional Bhd, 2014

6.1.3 Data from Sabah Electricity Sdn Bhd

The Figure 6.5 shows the Sabah Electricity Sdn. Bhd. (SESB) electricity demand trends for all three (3) sectors in this DSM plan study. The industrial sector shows declining trend after 2012. As this has been explained as being due to the reclassification of some industrial consumers to the commercial category. In general, the residential and commercial consumption trends show positive growth trend. The commercial sector has the highest energy consumption based on the last 10 years' historical trend and followed by residential sector.

Figure 6.5 SESB - 10 years' electrical demand trends



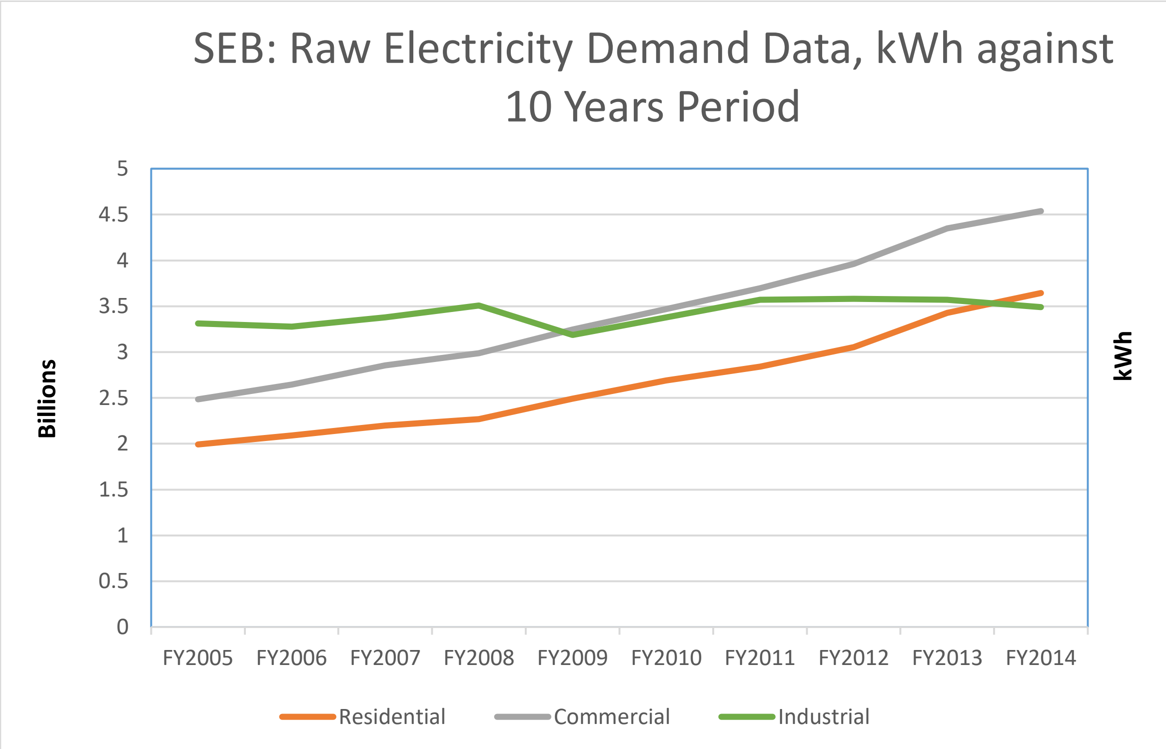
Source: Sabah Electricity Sdn Bhd, 2015

6.1.4 Data from Sarawak Energy Bhd

The Figure 6.6 below shows the Sarawak Energy Berhad (SEB) electricity consumption trends for all the three (3) sectors in this DSM plan study.

The commercial and residential sectors showed the growing trend due to increasing number of consumers and increased use of electricity, however the industrial sector remains constant energy consumptions after 2011. The share of electricity used by the industrial sector has been rather stagnant up to 2014 but has accelerated substantially since then because of the large, energy intensive industries that have been attracted to Sarawak in conjunction with the development of its large hydro-electric power generation capacity.

Figure 6.6 SEB - 10 years' electrical demand trends

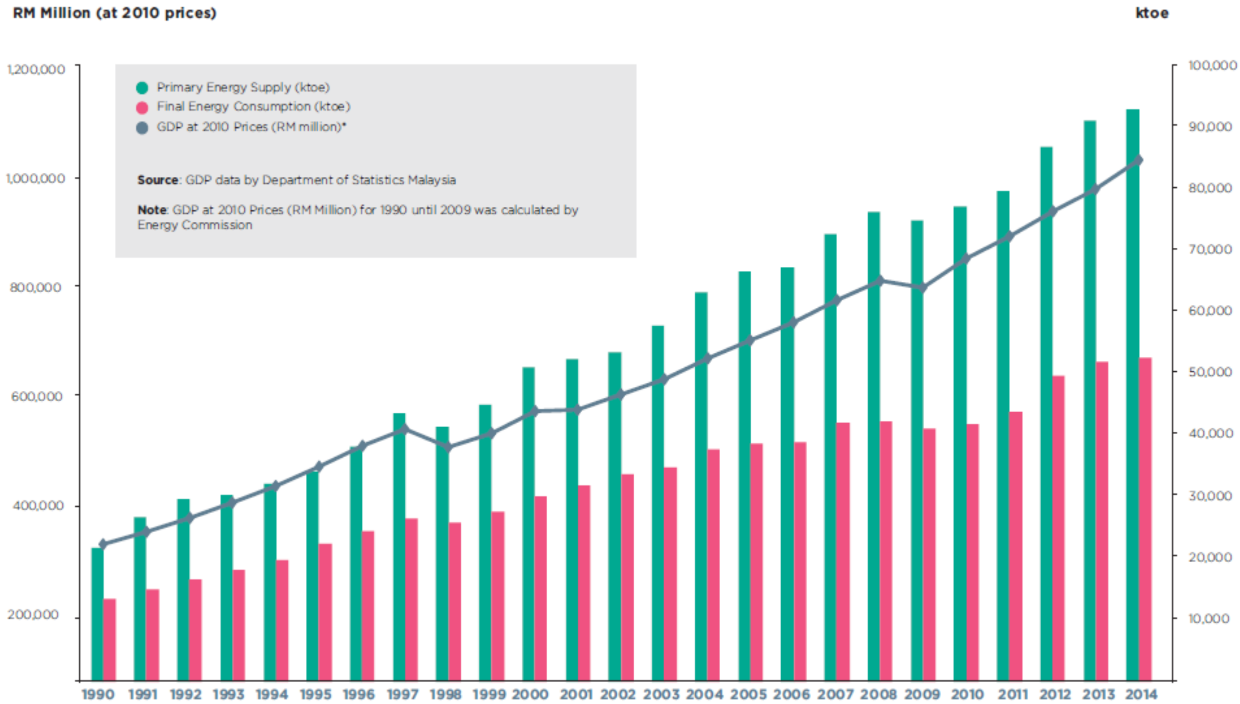


Source: Sarawak Energy Bhd, 2015

6.1.5 Electrical energy demand against GDP growth trends

From Figure 6.6, it is noticed that the overall GDP growth trend has followed the trend for energy consumption from the period 1990 to 2014 except in the years 1998 and 2009, when it declined due to the global economic and financial crises. From the figure, the GDP growth is closely coupled with the demand of electricity consumption. It is anticipated that a holistic and effectively implemented DSM plan can help to decouple their relationship in the future.

Figure 6.6 Primary supply vs final consumption with GDP growth, 1990 to 2014



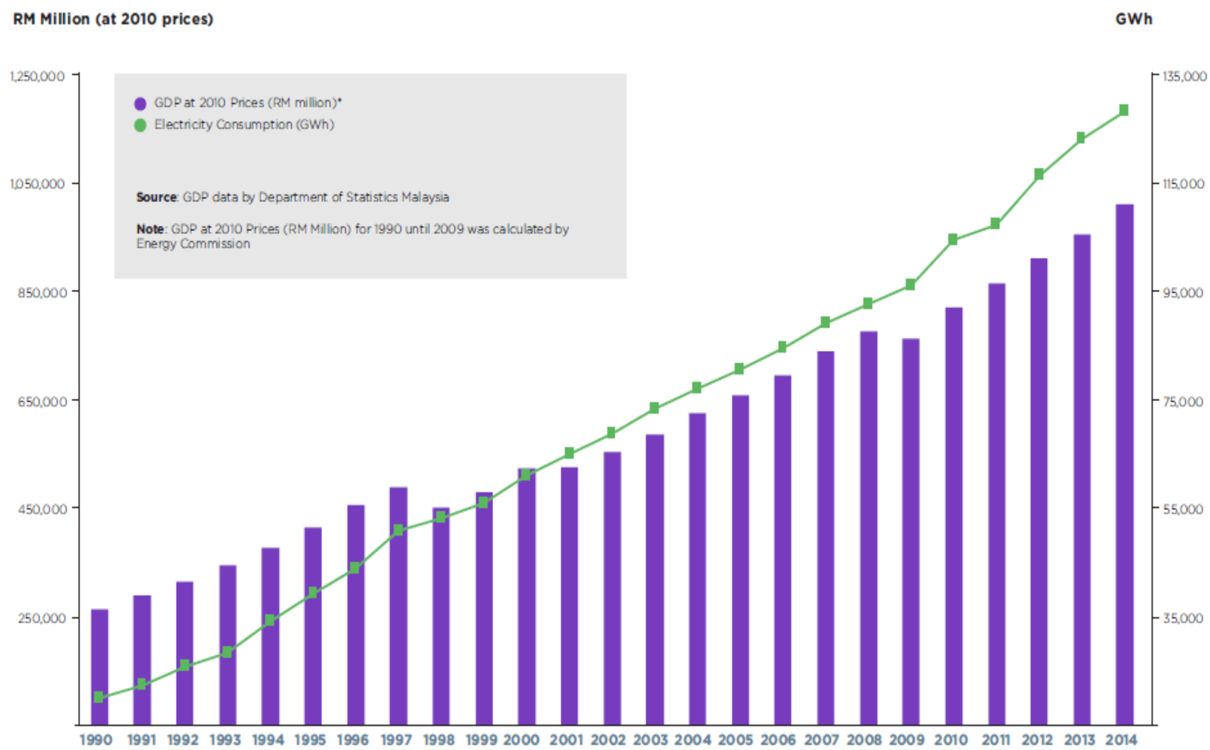
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
● (Primary Energy Supply)	21,471	26,335	29,291	29,925	31,662	33,879	37,840	43,173	40,996	44,534	50,710	51,979	53,196
● (Final Energy Consumption)	13,146	14,563	16,185	17,728	19,287	22,164	24,181	26,167	25,558	27,228	29,699	31,515	33,289
● (GDP)	263,488	288,639	314,285	345,384	377,201	414,276	455,715	489,086	453,092	480,901	523,503	526,213	554,581

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
● (Primary Energy Supply)	57,565	62,836	66,211	67,021	72,389	76,032	74,583	76,809	79,289	86,495	90,730	92,487
● (Final Energy Consumption)	34,586	37,323	38,285	38,567	41,606	41,968	40,845	41,476	43,455	49,291	51,583	52,209
● (GDP)	586,683	626,481	659,885	696,739	740,625	776,410	764,659	821,434	864,920	912,261	955,260	1,012,506

Source: Energy Commission, 2014

Figure 6.7 shows the overall GDP growth trend is directly related to the energy consumption from the period 1990 to 2014. The electricity consumption is expected to continue to rise in the next 15 years. The growth would be higher without any EE initiatives to control the rising energy consumption compared with the successful implementation of the proposed DSM project. The proposed DSM programme is therefore very important to reduce the final energy consumption for national economic development to reduce dependence on imported primary energy and to enhance indigenous energy security.

Figure 6.7 Electricity consumption vs GDP growth pattern, 1990 to 2014



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
GDP at 2010 Prices (RM million)*	263,488	288,639	314,285	345,384	377,201	414,276	455,715	489,086	453,092	480,901	523,503	526,213	554,581
Electricity Consumption (GWh)	19,932	22,373	25,778	28,474	34,076	39,225	43,897	50,952	53,195	55,961	61,168	65,015	68,827

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
GDP at 2010 Prices (RM million)*	586,683	626,481	659,885	696,739	740,625	776,410	764,659	821,434	864,920	912,261	955,260	1,012,506
Electricity Consumption (GWh)	73,371	77,195	80,705	84,517	89,294	92,815	96,302	104,519	107,331	116,350	123,079	128,330

Source: Energy Commission, 2014

6.2 Thermal Energy

The data collection format was presented and deliberated in three (3) workshops held with stakeholders. Thus, the format for the data and information gathering was developed as illustrated in Appendix B. The potential sources of data were identified and listed in Section 7.2.3. In addition, FMM organised a dialogue session with their members as the avenue to reach out to their members on the purpose to obtain the energy consumption data in the industrial sector.

6.2.1 Data from Energy Commission

The thermal energy data provided by ST were based on their industrial survey conducted with 520 manufacturing companies in Peninsular Malaysia in 2013. The period of the data made available spanned from 2010 to 2014. The data obtained were the final energy consumption by the sub-sectors in the manufacturing sector and, hence, energy consumption including gas flaring in energy supply side is not included in this study. It was noted that this survey was a one-off and voluntary programme. For the purpose of this DSM study, the data provided by ST include Sabah and Sarawak. ST's data included seven (7) types of thermal energy, namely natural gas, petrol, diesel, fuel oil, LPG, kerosene and coal for the eleven (11) industrial sub-sectors listed in Table 5.1 as well as the commercial and residential sectors.

It should be noted that ST's data did not include the consumption of biomass and biogas in the industrial sector in this study. ST's industrial survey data included electricity consumption, which was excluded in the analysis of the thermal energy consumption in this study.

6.2.2 Data from Gas Malaysia Bhd

Gas Malaysia Bhd (GMB) has provided the data on the supply of natural gas to the following eleven (11) industrial sub-sectors and one (1) commercial sector for the period of 2006 to 2015, in accordance with the data format provided:

- Food, beverages and tobacco products;
- Textiles products;
- Wood and wood products;
- Paper and paper products;
- Chemicals and chemical products;
- Rubber and plastic products;
- Non-metallic mineral products (incl. ceramic, concrete, glass but exclude cement due to non-supply);
- Basic metals (incl. basic iron and steel, basic precious and other non-ferrous metals, casting of metals);
- Fabricated metal products;
- Electrical and electronic equipment;
- Machinery and equipment; and
- Commercial / buildings.

The above classification by GMB is only for its own business purposes and may not be similar in definitions and coverage as compared to the classifications by MSIC and IEA.

6.2.3 Data from Federation of Malaysian Manufacturers

The data obtained from FMM members included both fossil fuels and RE sources such as saw dust, EFB, paddy husk, sludge, carbon black and biogas for the respective industrial processes.

An attempt was made to include the four (4) cement companies' data in the analysis of thermal energy shares by sectors in the consultation with stakeholders. However, it was pointed out that the ST's data included the consumption in the cement data, and hence, the analyses presented below do not consider of the data from the four (4) cement companies. The data obtained from the seven (7) FMM members were not complete as the data furnished did not necessarily represent their respective sub-sectors.

6.2.4 Findings from the data analyses

It was found that there were differences in the natural gas data between ST and GMB in the initial collection of data. The differences are summarised as follows:

i) There were no data available for some sub-sectors in the ST's data for natural gas consumption (e.g. rubber and plastic products, fabricated metal products, electrical and electronic equipment, and commercial buildings); and
ii) The values of natural gas consumption data produced by ST were significantly lower than those values produced by GMB in some industrial sub-sectors such as the non-metallic mineral products, and machinery and equipment. However, in some industrial sub-sectors such as the food, beverages and tobacco, chemical and basic metals, the ST's data on natural gas were significantly higher than those values produced by GMB.

In view of these differences, some assumptions have been made and are described as follows:

- For the natural gas consumption, data furnished by GMB has been used for the above-mentioned industrial sub-sectors and commercial sector where natural gas data were not available in the data furnished by ST;

- Where the GMB data showed lower consumption values in some industrial sub-sectors than those of the data furnished by ST, the latter data were used in the analyses since

GMB data did not include data from Sabah and Sarawak, whereas data from ST were deemed to cover both states;

- GMB has made available a small amount of natural gas consumption data in the commercial sector but there was none in the data from ST for this sector. Hence, this amount of natural gas consumption was added to the LPG gas consumption data in the commercial sector made available by ST.

A clarification with ST was made on the discrepancies and assumptions made in the analysis of the first set of data as described in the above. Thus, a second set of data that comprised the following was obtained:

- A complete set of data entirely based on ST's survey conducted with 520 manufacturing companies in Peninsular Malaysia in 2013. The manufacturing industry sub-sectors classification was in accordance with the IEA and APEC format of classification.
- Thermal energy consumption data in Sabah and Sarawak.
- Thermal energy consumption data in commercial and residential sectors.

It should be noted that the manufacturing industry sub-sector classification in ST's survey is different from the Malaysian Standard Industrial Classification (MSIC) adopted by the Department of Statistics Malaysia (DOSM), e.g. iron and steel is classified under basic metals in MSIC, rubber and plastic products, fabricated metal, and electrical and electronic sub-sectors in MSIC are not listed under their respectie sub-sectors in ST's survey.

Table 6.2 and Figure 6.8 illustrate the thermal energy consumption for industrial, commercial and residential sectors from 2010 to 2014 based on the second set of data from ST. It shows the biggest shares of the consumption were from the iron and steel and non-metallic mineral products industrial sub-sectors at 24% and 20.10% respectively.

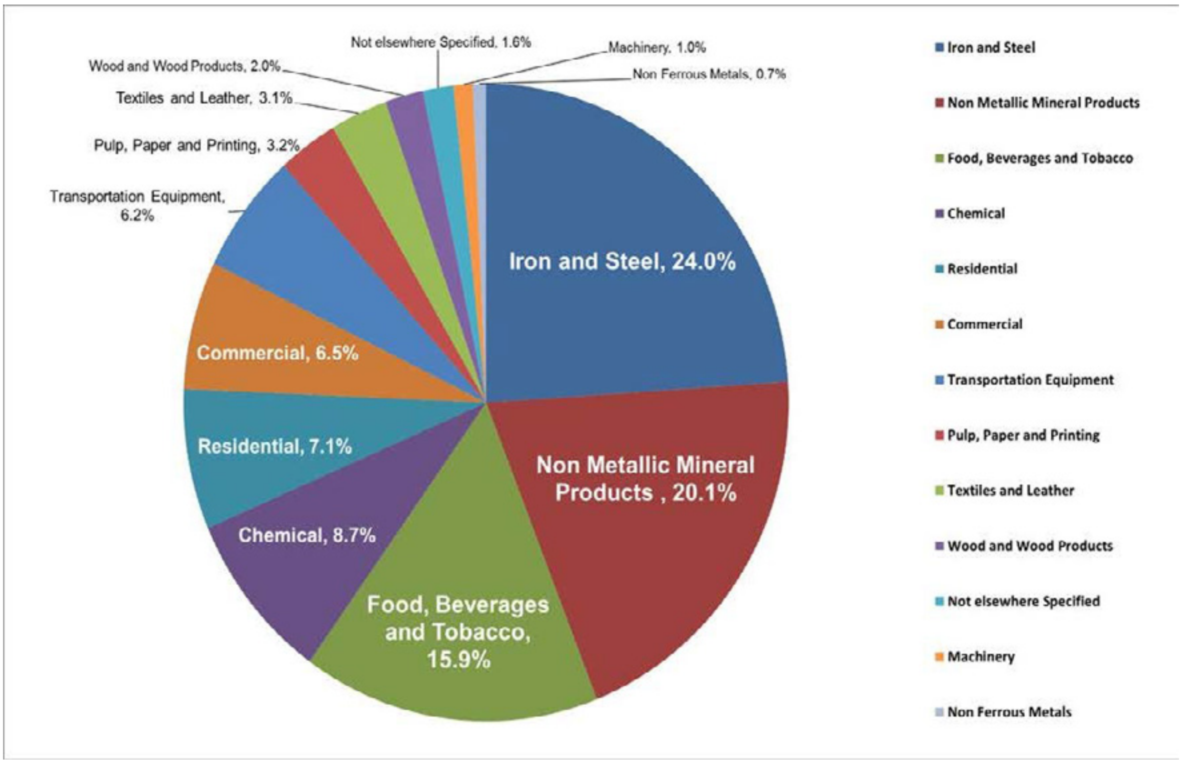
It should be noted that in view of the industrial sub-sector classification adopted by ST in accordance with the IEA and APEC format of classification, rubber and plastic products sub-sector is not featured in Table 6.2 although the natural gas consumption in this sub-sector is known to be substantial as shown in Appendix F on the analysis of natural gas consumption data. As detailed in Appendix F, the rubber and plastic sub-sector climbed from the third highest consumer of natural gas among the industrial sub-sectors in 2006 to the highest consumer of natural gas in 2015.Therefore, the inclusion of rubber and plastic data as a stand-alone sub-sector needs to be considered should there be any thermal energy data collection in the future.

Table 6.2 Thermal energy consumption in industrial, commercial and residential sectors in Malaysia, 2010 to 2014

Industrial / Commercial/ Residential	2010	2011	2012	2013	2014	Average Yearly Thermal Energy Consumption 2010-14 (ktoe)	Average Yearly Share of Thermal Energy Use (%)
Iron & Steel	2,471	2,264	2,466	2,484	2,287	2,394	24.0
Non-Metallic Mineral Products	2,143	2,027	2,123	1,805	1,938	2,007	20.1
Food, Beverages & Tobacco	1,525	1,480	1,580	1,627	1,724	1,587	15.9
Chemical	751	702	1,005	971	897	865	8.7
Transportation Equipment	613	483	775	805	400	615	6.2
Pulp, Paper & Printing	451	259	392	280	223	321	3.2
Textiles & Leather	461	307	324	228	209	306	3.1
Wood & Wood Products	249	212	334	128	91	203	2.0
Machinery	77	78	123	130	103	102	1.0
Non-Ferrous Metals	24	60	111	77	83	71	0.7
Not elsewhere specified (Industrial)	169	182	175	153	134	163	1.6
Commercial	611	592	631	693	721	650	6.5
Residential	699	781	703	735	640	712	7.1
Total Yearly Thermal Energy Consumption (ktoe)	10,244	9,427	10,743	10,115	9,450	9,996	100

Source: Energy Commission, 2014

Figure 6.8 Average yearly share (%) of thermal energy consumption in industrial, commercial and residential sectors in Malaysia, 2010 to 2014



The analyses of thermal energy data shown in Table 6.2 and Figure 6.8 were essentially based on ST's data as mentioned in the above. It is noteworthy to highlight that among the consumers of thermal energy; the following sector and sub-sectors show an increasing trend in energy consumption:

i) Food, beverages and tobacco sub-sector;
ii) Machinery sub-sector; and
iii) Commercial sector

On the other hand, the following sector and sub-sectors show decreasing trend in thermal energy consumption:

i) Iron and steel;
ii) Non-metallic mineral products;
iii) Chemical;
iv) Transportation equipment;
v) Pulp, paper and printing;
vi) Textiles and leather;
vii) Wood and wood products;
viii) Residential

The trend are likely to be due to the economic activities. The remaining sub-sectors of non-ferrous metals and “not elsewhere specified” do not show either of these two (2) trends. It is interesting to note in Table 6.2 that the total yearly thermal energy consumption in 2014 shows a decrease of about 6.50% from the 2013 consumption. Similarly, the total yearly thermal energy consumption in 2013 shows a decrease of about 5.80% from the 2012 consumption. This reduction could be due to a possible change of energy source and/or economic activities. However, due to the limited period and the one-off effort in thermal energy data collection, it is not possible to be conclusive about the thermal energy consumption pattern.

6.3 Transport Energy Use

In the present study, the data and information required to calculate the energy consumption and GHG emission (mainly CO_2 emission) by the total transport sector has been collected from different sources and/or methods. The sources of data and information used in the current study are listed in Table 6.3. It may be noticed from the table that the consultant had to adopt different ways including direct data collection from some authority or agency, estimation from available data base, prediction using different forecasting method, survey and even assumption wherever needed.

Table 6.3 Sources of data and information

Transport type	Year	Number of vehicle	Engine Capacity	Fuel types				Fuel economy (km/L)	Annual Distance Travel
				Petrol	Diesel	NGV	Electric		
Motor Cycle non- electric	2008 -2014	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	-	-	-	Collected, NAP 2014	Estimated Survey
	2007-2005	Estimated, JPJ	Collected, JPJ	Collected, JPJ	-	-	-	Collected, NAP 2014	Estimated Survey
Car non- electric	2008-2014	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	-	-	Estimated, NAP 2014 & manufacturers' specification	Estimated Survey
	2005-2007	Estimated, JPJ & MOT	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	-	Estimated, NAP 2014 & manufacturers' specification	Estimated Survey
Taxi	2008-2014	Collected, MOT & JPJ	Collected, JPJ	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	Estimated, NAP 2014 & manufacturers' specification	Estimated Survey
	2005-2007	Estimated, JPJ & MOT	Collected, JPJ	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	Estimated, NAP 2014 & manufacturers' specification	Estimated Survey
Goods Vehicle	2008-2014	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	-	-	Survey & info from FMFF	Survey & info from FMFF

Transport type	Year	Number of vehicle	Engine Capacity	Fuel types				Fuel economy (km/L)	Annual Distance Travel
				Petrol	Diesel	NGV	Electric		
	2005-2007	Estimated, JPJ & MOT	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	-	Survey & info from FMFF	Survey & info from FMFF
Bus	2008-2014	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	-	-	Manufacturers' specification	Estimated SPAD & Survey
	2005-2007	Estimated, JPJ & MOT	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	-	Manufacturers' specification	Estimated SPAD & Survey
Electric Vehicle	2011-2014	Collected, MOT & JPJ	-	-	-	-	Collected, MOT & JPJ	Estimated, NAP 2014 & manufacturers' specification	Estimated Survey
	2005-2010	No data	-	-	-	-	-	-	-
Other vehicles	2008-2014	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	Collected, MOT & JPJ	-	-	Assumption	Assumption
	2005-2007	Estimated, JPJ & MOT	Collected, JPJ	Collected, JPJ	Collected, JPJ	-	-	Assumption	Assumption
Train	2005-2014	Collected, MOT & SPAD	-	-	Collected, MOT & SPAD	-	Collected, MOT & SPAD	Electric train, Collected, NEB, Non-electric train estimated, KTMB	-
Air transport	2005-2014	-	-	-	-	-		Collected, NEB	Collected, NEB
Ferry	2014	Survey	Survey	Survey	Survey	Survey	-	Survey	Survey
	2005-2013	Survey	Survey	Survey	Survey	-	-	Survey	Survey
Fishing boat	2005-2014	DoF	DoF	-	DoF	-	-	DoF	DoF

Source: Energy Commission, *Jabatan Pengangkutan Jalan,* Ministry of Transport Malaysia, National Automotive Policy (Ministry of International Trade and Industry), Land Public Transport Commission, Department of Fisheries (DoF) Malaysia and Ferry Operators, Federation of Malaysian Freight Forwarders (FMFF)

Note: Collected means these data and information are directly excerpted from the sources as mentioned. The primary sources used for data and information are the data bases of MOT, JPJ, SPAD.

- Estimated means these data were not directly available from the primary data bases, rather these were estimated and/or calculated from the primary data by using standard formulae or correlations.
- Survey means the consultant collected these data based on survey conducted on limited basis.
- Assumption means these data were assumed on logical and rational basis due to unavailability of adequate information.

6.3.1 Motorcycles

Motorcycles are ranked to be the largest group of road vehicle in Malaysia. Based on a statistic from the Ministry of Transport Malaysia, Table 6.4 represents total of newly registered motorcycles based by engine capacity (cc) from 2011 to 2014. Referring to Table 6.5, in average of 4 years' worth data's of newly registered motorcycles, motorcycles with engine capacity (cc) of 101-150cc shows highest in average followed by motorcycles with engine capacity (cc) equal or less than 100cc.

Table 6.4 Number of newly registered motorcycles by engine capacity (cc), Malaysia, 2011 to 2014

Year/ cc	2014	2013	2012	2011
≤ 100cc	68,887	6,189	227,025	200,238
101-150cc	437,219	11,579	347,618	312,460
151-250cc	21,533	136	12,750	6,380
251-500cc	2,262	4	409	75
>500cc	11,511	49	8,937	5,938
Total	**541,412**	**17,957**	**596,739**	**525,091**

Source: Ministry of Transport Malaysia, 2014

Table 6.5 Analysis and findings of percentage of newly registered motorcycles by engine capacity (cc), Malaysia, 2011 to 2014

Year/ cc	2014 (%)	2013 (%)	2012 (%)	2011 (%)	Average (%)
≤ 100cc	12.72	34.47	38.04	38.13	**30.84**
101-150cc	80.76	64.48	58.25	59.51	**65.75**
151-250cc	3.98	0.76	2.14	1.22	**2.02**
251-500cc	0.42	0.02	0.07	0.01	**0.13**
>500cc	2.13	0.27	1.50	1.13	**1.26**

Table 6.6 provides the findings of the analysis on the quantity of motorcycles in Malaysia in the period from 2005 to 2014 according to the engine capacity. In 2005, the quantity of bikes

was seven (7) million and increased to 11.6 million in 2014. In all years, the first two (2) types are obviously the most (97%) elevated needs of clients, which are more than 11 million in 2014. Interestingly, out of the five (5) categories, the 250-500cc type has lowest contribution just around 0.10%. From the bar outline Figure 6.9, it can obviously be seen that the quantity of autos increases reasonably at a normal rate of 6%. In addition, Table 6.7 shows the fuel type and fuel economy of motorcycle in terms of mileage for Malaysia**.**

Table 6.6 Analysis and findings of total number of motorcycles in Malaysia by engine capacity (million), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 100cc	2.163	2.302	2.452	2.618	2.757	2.912	3.079	3.266	3.419	3.586
101-150cc	4.612	4.908	5.227	5.580	5.878	6.208	6.565	6.963	7.290	7.646
151-250cc	0.142	0.151	0.161	0.171	0.181	0.191	0.202	0.214	0.224	0.235
251-500cc	0.009	0.010	0.010	0.011	0.012	0.012	0.013	0.014	0.014	0.015
>500cc	0.088	0.094	0.100	0.107	0.113	0.119	0.126	0.133	0.140	0.147
Total	**7.014**	**7.464**	**7.950**	**8.487**	**8.940**	**9.442**	**9.985**	**10.589**	**11.087**	**11.628**

Figure 6.9 Analysis and findings of the growth trend of the total number of motorcycles in Malaysia by engine capacity, 2005 to 2014

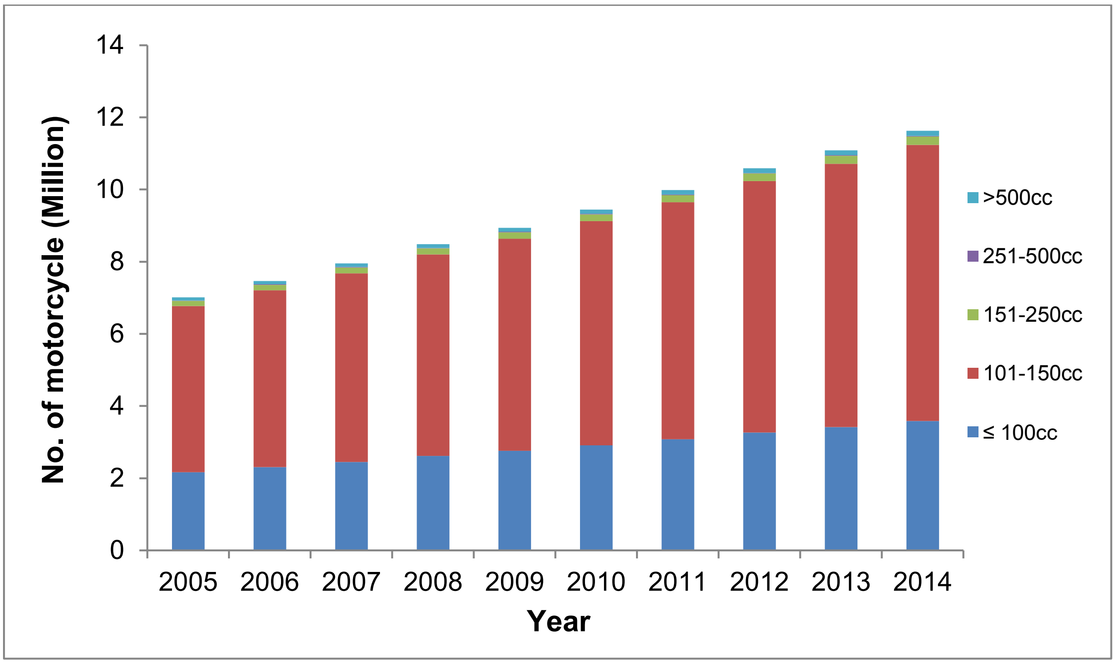


Table 6.7 Fuel type and fuel economy of motorcycles in terms of mileage (km/L), Malaysia

Engine capacity	Fuel Type	Mileage(km/L)
≤ 100cc	Petrol	50
101-150cc	Petrol	45.5
151-250cc	Petrol	40
251-500cc	Petrol	33.5
>500cc	Petrol	27

Source: Ministry of International Trade and Industry, 2014

6.3.2 Cars

Table 6.8 shows the number of newly registered cars by 11 different engine capacities in Malaysia for a ten (10) years' period from 2005 to 2014. By using these values, the percentage of each engine type for corresponding year has been calculated and shown in Table 6.9.

Table 6.8 Number of newly registered cars by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
<=1000cc	107,167	77,369	79,510	79,986	74,327	69,569	61,410	57,061	50,951	58,174
>5000cc	63	63	96	109	204	355	369	376	311	321
1001-1300cc	118,619	141,990	146,901	113,718	98,281	84,036	74,486	51,758	74,298	69,661
1301-1500cc	106,222	81,156	77,199	137,942	143,095	182,535	185,559	227,416	248,845	267,841
1501-2000cc	166,162	118,010	113,134	147,148	148,157	178,611	187,428	195,589	184,961	166,610
2001-2500cc	49,533	39,918	43,558	50,246	52,079	62,494	64,690	68,566	72,548	78,892
2501-3000cc	10,940	8,992	10,935	11,754	11,265	14,569	15,869	17,323	14,891	14,227
3001-3500cc	832	998	1,768	2,201	3,053	4,456	3,944	3,024	3,505	4,575
3501-4000cc	201	160	439	622	739	951	1,380	1,359	1,285	1,367

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
4001-4500cc	564	434	617	455	567	655	612	514	375	296
4501-5000cc	160	233	522	756	954	1,197	1,376	1,271	1,213	1,138
Total	560,463	469,323	474,679	544,937	532,721	599,428	597,123	624,257	653,183	663,102

Source: Ministry of Transport Malaysia, 2014

Table 6.9 Analysis and findings of percentage of newly registered cars by engine capacity (cc), Malaysia, 2005 - 2014

Year/ cc	2005 %	2006 %	2007 %	2008 %	2009 %	2010 %	2011 %	2012 %	2013 %	2014 %	Average %
<=1000cc	19.12	16.49	16.75	14.68	13.95	11.61	10.28	9.14	7.80	8.77	**12.86**
>5000cc	0.01	0.01	0.02	0.02	0.04	0.06	0.06	0.06	0.05	0.05	**0.04**
1001-1300cc	21.16	30.25	30.95	20.87	18.45	14.02	12.47	8.29	11.37	10.51	**17.83**
1301-1500cc	18.95	17.29	16.26	25.31	26.86	30.45	31.08	36.43	38.10	40.39	**28.11**
1501-2000cc	29.65	25.14	23.83	27.00	27.81	29.80	31.39	31.33	28.32	25.13	**27.94**
2001-2500cc	8.84	8.51	9.18	9.22	9.78	10.43	10.83	10.98	11.11	11.90	**10.08**
2501-3000cc	1.95	1.92	2.30	2.16	2.11	2.43	2.66	2.77	2.28	2.15	**2.27**
3001-3500cc	0.15	0.21	0.37	0.40	0.57	0.74	0.66	0.48	0.54	0.69	**0.48**
3501-4000cc	0.04	0.03	0.09	0.11	0.14	0.16	0.23	0.22	0.20	0.21	**0.14**
4001-4500cc	0.10	0.09	0.13	0.08	0.11	0.11	0.10	0.08	0.06	0.04	**0.09**
4501-5000cc	0.03	0.05	0.11	0.14	0.18	0.20	0.23	0.20	0.19	0.17	**0.15**

Table 6.10 shows findings on the analysis of the number of cars in Malaysia in the period from 2005 to 2014 according to their engine capacity. In 2005, the total number of cars are 6.47 million and become near to double (11.03 million) in 2014. In all years, cars with engine capacities 1301-1500cc and 1501-2000cc are clearly the highest demand among users, which are more than 6.0 million in 2014. In contrast, only around 0.1 million cars having the

engine capacity above 3000cc. From the Figure 6.10, it can clearly be seen that the number of cars increases moderately at an average rate of 6.10%, lowest rate at 1.75% in 2013 and the highest rate at 7.34% in 2008. Finally, the fuel type and fuel economy of motor car in terms of mileage (km/L) for Malaysia is presented in Table 6.11.

Table 6.10 Analysis and findings of total number of cars by engine capacity (cc), Malaysia (million), 2005 - 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1000cc	0.833	0.893	0.954	1.024	1.094	1.172	1.250	1.332	1.355	1.418
1001-1300cc	1.155	1.239	1.323	1.420	1.517	1.625	1.733	1.846	1.878	1.966
1301-1500cc	1.821	1.953	2.086	2.239	2.391	2.562	2.733	2.911	2.962	3.100
1501-2000cc	1.810	1.941	2.074	2.226	2.377	2.547	2.716	2.893	2.944	3.081
2001-2500cc	0.653	0.700	0.748	0.803	0.857	0.919	0.980	1.044	1.062	1.112
2501-3000cc	0.147	0.158	0.168	0.181	0.193	0.207	0.221	0.235	0.239	0.250
3001-3500cc	0.031	0.033	0.036	0.038	0.041	0.044	0.047	0.050	0.051	0.053
3501-4000cc	0.009	0.010	0.010	0.011	0.012	0.013	0.014	0.014	0.015	0.015
4001-4500cc	0.006	0.007	0.007	0.008	0.009	0.009	0.010	0.010	0.011	0.011
4501-5000cc	0.010	0.010	0.011	0.012	0.013	0.014	0.015	0.016	0.016	0.017
>5000cc	0.003	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004
Total	**6.478**	**6.947**	**7.422**	**7.967**	**8.506**	**9.115**	**9.721**	**10.355**	**10.536**	**11.028**

Figure 6.10 Analysis and findings of the growth trend of the total number of cars in Malaysia by engine capacity, 2005 to 2014

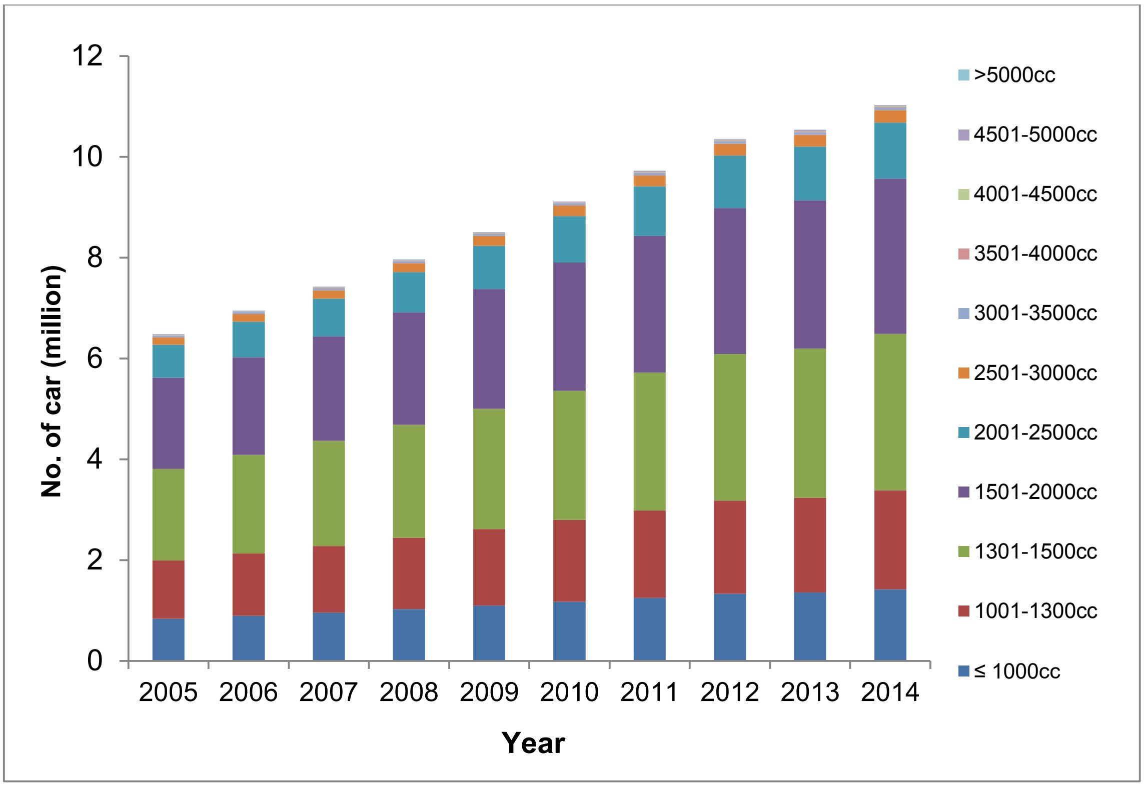


Table 6.11 Fuel type and fuel economy of cars in terms of mileage (km/L), Malaysia

Engine capacity	Percentage of cars using a particular fuel	Mileage (km/L)
≤ 1000cc	100% car on petrol	17
1001-1300cc	100% car on petrol	14
1301-1500cc	100% car on petrol	12
1501-2000cc	100% car on petrol	10
2001-2500cc	50% petrol+50% diesel	9
2501-3000cc	50% petrol+50% diesel	8
3001-3500cc	50% petrol+50% diesel	8
3501-4000cc	50% petrol+50% diesel	8
4001-4500cc	50% petrol+50% diesel	7
4501-5000cc	50% petrol+50% diesel	7
>5000cc	50% petrol+50% diesel	7

Source: Ministry of International Trade and Industry, 2014, Cars Manufacturer Specifications, 2016

6.3.3 Buses

Table 6.12 provides the number of newly registered buses by nine (9) available engine capacities in Malaysia for ten (10) years' period from 2005 to 2014. The percentage of each engine type for corresponding year is calculated from these values and pointed out in Table 6.13.

Table 6.12 Number of newly registered buses by engine capacity (cc), Malaysia, 2011 to 2014

Year/ cc	2011	2012	2013	2014
≤ 1500cc	91	0	0	0
1501-2000cc	138	9	1	0
2001-2500cc	303	289	394	1
2501-3000cc	322	312	467	5
3001-3500cc	14	0	0	0
3501-4000cc	7	5	10	20
4001-4500cc	116	87	104	85
4501-5000cc	10	2	0	0
> 5000cc	1,146	785	1,015	1,170
Total	**2,147**	**1,489**	**1,991**	**1,281**

Source: Ministry of Transport Malaysia, 2014

Table 6.13 Analysis and findings of the percentage of newly registered buses by engine capacity (cc), Malaysia, 2011 to 2014

Year/ cc	2011 %	2012 %	2013 %	2014 %	Average %
≤ 1500cc	4.24	0.00	0.00	0.00	**1.06**
1501-2000cc	6.43	0.60	0.05	0.00	**1.77**
2001-2500cc	14.11	19.41	19.79	0.08	**13.35**
2501-3000cc	15.00	20.95	23.46	0.39	**14.95**
3001-3500cc	0.65	0.00	0.00	0.00	**0.16**
3501-4000cc	0.33	0.34	0.50	1.56	**0.68**
4001-4500cc	5.40	5.84	5.22	6.64	**5.78**

Year/ cc	2011 %	2012 %	2013 %	2014 %	Average %
4501-5000cc	0.47	0.13	0.00	0.00	**0.15**
> 5000cc	53.38	52.72	50.98	91.33	**62.10**

Table 6.14 demonstrates the quantity of bus in Malaysia for the period from 2005 to 2014 according to their engine capacity. In 2005, the quantity of buses is nearly 60,000 and has increased to around 74,000 in 2012.Throughout 2005 to 2014, 62% of the total number of buses are with the engine capacity of above 5000cc. Just around 0.20% buses are with the engine capacity of 4501-5000cc. Figure 6.11 shows that the quantity of buses increased at a rate of 3% from 2005 to 2012. However, in 2013 it has decreased by 15% due to more buses being scrapped versus the newly registered ones. Finally, in 2014, the number of buses increased by 3.50% to a total of 65,000. The fuel used and its corresponding fuel economy for buses in terms of mileage (km/L) are shown in Table 6.15.

Table 6.14 Analysis and findings of the total number of buses by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	630	647	660	679	706	733	761	779	666	689
1501- 2000cc	1,052	1,081	1,103	1,134	1,178	1,224	1,271	1,302	1,111	1,151
2001-2500cc	7,932	8,153	8,316	8,551	8,889	9,231	9,583	9,817	8,382	8,683
2501-3000cc	8,882	9,130	9,313	9,575	9,954	10,338	10,732	10,994	9,386	9,724
3001-3500cc	95	98	100	102	107	111	115	118	100	104
3501-4000cc	404	415	424	436	453	470	488	500	427	442
4001-4500cc	3,434	3,530	3,601	3,702	3,848	3,997	4,149	4,250	3,629	3,760
4501-5000cc	89	92	93	96	100	104	108	110	94	98
>5000cc	36,895	37,925	38,685	39,775	41,347	42,942	44,578	45,666	38,989	40,392
Total	**59,413**	**61,071**	**62,294**	**64,050**	**66,581**	**69,149**	**71,784**	**73,536**	**62,784**	**65,044**

Figure 6.11 Analysis and findings of the growth trend of the total number of buses in Malaysia by engine capacity, 2005 to 2014

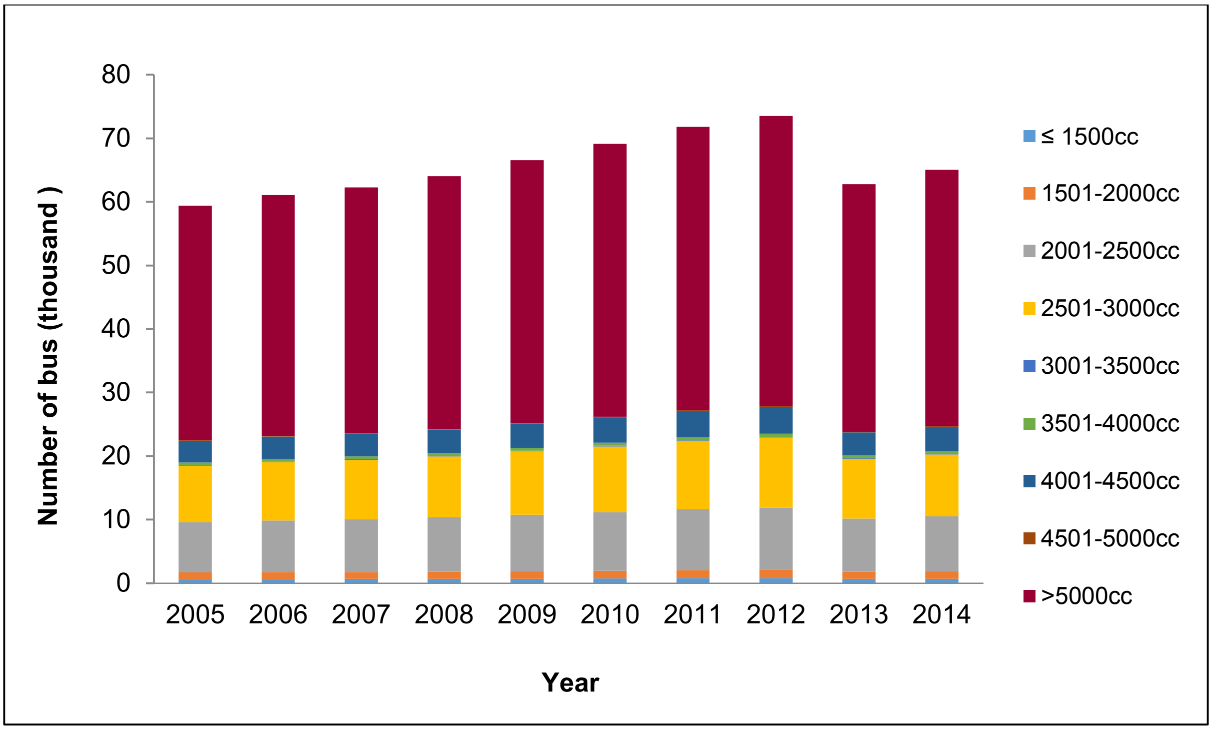


Table 6.15 Fuel type and fuel economy of buses in terms of mileage (km/L), Malaysia

Engine capacity	Fuel type	Mileage (km/L)
≤ 1500cc	Diesel	6.5
1501-2000cc	Diesel	6.5
2001-2500cc	Diesel	4.5
2501-3000cc	Diesel	4.5
3001-3500cc	Diesel	4.5
3501-4000cc	Diesel	3.5
4001-4500cc	Diesel	3.5
4501-5000cc	Diesel	3.5
>5000cc	Diesel	3

Source: Ministry of International Trade and Industry, 2014, Bus Manufacturer Specifications, 2016

6.3.4 Taxis

Table 6.16 provides information on the number of newly registered taxis by five (5) engine capacities available in Malaysia for ten (10) years' time frame, 2005 to 2014. The percentage of each engine type for corresponding year has been calculated from these data and figured in Table 6.17.

Table 6.16 Number of newly registered taxis by engine capacity (cc), Malaysia, (JPJ, 2005-2014)

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	3,176	3,507	2,893	2,106	1,969	555	503	347	377	981
1501-2000cc	414	536	636	1,873	2,288	5,493	7,655	5,709	4,649	6,673
2001-2500cc	33	212	309	147	239	173	525	394	547	613
2501-3000cc	106	33	248	97	100	145	123	92	81	60
>3000cc	2	2	20	4	7	3	5	22	19	31
Total	3,731	4,290	4,106	4,227	4,603	6,369	8,811	6,564	5,673	8,358

Source: Ministry of Transport Malaysia, 2014

Table 6.17 Analysis and findings of the percentage of newly registered taxis by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005 %	2006 %	2007 %	2008 %	2009 %	2010 %	2011 %	2012 %	2013 %	2014 %	Average %
≤ 1500cc	85.12	81.75	70.46	49.82	42.78	8.71	5.71	5.29	6.65	11.74	**36.80**
1501-2000cc	11.10	12.49	15.49	44.31	49.71	86.25	86.88	86.97	81.95	79.84	**55.50**
2001-2500cc	0.88	4.94	7.53	3.48	5.19	2.72	5.96	6.00	9.64	7.33	**5.37**
2501-3000cc	2.84	0.77	6.04	2.29	2.17	2.28	1.40	1.40	1.43	0.72	**2.13**
>3000cc	0.05	0.05	0.49	0.09	0.15	0.05	0.06	0.34	0.33	0.37	**0.2**

Table 6.18 demonstrates the number of taxis for Malaysia in the period from 2005 to 2014. Taxis are categorised into five (5) classes based on engine capacity. In 2005, the quantity

of taxis is around 74,000 and has grown more than double (165,000) in 2014. In all years, taxis with 1501-2000cc capacity makes up the biggest number, which is more than 138,000 in 2014. Figure 6.12 shows that the sudden increase of taxis in 2013 from 2012. Different types of fuel are used in taxi and the economy of taxis in terms of mileage (km/L) for Malaysia are shown in Table 6.19.

Table 6.18 Analysis and findings of the total number of taxis by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	5,413	5,728	6,030	6,645	7,031	7,562	8,021	8,251	11,301	12,091
1501-2000cc	61,844	65,444	68,889	75,918	80,326	86,396	91,642	94,262	129,118	138,138
2001-2500cc	5,332	5,642	5,939	6,545	6,925	7,449	7,901	8,127	11,132	11,910
2501-3000cc	911	964	1,015	1,118	1,183	1,272	1,350	1,388	1,902	2,034
>3000cc	202	214	225	248	263	283	300	308	422	452
Total	**73,702**	**77,992**	**82,098**	**90,474**	**95,728**	**102,961**	**109,214**	**112,336**	**153,875**	**164,625**

Figure 6.12 Analysis and findings of the total number of taxis in Malaysia by engine capacity, 2005 to 2014

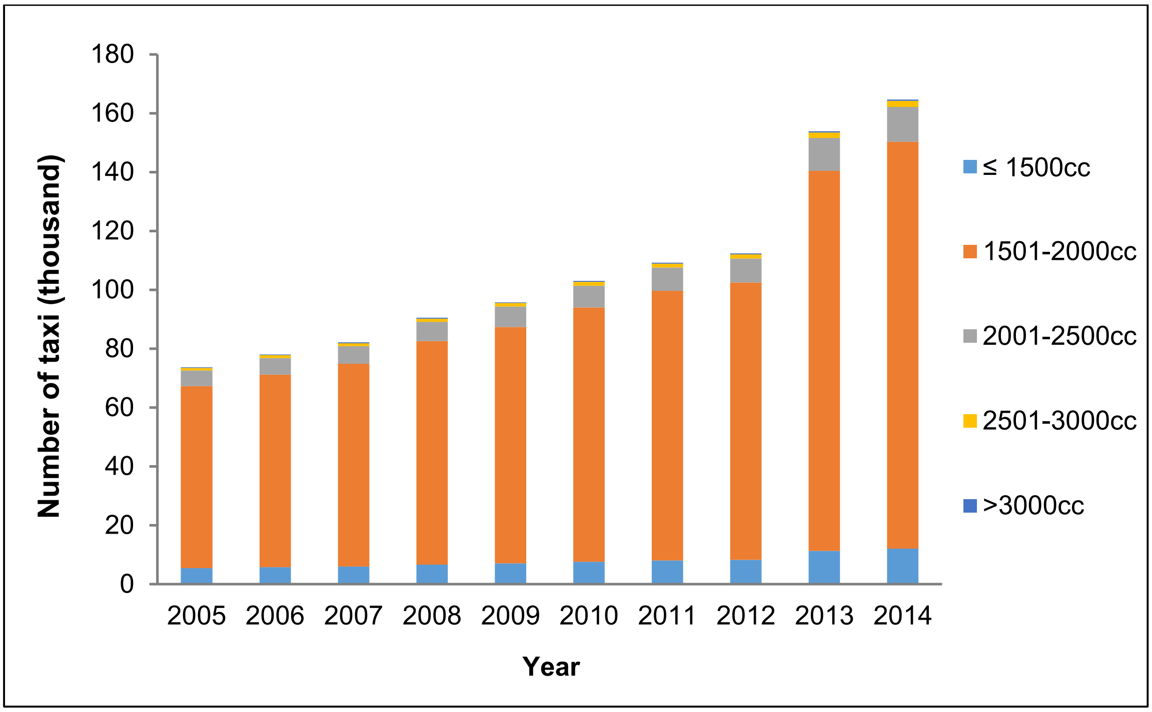


Table 6.19 Fuel type and fuel economy of taxis in term of mileage (km/L), Malaysia

Engine capacity	% of taxi using a particular fuel	Mileage km/L (liquid fuel)	Mileage km/L NGV (as CNG)
≤ 1500cc	Petrol-30%+NGV-70%	14	11.9
1501-2000cc	Petrol-30%+NGV-70%	10	11.9
2001-2500cc	Diesel-65%+P-35%	9	11.9
2501-3000cc	Diesel	8	11.9
>3000cc	Diesel	8	11.9

Source: Ministry of International Trade and Industry, 2014, Car Manufacturer Specifications, 2016

6.3.5 Goods vehicles

Motor vehicles which are used for carrying goods are normally regarded as goods vehicles. They are diverse in size according to its weight carrying capacity from small size as 2.5tons such as small vans and as large as above 55tons such as prime movers. Engine capacity of goods vehicles is normally higher than all other vehicle types. Fuel consumption is directly related to engine capacity and distance travelled of the vehicle. Normally available engine capacities of goods vehicles in Malaysia are up to 15,000cc. For appropriate calculation of fuel consumption, the total number of goods vehicles is split according to engine capacity. The percentage number of vehicle is calculated from the number of newly registered vehicles as shown in Table 6.20.

Table 6.20 Number of newly registered goods vehicles by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤2000cc	8,716	9,577	9,520	9,711	7,729	7,928	7,049	7,393	8,763	9,927
2001-4000cc	11,880	11,869	11,814	13,115	11,011	12,452	11,280	11,161	10,312	9,808
4001-6000cc	6,266	6,494	8,948	10,505	8,762	11,142	11,655	12,309	12,375	12,140
6001-8000cc	1,025	1,126	1,268	1,489	1,020	1,295	1,303	1,582	1,967	1,674
8001-10000cc	619	452	563	846	724	964	925	1,189	1,886	1,918

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
10001-15000cc	2,659	3,369	4,050	4,544	3,797	4,936	5,297	5,265	6,274	6,692
>15000cc	2,183	1,978	2,782	2,884	2,655	3,032	2,638	2,233	2,057	1,629
Total	**33,348**	**34,865**	**38,945**	**43,094**	**35,698**	**41,749**	**40,147**	**41,132**	**43,634**	**43,788**

Source: Ministry of Transport, 2014

Table 6.21 shows the findings from the analysis on the percentage of number of goods vehicles according to engine capacity registered at different years and percentages are averaged. Based on the average percentage, total number of goods vehicles is distributed by engine type. Total number of goods vehicles according to engine type is shown in Table 6.22. Number of goods vehicles increase from 792,340 in 2005 to 1.15 million in 2014. From Figure 6.13, it is shown that every year 2001-4000cc engine type is the maximum amount and then followed by 4001-6000cc and ≤ 2000cc. Lowest proportion in number is 8001-10000cc engine type.

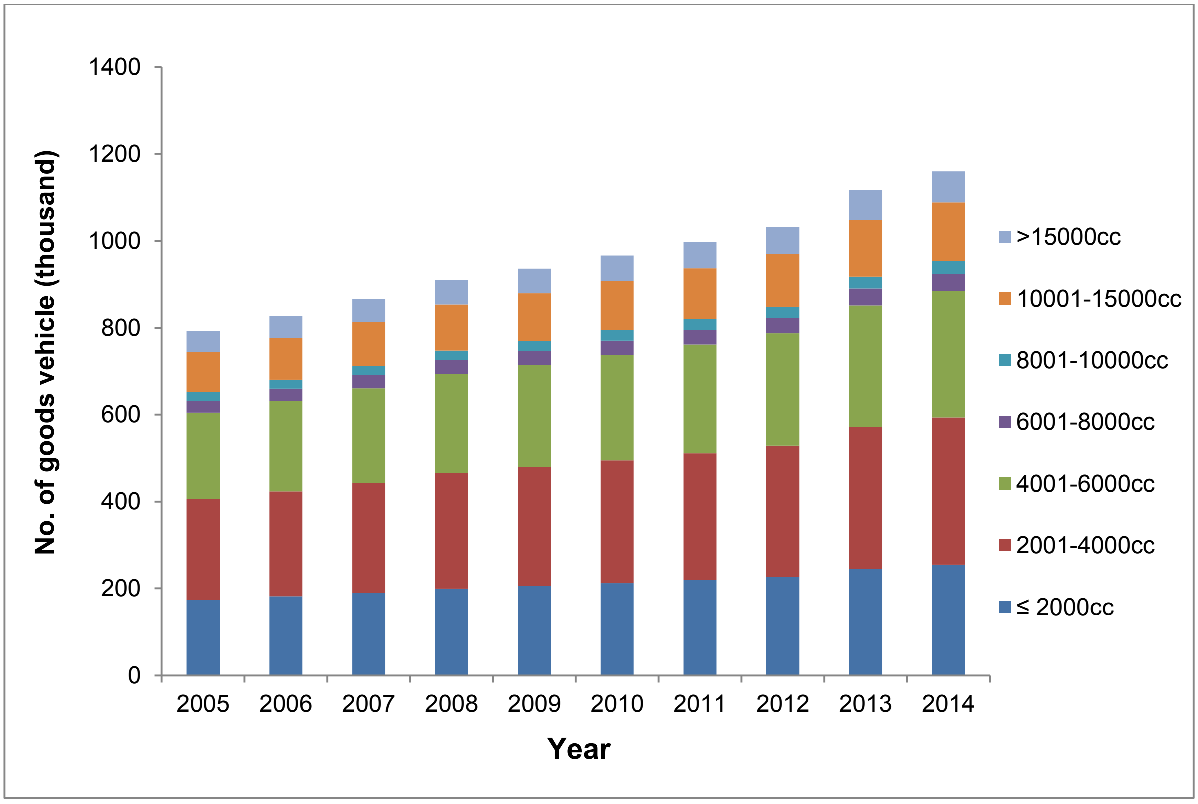
Table 6.21 Analysis and findings of the percentage of newly registered goods vehicles by engine capacity (cc), Malaysia, 2005 to 2014

Year/ cc	2005 %	2006 %	2007 %	2008 %	2009 %	2010 %	2011 %	2012 %	2013 %	2014 %	Average %
≤2000cc	26.14	27.47	24.44	22.53	21.65	18.99	17.56	17.97	20.08	22.67	**21.95**
2001-4000cc	35.62	34.04	30.34	30.43	30.84	29.83	28.10	27.13	23.63	22.40	**29.24**
4001-6000cc	18.79	18.63	22.98	24.38	24.54	26.69	29.03	29.93	28.36	27.72	**25.10**
6001-8000cc	3.07	3.23	3.26	3.46	2.86	3.10	3.25	3.85	4.51	3.82	**3.44**
8001-10000cc	1.86	1.30	1.45	1.96	2.03	2.31	2.30	2.89	4.32	4.38	**2.48**
10001-15000cc	7.97	9.66	10.40	10.54	10.64	11.82	13.19	12.80	14.38	15.28	**11.67**
>15000cc	6.55	5.67	7.14	6.69	7.44	7.26	6.57	5.43	4.71	3.72	**6.12**

Table 6.22 Analysis and findings of the total number of goods vehicles by engine capacity (cc), Malaysia (thousand), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	173.92	181.57	190.12	199.58	205.50	212.08	218.98	226.52	245.00	254.51
2001-4000cc	231.68	241.87	253.26	265.86	273.75	282.51	291.71	301.76	326.37	339.04
4001-6000cc	198.88	207.63	217.40	228.22	234.99	242.51	250.41	259.03	280.16	291.04
6001-8000cc	27.26	28.46	29.80	31.28	32.21	33.24	34.32	35.50	38.40	39.89
8001-10000cc	19.65	20.51	21.48	22.55	23.22	23.96	24.74	25.59	27.68	28.76
10001-15000cc	92.47	96.53	101.08	106.11	109.26	112.75	116.43	120.43	130.26	135.32
>15000cc	48.49	50.62	53.01	55.65	57.30	59.13	61.06	63.16	68.31	70.96
Total	792.34	827.20	866.15	909.24	936.22	966.18	997.65	1,032.00	1,116.17	1,159.52

Figure 6.13 Analysis and findings of the growth trend of the total number of goods vehicles in Malaysia by engine capacity, 2005 to 2014



Fuel type and mileage in terms of km/L of goods vehicles varies according to engine capacity. Table 6.23 shows the fuel type and fuel economy of goods vehicles in terms of mileage for Malaysia having different engine capacity. Only ≤ 2000cc type engine uses two (2) different fuel, where 45% of them use petrol and 55% use diesel. All other engine type use diesel as a fuel. Diesel is the main fuel used in goods vehicles.

However, Table 6.23 also shows their fuel types and fuel economy of goods vehicles in terms of mileage for Malaysia. Data obtain from JPJ, 2005-2014 and Freight Metrics (FM), 2016. FM is an association supported by qualifications in Engineering (Mechanical), Masters of Technology Management (Logistics), experience in road transport industry and experience in international project management in the mining sector (FM, 2016).

Table 6.23 Fuel type and fuel economy of goods vehicles in term of mileage (km/L), Malaysia

Engine capacity	Percentage of goods vehicle using a particular fuel	Mileage (km/L)
≤ 2000cc	45% petrol +55% diesel	9
2001-4000cc	100% goods vehicle on diesel	5
4001-6000cc	100% goods vehicle on diesel	4
6001-8000cc	100% goods vehicle on diesel	3
8001-10000cc	100% goods vehicle on diesel	3
10001-15000cc	100% goods vehicle on diesel	2.5
>15000cc	100% goods vehicle on diesel	2.5

Source: Ministry of Transport Malaysia, 2014, Freight Metrics, Australia, 2016

6.3.6 Electric vehicles

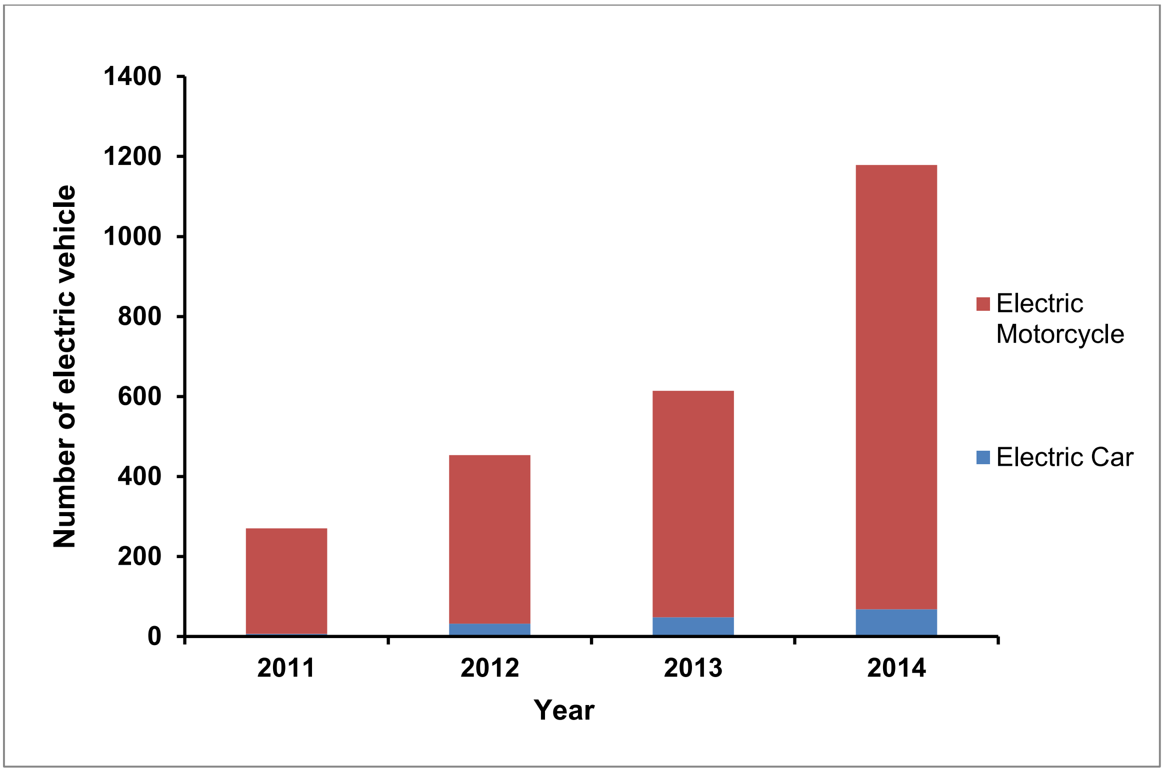
The EVs was introduced in Malaysia in 2011. Information on the number of EV in this country is shown in Table 6.24, for the 2011 to 2014. Only data for electric motorcycles and electric cars are available where the latter is more than 90% in numbers. However, nearly 50% of EVs are registered in 2014 as shown both in Table 6.24 and Figure 6.14.

Table 6.24 Number of EVs in Malaysia, 2011 to 2014

Year	2011	2012	2013	2014
Electric motorcycle	264	421	566	1,111
Electric car	6	32	48	68
Total	**270**	**453**	**614**	**1,179**

Source: Ministry of Transport Malaysia, 2014

Figure 6.14 Analysis and findings of the growth trend of the total number of EVs in Malaysia, 2011 to 2014



6.3.7 Other vehicles

Tables 6.25 to 6.27 and Figure 6.15 provide information on the newly registered and the number of other vehicles (i.e. ambulances, fire fighting vehicles, government agency vehicles, etc.) respectively in Malaysia for the year 2005 to 2014. They are categorised into seven (7) classes as per the engine capacity. In 2005, the quantity of these vehicles is about 13,000 and increase to more than 90% (21,000) in 2014. In these years, vehicles with 2001-

4000cc capacity are highest in numbers, which are more than 8,000, while >15000cc vehicles are the lowest (only 98), in 2014. Table 6.28 shows the fuel type and fuel economy of other vehicles in terms of mileage.

Table 6.25 Number of newly registered other vehicles by engine capacity (cc), Malaysia, 2005 to 2014

Year/cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	4,586	5,046	6,322	7,040	5,709	6,094	5,611	5,301	4,718	4,673
2001-4000cc	4,529	4,625	5,746	7,080	5,405	7,730	8,200	8,027	8,097	8,081
4001-6000cc	2,321	2,405	3,139	3,892	3,124	4,609	5,259	5,836	5,322	4,716
6001-8000cc	820	1,039	1,376	1,264	1,109	1,783	2,053	2,232	2,301	2,032
8001-10000cc	180	171	272	251	253	456	621	848	860	751
10001-15000cc	398	333	292	337	269	531	693	757	860	732
>15000cc	40	28	30	37	61	114	82	106	111	98
Total	12,874	13,647	17,177	19,901	15,930	21,317	22,519	23,107	22,269	21,083

Source: Ministry of Transport, 2014

Table 6.26 Percentage of newly registered other vehicles in Malaysia by engine capacity (cc), 2005 to 2014

Year/ cc	2005 %	2006 %	2007 %	2008 %	2009 %	2010 %	2011 %	2012 %	2013 %	2014 %	Average %
≤ 2000cc	35.62	36.98	36.81	35.38	35.84	28.59	24.92	22.94	21.19	22.16	**30.04**
2001-4000cc	0.31	0.21	0.17	0.19	0.38	0.53	0.36	0.46	0.50	0.46	**0.36**
4001-6000cc	3.09	2.44	1.70	1.69	1.69	2.49	3.08	3.28	3.86	3.47	**2.68**
6001-8000cc	35.18	33.89	33.45	35.58	33.93	36.26	36.41	34.74	36.36	38.33	**35.41**
8001-10000cc	18.03	17.62	18.27	19.56	19.61	21.62	23.35	25.26	23.90	22.37	**20.96**
10001-15000cc	6.37	7.61	8.01	6.35	6.96	8.36	9.12	9.66	10.33	9.64	**8.24**
>15000cc	1.40	1.25	1.58	1.26	1.59	2.14	2.76	3.67	3.86	3.56	**2.31**

Table 6.27 Analysis and findings of total number of other vehicles by engine capacity (cc), Malaysia (thousand), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	121.19	125.29	130.45	136.43	141.77	148.23	154.97	162.17	168.86	175.19
2001-4000cc	142.86	147.69	153.77	160.82	167.11	174.73	182.67	191.16	199.05	206.51
4001-6000cc	84.56	87.42	91.02	95.19	98.92	103.43	108.13	113.15	117.82	122.24
6001-8000cc	33.24	34.37	35.78	37.42	38.89	40.66	42.51	44.48	46.32	48.06
8001-10000cc	9.32	9.63	10.03	10.49	10.90	11.40	11.92	12.47	12.98	13.47
10001-15000cc	10.81	11.18	11.64	12.17	12.65	13.22	13.83	14.47	15.06	15.63
>15000cc	1.45	1.50	1.56	1.63	1.70	1.78	1.86	1.94	2.02	2.10
Total	403.43	417.08	434.26	454.16	471.94	493.45	515.87	539.85	562.12	583.20

Figure 6.15 Analysis and findings of total number of other vehicles in Malaysia by engine capacity, 2005 to 2014

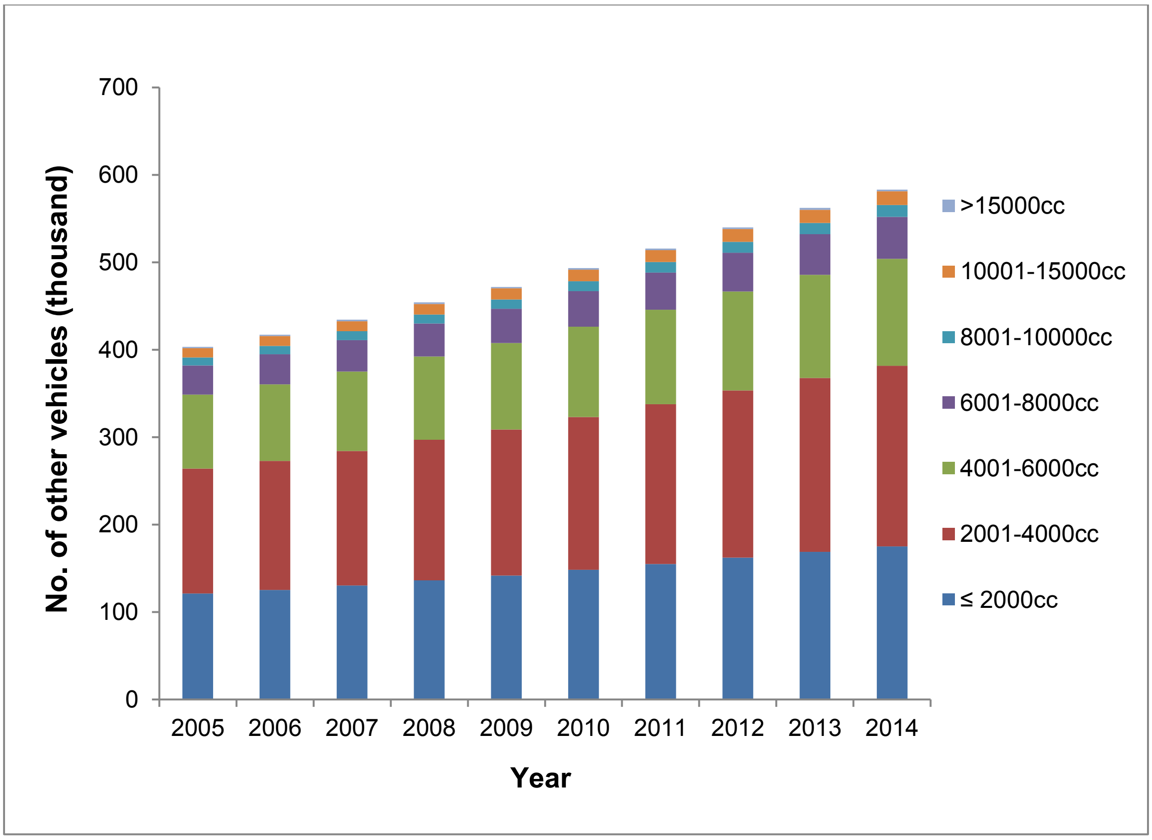


Table 6.28 Fuel type and fuel economy of other vehicles in terms of mileage (km/L)

Engine capacity	Percentage of other vehicles using a particular fuel	Mileage (km/L)
≤ 2000cc	20%petrol +80% diesel	9
2001-4000cc	10% Petrol +90% on diesel	5
4001-6000cc	100% others vehicle on diesel	4
6001-8000cc	100% others vehicle on diesel	3
8001-10000cc	100% others vehicle on diesel	3
10001-15000cc	100% others vehicle on diesel	2.5
>15000cc	100% others vehicle on diesel	2.5

Source: *Jabatan Pengangkutan Jalan,* 2014, Freight Metrics, Australia, 2016

6.3.8 Rail transport

Information on the electric trains (ET) in Malaysia are mentioned in Table 6.29 and Table 6.30, for the last ten (10) years from 2005 to 2014, where Table 6.27 presents the number of sets and Table 6.28 presents the number of locomotive trains (LT) with six (6) different classes, Class 22 to Class 29, excluding Class 27 and 28. The total number of LT (81), at the end of 2014 is slightly lower than the number (88) at the beginning of 2005, which is the reverse scenario from almost all other vehicles in this country.

Table 6.29 Number of electric train sets in Malaysia, 2005 to 2014

Year	EMU sets	ETS sets	Total
2005	58	-	58
2006	53	-	53
2007	58	-	58
2008	54	-	54
2009	58	-	58
2010	58	-	58
2011	67	5	72
2012	60	5	65
2013	50	5	55
2014	96	5	101

Source: Ministry of Transport Malaysia, 2014

Note:

EMU: Electric Multiple Unit train consisting of self-propelled carriages, using electricity as the motive power. ETS: Electric Train Service is an inter-city rail service operated by KTMB utilising electric multiple units.

Table 6.30 Number of locomotive train (diesel), 2005 to 2014

Year	Class 22	Class 23	Class 24	Class 25	Class 26	Class 29	Total
2005	10	15	26	17	20	-	**88**
2006	5	11	20	17	20	-	**73**
2007	5	11	26	17	20	-	**79**
2008	5	11	21	17	20	-	**74**
2009	4	11	18	17	20	20	**90**
2010	-	7	18	17	20	20	**82**
2011	-	7	18	17	20	20	**82**
2012	-	7	18	17	20	20	**82**
2013	-	7	18	17	20	20	**82**
2014	-	7	17	17	20	20	**81**

Source: Ministry of Transport Malaysia, 2014

6.3.9 Air transport

Table 6.31 provides information about the total number of domestic commercial aircraft movements by different airports within Malaysia, for the last ten (10) years from 2005 to 2014. The average increment in aircraft handled is near 9% per year.

Table 6.31 Total number of domestic commercial aircraft movements handled by airports in Malaysia, 2005 to 2014

Location	2008	2009	2010	2011	2012	2013	2014
Klia	80,787	83,031	86,549	95,243	97,154	114,720	112,197
Pulau Pinang	21,574	20,802	23,299	26,645	26,427	31,434	38,127
Kota Kinabalu	41,390	41,499	44,004	48,556	46,320	53,168	54,418
Kuching	32,606	36,401	38,637	44,437	38,325	47,448	46,126
Langkawi	11,165	10,971	11,571	12,902	14,067	16,362	20,094

Location	2008	2009	2010	2011	2012	2013	2014
Johor Bharu	-	-	11,766	12,245	12,500	35,670	40,021
Kota Bharu	14,083	13,709	13,180	15,304	16,947	20,309	24,814
Ipoh	-	-	-	40	28	7	434
Kuala Terengganu	6,027	5,930	5,729	5,929	6,491	7,335	9,445
Alor Setar	2,934	4,578	4,513	4,841	5,274	5,775	8,401
Melaka	-	-	-	24	198	-	140
Subang	10,388	15,771	18,514	22,520	25,164	33,662	48,104
Kuantan	3,282	2,710	2,177	2,732	2,800	2,507	2,792
Tioman	982	960	1,020	1,111	1,150	985	266
Pangkor	503	502	174	32	324	258	8
Redang	765	584	898	849	565	575	280
Labuan	10,794	10,563	11,822	12,524	13,236	14,832	15,091
Lahad Datu	2,922	2,922	2,860	2,941	3,058	3,321	3,689
Sandakan	8,940	9,902	11,428	10,727	12,139	11,477	11,702
Tawau	7,301	8,762	9,658	9,310	9,206	11,050	12,137
Bintulu	8,922	10,942	10,967	11,208	11,378	12,385	12,224
Miri	35,178	38,706	39,441	40,346	41,210	43,702	45,214
Sibu	14,307	16,274	17,899	18,211	15,923	17,195	17,877
Mulu	1,642	1570	1,726	1,912	1,760	2,306	2,385
Limbang	1,860	1697	1,947	1,896	1,880	2,075	2,154
Stol Sabah	459	-	167	264	192	231	226
Stol Sarawak	12,716	12,140	13,538	14,118	13,534	12,886	15,324
Peninsular	152,490	159,548	79,939	200,417	84,151	269,599	305,123
Sabah	71,806	73,648	124,155	84,322	124,010	94,079	97,263
Sarawak	107,231	117,730	179,390	132,128	417,250	137,997	141,304
Total	331,527	350,926	383,484	416,867	209,089	501,675	543,690

Source: Ministry of Transport Malaysia, 2014

6.3.10 Water transport

Information on water transport including fishing boats and ferries in Malaysia are shown in Table 6.32. These are grouped into four (4) major categories, i.e. commercial (inboard-diesel), traditional (inboard-diesel), traditional (outboard-petrol) and ferry (diesel) trip/day. Category 3 is an average more than 50% of the total number, which runs on petrol.

Table 6.32 Number of fishing boat and ferry (trip/day) in Malaysia, 2005 to 2014

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.Commercial (inboard-diesel)[1]	7,300	7,000	7,100	7,300	7,300	7,500	7,300	7,200	7,300	7,200
2.Traditional (inboard-diesel)[1]	9,700	11,000	10,900	10,300	10,500	10,200	9,900	9,800	9,900	9,800
3.Traditional (outboard-petrol)[2]	18,800	20,200	21,100	23,200	30,800	31,900	35,700	37,000	39,800	40,800
4.Ferry (diesel) Trip/day	378	378	426	426	426	426	426	426	426	426
Total	**36,178**	**38,578**	**39,526**	**41,226**	**49,026**	**50,026**	**53,326**	**54,426**	**57,426**	**58,226**

Source: Fisheries Development Authority of Malaysia and Ferry Operators, 2014

Note:

[1]Inboard: engine enclosed within the hull of the boat, usually connected to a propulsion screw by a driveshaft.

[2]Outboard: engine is mounted outside the hull of the craft.

6.3.11 Motorcycle fuel consumption, energy consumption and CO_2 emission

Table 6.33 shows findings from the analysis of the data on fuel consumption by motorcycles in Malaysia for the years 2005 to 2014, for five (5) different groups. In 2005, the total fuel consumed is 1.52 billion litres and increases to 2.52 billion litres in 2014. In these years, motorcycles with engine capacity of 101-150cc are the significant fuel users, and on average utilised more than 60% of total fuel consumption. Figure 6.16 shows the increase in the amount of fuel consumption at an average rate of 6%.

Table 6.33 Analysis and findings of total fuel consumption by motorcycles, Malaysia (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 100cc	432.64	460.41	490.38	523.51	551.43	582.38	615.88	653.15	683.87	717.22
101-150cc	1,013.60	1,078.66	1,148.87	1,226.48	1,291.91	1,364.41	1,442.89	1,530.23	1,602.18	1,680.33
151-250cc	35.42	37.70	40.15	42.86	45.15	47.68	50.42	53.48	55.99	58.72
251-500cc	2.72	2.90	3.09	3.29	3.47	3.66	3.87	4.11	4.30	4.51
>500cc	32.73	34.83	37.10	39.61	41.72	44.06	46.60	49.42	51.74	54.26
Total	1,517.11	1,614.49	1,719.58	1,835.75	1,933.68	2,042.19	2,159.67	2,290.38	2,398.08	2,515.06

Figure 6.16 Analysis and findings of fuel consumption growth trend by motorcycles in Malaysia by engine capacity, 2005 to 2014

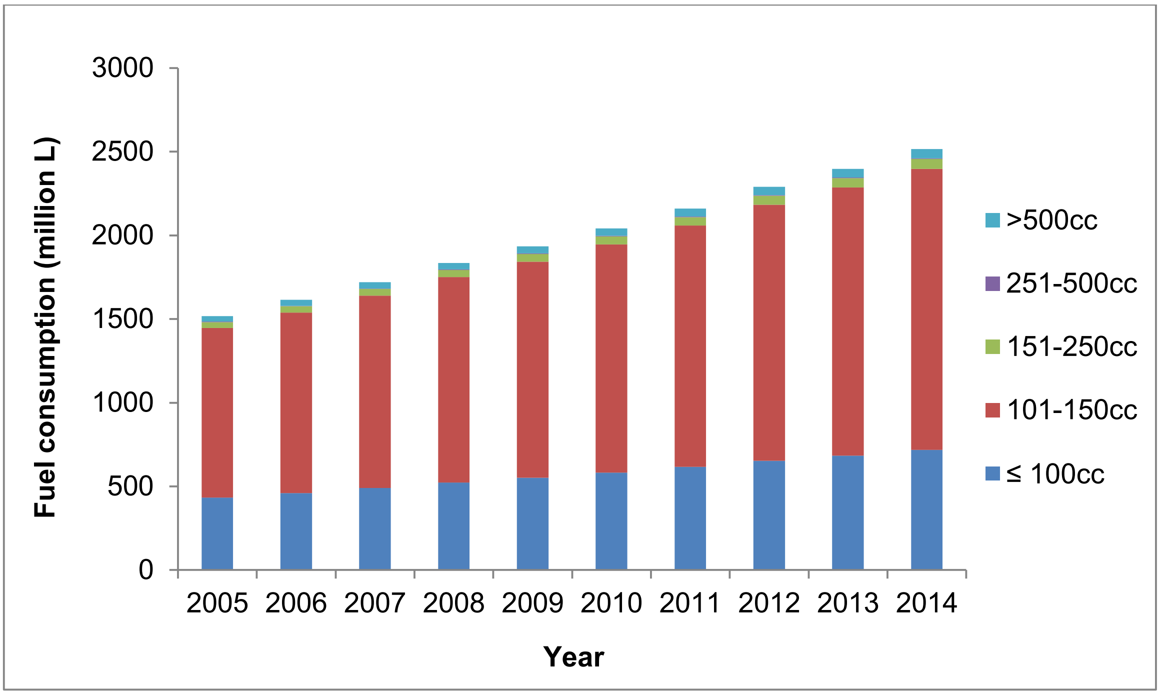


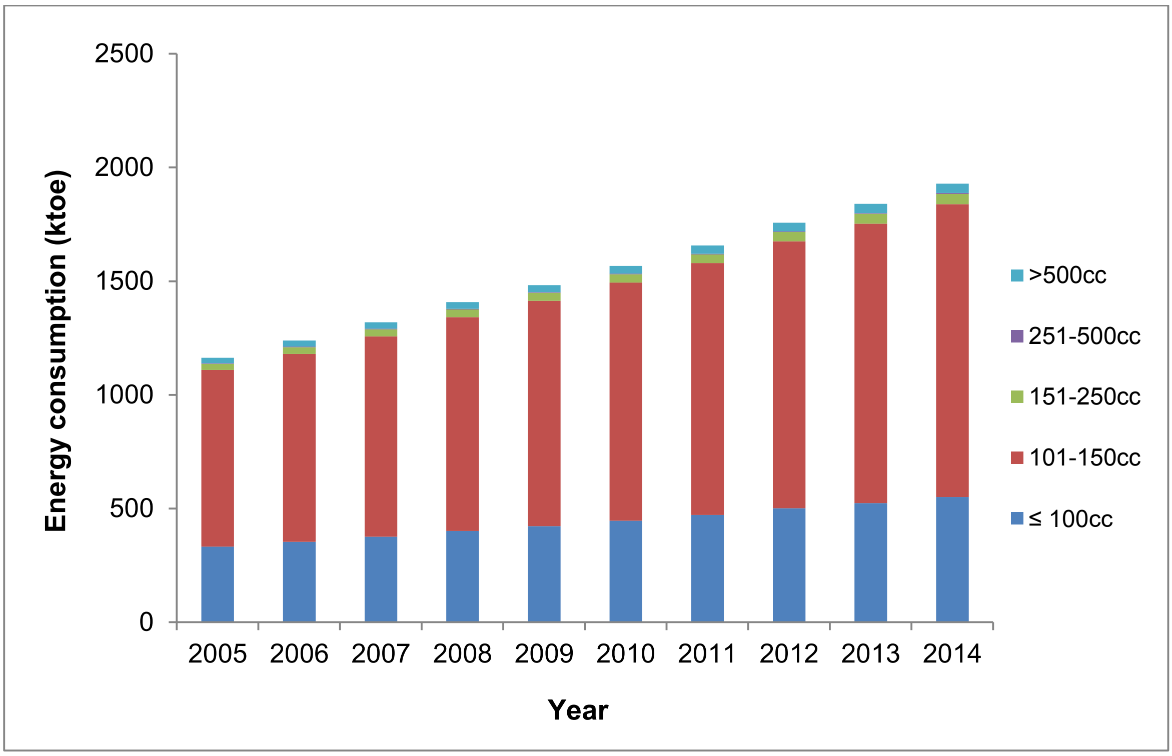
Table 6.34 outlines findings from the analysis on the energy consumption by motorcycles in Malaysia for ten (10) years' time frame. Towards the end of 2014, energy consumption by motorcycles in Malaysia is 1,929ktoe. Within that period, the lowest energy (average

2.8ktoe) consumption type is the 251-500cc category. Figure 6.17 demonstrates in general the development rate of energy consumption within that period.

Table 6.34 Analysis and findings of energy consumption by motorcycles in Malaysia, (ktoe) 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 100cc	331.83	353.13	376.12	401.53	422.95	446.68	472.38	500.97	524.52	550.11
101-150cc	777.43	827.33	881.18	940.71	990.90	1,046.50	1,106.70	1,173.68	1,228.87	1,288.81
151-250cc	27.17	28.91	30.79	32.87	34.63	36.57	38.68	41.02	42.95	45.04
251-500cc	2.09	2.22	2.37	2.53	2.66	2.81	2.97	3.15	3.30	3.46
>500cc	25.11	26.72	28.46	30.38	32.00	33.80	35.74	37.90	39.69	41.62
Total	1,163.62	1,238.31	1,318.92	1,408.02	1,483.14	1,566.36	1,656.46	1,756.72	1,839.33	1,929.05

Figure 6.17 Analysis and findings of energy consumption growth trend by motorcycles in Malaysia by engine capacity, 2005 to 2014

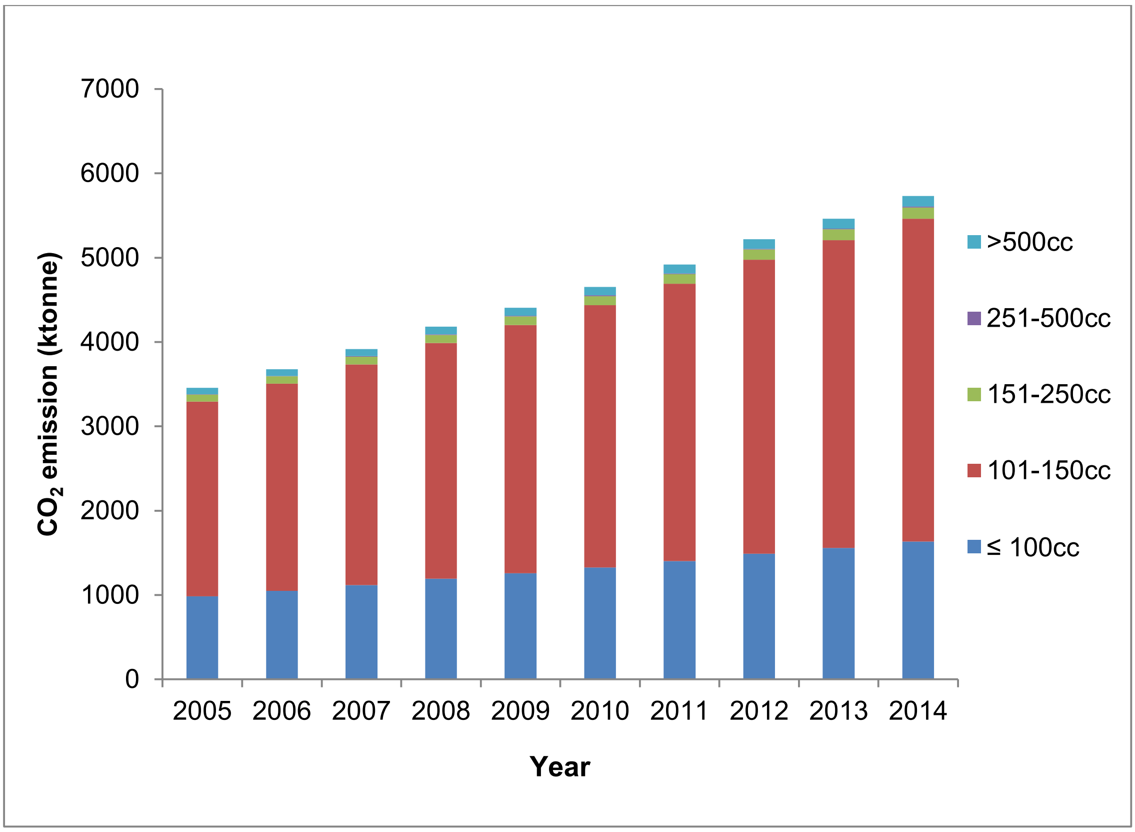


The CO_2 emission by motorcycles in Malaysia has been calculated from the analysis as shown in Table 6.35, for the years 2005 to 2014. Total CO_2 emission, towards the end of this period, is about 5,731ktonne. This figure was about half 3,457ktonne at the starting of 2005. The CO_2 emission raising rate shown in Figure 6.18 is comparable to energy consumption increase rate for each year.

Table 6.35 Analysis and findings of CO_2 emission by motorcycles in Malaysia, (ktonne) 2005 to 2014

Year/ Cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 100cc	986	1049	1,117	1,193	1,256	1,327	1,403	1,488	1,558	1,634
101-150cc	2,310	2,458	2,618	2,795	2,944	3,109	3,288	3,487	3,651	3,829
151-250cc	81	86	91	98	103	109	115	122	128	134
251-500cc	6	7	7	8	8	8	9	9	10	10
>500cc	75	79	85	90	95	100	106	113	118	124
Total	3,457	3,679	3,918	4,183	4,406	4,653	4,921	5,219	5,464	5,731

Figure 6.18 Analysis and findings of CO_2 emission growth trend by motorcycles in Malaysia by engine capacity, 2005 to 2014



6.3.12 Car fuel consumption, energy consumption and CO_2 emission

Table 6.36 provides the information based on findings from the analysis of the fuel consumption of cars in Malaysia for ten (10) consecutive years from 2005 to 2014. In 2005, the total fuel used is 11.26 billion litres and increased to 19.17 billion litres in 2014. Within these years, cars with engine capacities of 1001-2500cc are the major fuel users, and consume about 87% of total fuel in 2014. From the Figure 6.19, it shows the amount of fuel consumption increases at an average rate of 6.10%.

Table 6.36 Analysis and findings of total fuel consumption by cars in Malaysia (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1000cc	980.02	1,051.03	1,122.84	1,205.29	1,286.92	1,379.03	1,470.80	1,566.60	1,593.96	1,668.51
1001- 300cc	1,649.93	1,769.48	1,890.38	2,029.19	2,166.62	2,321.70	2,476.19	2,637.48	2,683.55	2,809.05
1301-1500cc	3,034.75	3,254.63	3,477.01	3,732.32	3,985.10	4,270.34	4,554.50	4,851.15	4,935.89	5,166.72
1501-2000cc	3,619.68	3,881.93	4,147.18	4,451.69	4,753.20	5,093.42	5,432.34	5,786.18	5,887.25	6,162.57
2001-2500cc	1,450.98	1,556.11	1,662.44	1,784.50	1,905.36	2,041.74	2,177.60	2,319.44	2,359.96	2,470.32
2501-3000cc	367.60	394.24	421.18	452.10	482.72	517.27	551.69	587.63	597.89	625.85
3001-3500cc	77.73	83.36	89.06	95.60	102.07	109.38	116.66	124.26	126.43	132.34
3501-4000cc	22.67	24.31	25.98	27.88	29.77	31.90	34.03	36.24	36.87	38.60
4001-4500cc	18.51	19.85	21.20	22.76	24.30	26.04	27.78	29.58	30.10	31.51
4501-5000cc	27.76	29.77	31.81	34.14	36.45	39.06	41.66	44.38	45.15	47.26
>5000cc	7.40	7.94	8.48	9.10	9.72	10.42	11.11	11.83	12.04	12.60
Total	11,257.03	12,072.64	12,897.56	13,844.58	14,782.24	15,840.31	16,894.35	17,994.76	18,309.10	19,165.34

Figure 6.19 Analysis and findings of fuel consumption growth trend by cars in Malaysia by engine capacity, 2005 to 2014

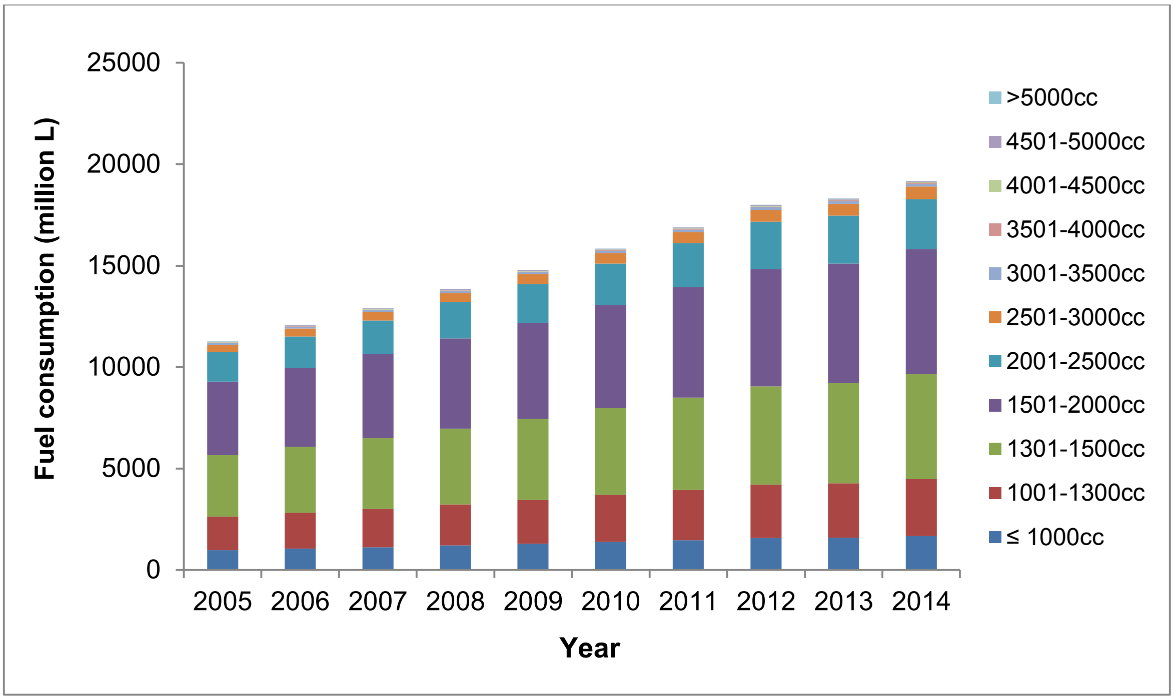


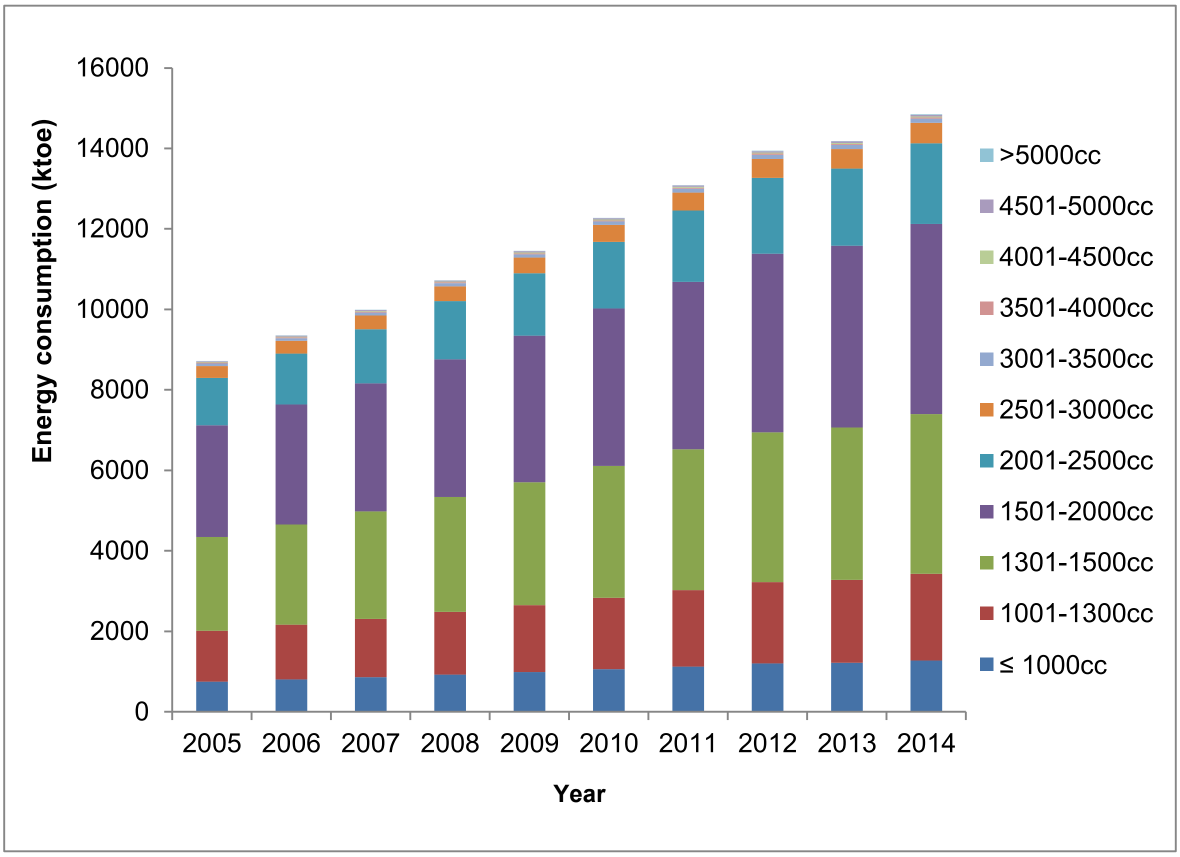
Table 6.37 summarises findings from the analysis on the energy consumption trend of cars in Malaysia for the same ten (10) years' period. At the end of 2014, energy consumption by cars in Malaysia hit a new threshold of 14,847ktoe. Figure 6.20 shows the relatively growing rate of energy consumption in different years.

Table 6.37 Analysis and findings of total energy consumption in Malaysia by cars (ktoe), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1000cc	751.68	806.14	861.22	924.46	987.07	1,057.72	1,128.10	1,201.58	1,222.57	1,279.74
1001-1300cc	1,265.50	1,357.19	1,449.92	1,556.39	1,661.80	1,780.74	1,899.24	2,022.94	2,058.28	2,154.54
1301-1500cc	2,327.65	2,496.30	2,666.87	2,862.69	3,056.57	3,275.35	3,493.30	3,720.83	3,785.83	3,962.88
1501-2000cc	2,776.29	2,977.44	3,180.89	3,414.45	3,645.70	3,906.65	4,166.61	4,438.00	4,515.52	4,726.69
2001-2500cc	1,176.74	1,262.00	1,348.24	1,447.23	1,545.25	1,655.85	1,766.04	1,881.07	1,913.93	2,003.43

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
2501-3000cc	298.13	319.73	341.57	366.65	391.49	419.51	447.42	476.56	484.89	507.57
3001-3500cc	63.04	67.61	72.23	77.53	82.78	88.71	94.61	100.77	102.53	107.33
3501-4000cc	18.39	19.72	21.07	22.61	24.14	25.87	27.59	29.39	29.91	31.30
4001-4500cc	15.01	16.10	17.20	18.46	19.71	21.12	22.53	23.99	24.41	25.55
4501-5000cc	22.51	24.15	25.80	27.69	29.56	31.68	33.79	35.99	36.62	38.33
>5000cc	6.00	6.44	6.88	7.38	7.88	8.45	9.01	9.60	9.76	10.22
Total	8,720.94	9,352.80	9,991.88	10,725.54	11,451.96	12,271.65	13,088.23	13,940.73	14,184.25	14,847.59

Figure 6.20 Analysis and findings of energy consumption growth trend by cars in Malaysia by engine capacity, 2005 to 2014

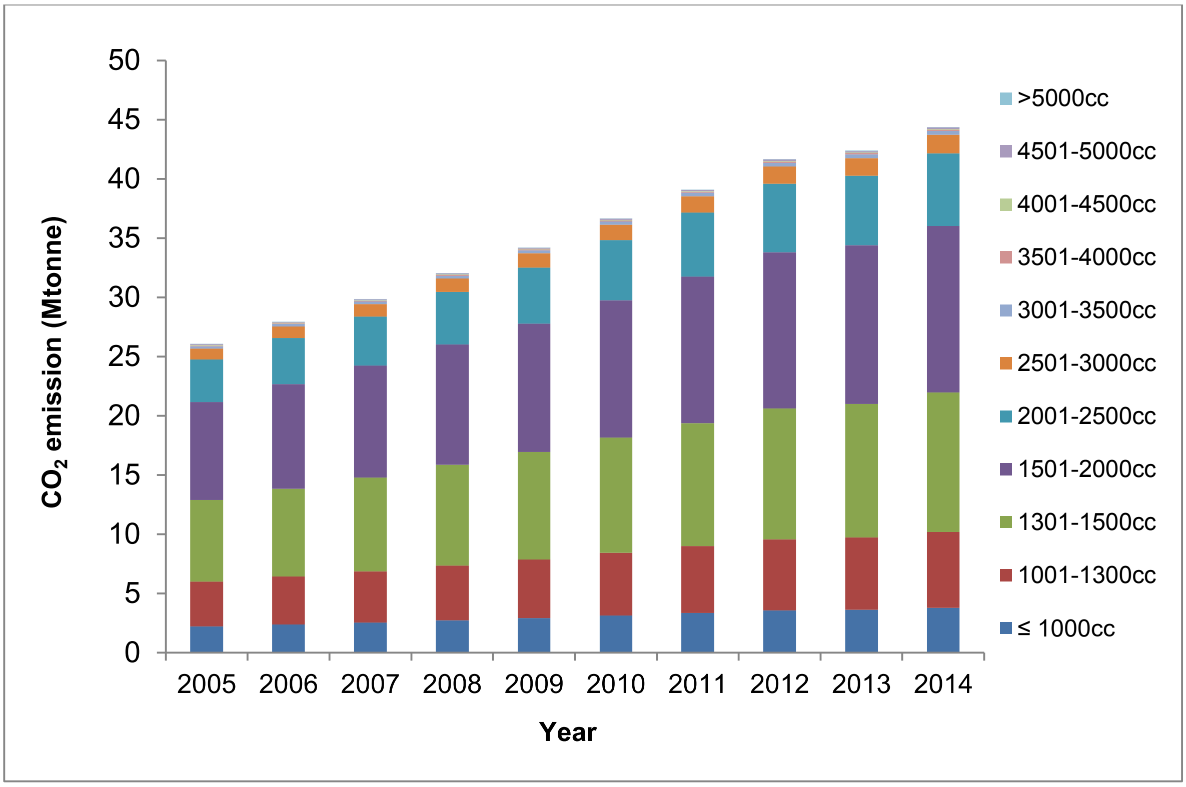


The CO_2 emission by cars in Malaysia based on findings of the analysis is shown in Table 6.38 for the year 2005 to 2014. Total CO_2 emission, at the end of this period, is close to 44,376ktonne. This impact was almost double 26,065ktonne from the 2005. The CO_2 emission increase rate as shown in Figure 6.21 follows the energy consumption rate of every year.

Table 6.38 Analysis and findings of CO_2 emission in Malaysia by cars, (ktonne) 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1000cc	2,233	2,395	2,559	2,746	2,932	3,142	3,351	3,570	3,632	3,802
1001-1300cc	3,760	4,032	4,307	4,624	4,937	5,290	5,642	6,010	6,115	6,401
1301-1500cc	6,915	7,416	7,923	8,504	9,080	9,730	10,378	11,054	11,247	11,773
1501-2000cc	8,248	8,845	9,450	10,144	10,831	11,606	12,378	13,184	13,415	14,042
2001-2500cc	3,611	3,873	4,137	4,441	4,742	5,081	5,420	5,773	5,873	6,148
2501-3000cc	915	981	1,048	1,125	1,201	1,287	1,373	1,462	1,488	1,558
3001-3500cc	193	207	222	238	254	272	290	309	315	329
3501-4000cc	56	61	65	69	74	79	85	90	92	96
4001-4500cc	46	49	53	57	60	65	69	74	75	78
4501-5000cc	69	74	79	85	91	97	104	110	112	118
>5000cc	18	20	21	23	24	26	28	29	30	31
Total	26,065	27,953	29,863	32,056	34,227	36,677	39,118	41,666	42,393	44,376

Figure 6.21 Analysis and findings of CO_2 emission growth trend by cars in Malaysia by engine capacity, 2005 to 2014



6.3.13 Bus fuel consumption, energy consumption and CO_2 emission

Table 6.39 summaries findings from the analysis on the fuel consumption of buses in Malaysia from 2005 to 2014. In 2005, the total fuel consumed is around 1.7 billion litres that increases to 2.2 billion litres in 2012, then it declines to 2.0 billion litres in 2014 due to the reduction in the number of buses. Within the period, buses with engine capacity above 5000cc are the main fuel consumption, and expand to about 70% of total fuel consumption in 2012. Figure 6.22 shows the growth trend of fuel consumption by buses in Malaysia from 2005 to 2014.

Table 6.39 Analysis and findings of total fuel consumption by buses in Malaysia (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	9.69	9.96	10.16	10.45	10.86	11.28	11.71	11.99	10.24	10.61
1501-2000cc	16.18	16.63	16.96	17.44	18.13	18.83	19.55	20.02	17.10	17.71
2001-2500cc	176.26	181.18	184.81	190.02	197.52	205.14	212.96	218.16	186.26	192.96
2501-3000cc	197.38	202.89	206.95	212.79	221.20	229.73	238.48	244.30	208.58	216.09
3001-3500cc	2.11	2.17	2.21	2.28	2.37	2.46	2.55	2.61	2.23	2.31
3501-4000cc	11.54	11.87	12.10	12.44	12.94	13.43	13.95	14.29	12.20	12.64
4001-4500cc	98.12	100.85	102.87	105.77	109.95	114.19	118.55	121.44	103.68	107.42
4501-5000cc	2.55	2.62	2.67	2.75	2.85	2.96	3.08	3.15	2.69	2.79
>5000cc	1,229.85	1,264.17	1,289.49	1,325.84	1,378.23	1,431.38	1,485.93	1,522.20	1,299.63	1,346.41
Total	**1743.68**	**1792.34**	**1828.23**	**1879.77**	**1954.05**	**2029.41**	**2106.75**	**2158.16**	**1842.61**	**1908.94**

Figure 6.22 Analysis and findings of fuel consumption growth trend by buses in Malaysia by engine capacity, 2005 to 2014

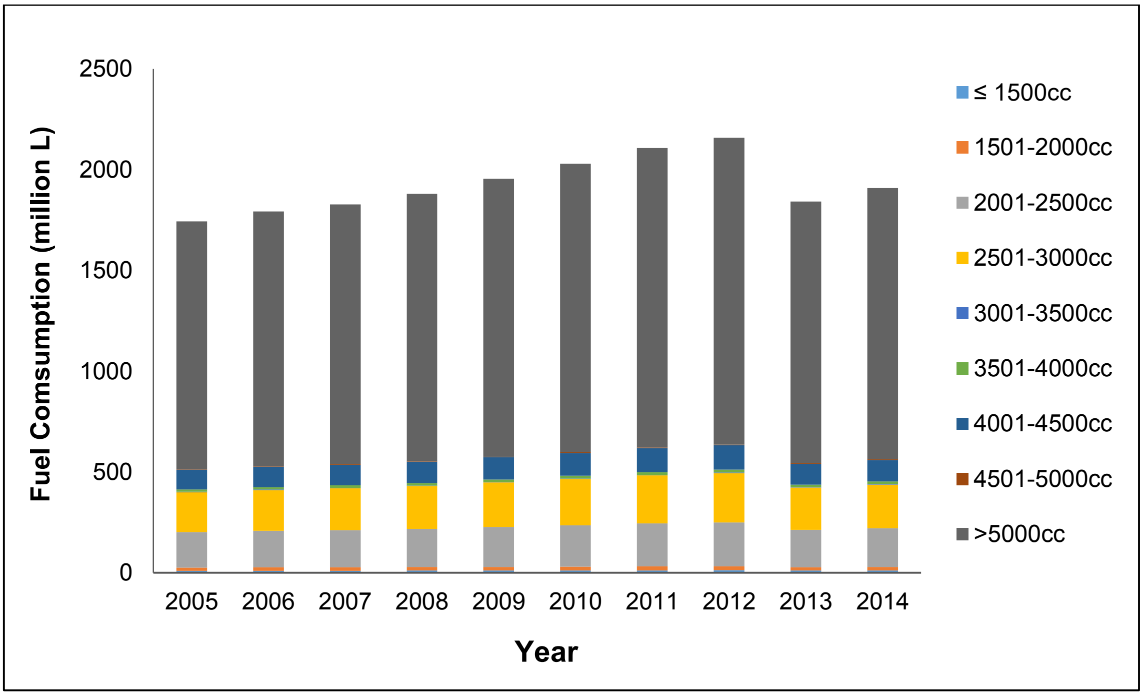
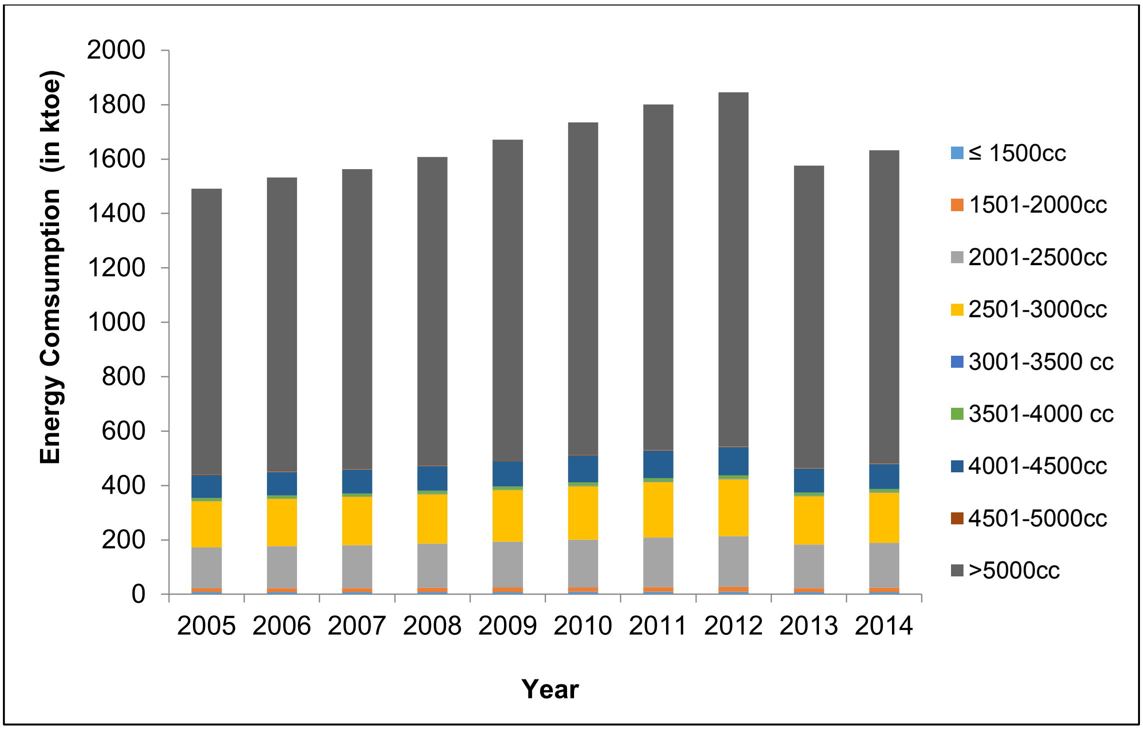


Table 6.40 summarises findings from the analysis on the energy consumption trend of buses in Malaysia from 2005 to 2014. Towards the year 2014, energy utilisation by buses in Malaysia is 1632ktoe, whereas the highest is 1845ktoe in 2012. Within this period, the lowest average energy of 2.3ktoe is consumed by 3000-3500cc, while the highest of 1357ktoe is consumed by buses above 5000cc. Figure 6.23 demonstrates the growth trend of energy consumption by buses from 2005 to 2014

Table 6.40 Analysis and findings of total energy consumption in Malaysia by buses (ktoe), 2005 to 2014

Year/ Cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	8.28	8.52	8.69	8.93	9.28	9.64	10.01	10.25	8.75	9.07
1501-2000cc	13.83	14.22	14.50	14.91	15.50	16.10	16.71	17.12	14.62	15.14
2001-2500cc	150.70	154.91	158.01	162.46	168.88	175.40	182.08	186.52	159.25	164.98
2501-300cc	168.76	173.47	176.95	181.93	189.12	196.42	203.90	208.88	178.34	184.76
3001-3500cc	1.81	1.86	1.89	1.95	2.02	2.10	2.18	2.24	1.91	1.98
3501-4000cc	9.87	10.14	10.35	10.64	11.06	11.49	11.92	12.22	10.43	10.80
4001-4500cc	83.89	86.23	87.96	90.44	94.01	97.64	101.36	103.83	88.65	91.84
4501-5000cc	2.18	2.24	2.28	2.35	2.44	2.53	2.63	2.69	2.30	2.38
>5000cc	1,051.52	1,080.87	1,102.51	1,133.59	1,178.38	1,223.83	1,270.47	1,301.48	1,111.18	1,151.18
Total	**1,490.84**	**1,532.45**	**1,563.14**	**1,607.20**	**1,670.71**	**1,735.15**	**1,801.27**	**1,845.23**	**1,575.43**	**1,632.14**

Figure 6.23 Analysis and findings of energy consumption growth trend by buses in Malaysia by engine capacity, 2005 to 2014



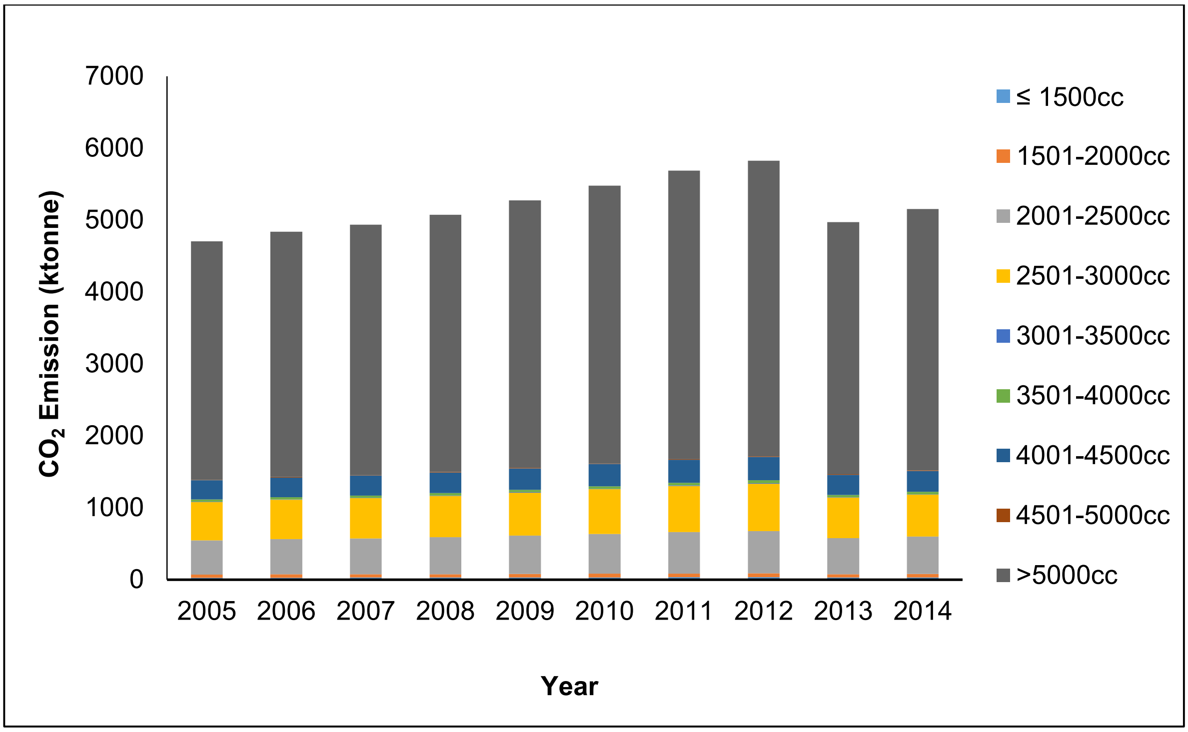
The CO_2 emission by buses in Malaysia based on findings of the analysis is shown in Table 6.41 from 2005 to 2014. It indicates the patterns of energy consumption of different engine capacity of buses. Total CO_2 emission in 2012, is about 5,825ktonne, where more than 50% are from the buses that are above 5000cc. Meanwhile, in year 2013, the overall CO_2 emission reduces to almost 4,973ktonne as shown in Figure 6.24.

Table 6.41 Analysis and findings of CO_2 emission by buses in Malaysia, (ktonne) 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	26	27	27	28	29	30	32	32	28	29
1501-2000cc	44	45	46	47	49	51	53	54	46	48
2001-2500cc	476	489	499	513	533	554	575	589	503	521
2501-3000cc	533	548	559	574	597	620	644	659	563	583
3001-3500cc	6	6	6	6	6	7	7	7	6	6

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3501-4000cc	31	32	33	34	35	36	38	39	33	34
4001-4500cc	265	272	278	285	297	308	320	328	280	290
4501-5000cc	7	7	7	7	8	8	8	9	7	8
>5000cc	3,319	3,412	3,480	3,578	3,720	3,863	4,010	4,108	3,508	3,634
Total	4,706	4,837	4,934	5,073	5,274	5,477	5,686	5,825	4,973	5,152

Figure 6.24 Analysis and findings of CO_2 emission growth trend by buses in Malaysia by engine capacity, 2005 to 2014



6.3.14 Taxis fuel consumption, energy consumption and CO_2 emission

Table 6.42 summarises findings from the analysis on the fuel consumption of taxis in Malaysia from 2005 to 2014, for different engine capacities. In 2005, the total fuel consumed was about 590.42 million litres and increased more than double, 1,318.79 million litres in 2014. From 2005 to 2014, taxis with 1501-2000cc are the major fuel consumption. From the

Figure 6.25, it shows that the amount of fuel consumption gradually increases from 2005 to 2014.

Table 6.42 Analysis and findings of total fuel consumption in Malaysia by taxis (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	37.36	39.53	41.61	45.86	48.52	52.19	55.36	56.94	78.00	83.45
1501-2000cc	490.14	518.67	545.98	601.68	636.62	684.73	726.31	747.07	1023.32	1094.81
2001-2500cc	50.95	53.91	56.75	62.54	66.17	71.18	75.50	77.66	106.37	113.80
2501-3000cc	9.79	10.36	10.91	12.02	12.72	13.68	14.51	14.92	20.44	21.87
>3000cc	2.17	2.30	2.42	2.67	2.82	3.04	3.22	3.31	4.54	4.86
Total	590.42	624.78	657.68	724.78	766.87	824.81	874.90	899.91	1,232.67	1,318.79

Figure 6.25 Analysis and findings of fuel consumption growth trend by taxis in Malaysia by engine capacity, 2005 to 2014

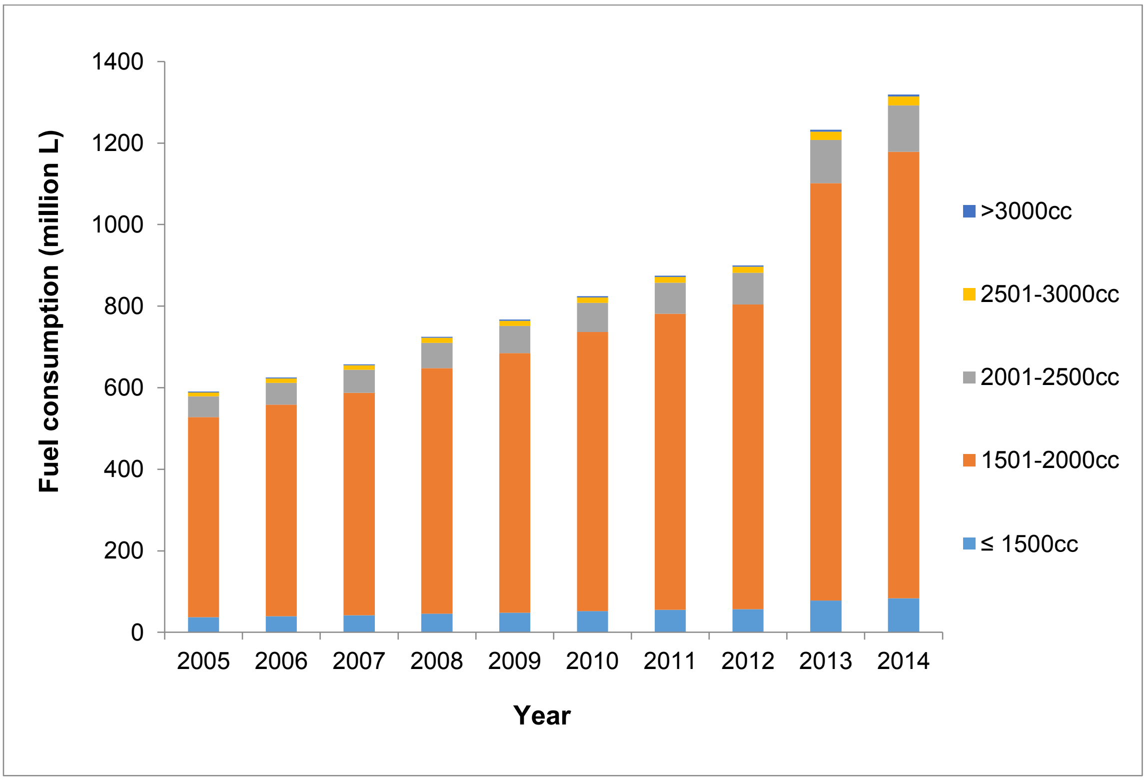
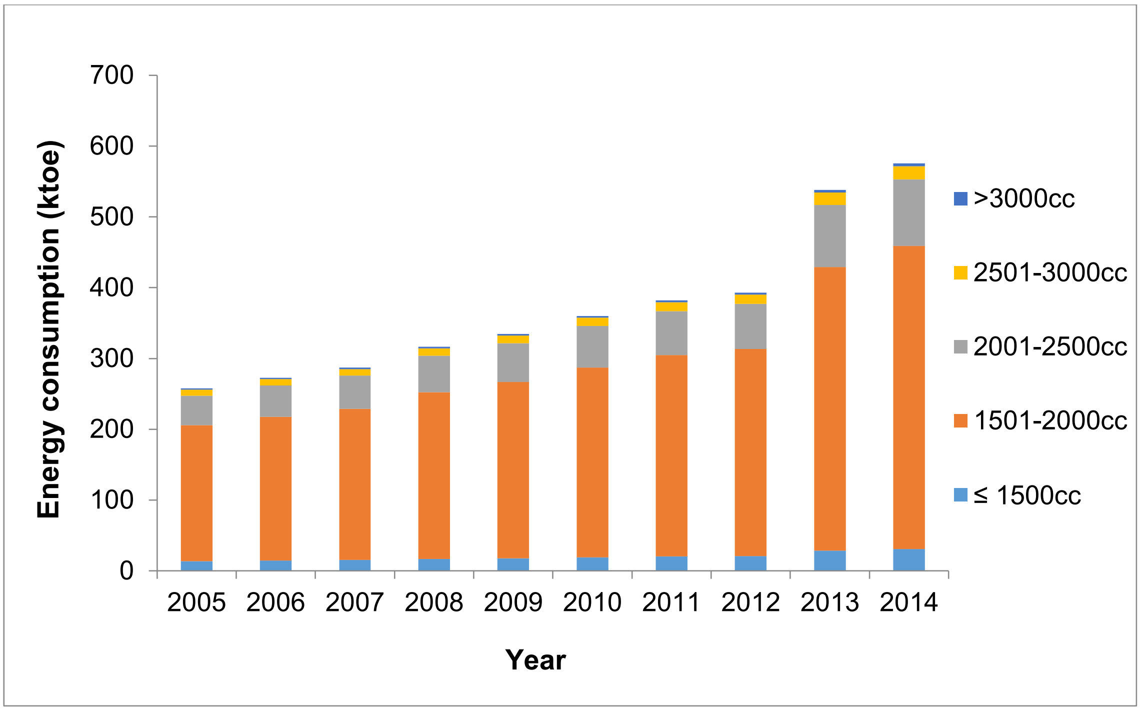


Table 6.43 summaries findings from the analysis on the energy consumption of taxis in Malaysia from 2005 to 2014. In 2014, energy consumption by taxis in Malaysia is 575.81ktoe. Taxis with engine capacity of 1501-2000cc consumed energy of 428ktoe which is considered as the main energy consumption. Figure 6.26 shows the growth trend of energy consumption by taxis from 2005 to 2014.

Table 6.43 Analysis and findings of energy consumption in Malaysia by taxis (ktoe), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	13.73	14.53	15.29	16.85	17.83	19.18	20.35	20.93	28.67	30.67
1501-2000cc	191.84	203.00	213.69	235.49	249.17	267.99	284.27	292.39	400.51	428.49
2001-2500cc	41.99	44.44	46.78	51.55	54.54	58.66	62.23	64.00	87.67	93.80
2501-3000cc	8.37	8.86	9.33	10.28	10.87	11.70	12.41	12.76	17.48	18.70
>3000cc	1.86	1.97	2.07	2.28	2.41	2.60	2.75	2.83	3.88	4.15
Total	257.79	272.79	287.15	316.45	334.83	360.13	382.00	392.92	538.21	575.81

Figure 6.26 Analysis and findings of energy consumption growth trend by taxis in Malaysia by engine capacity, 2005 to 2014

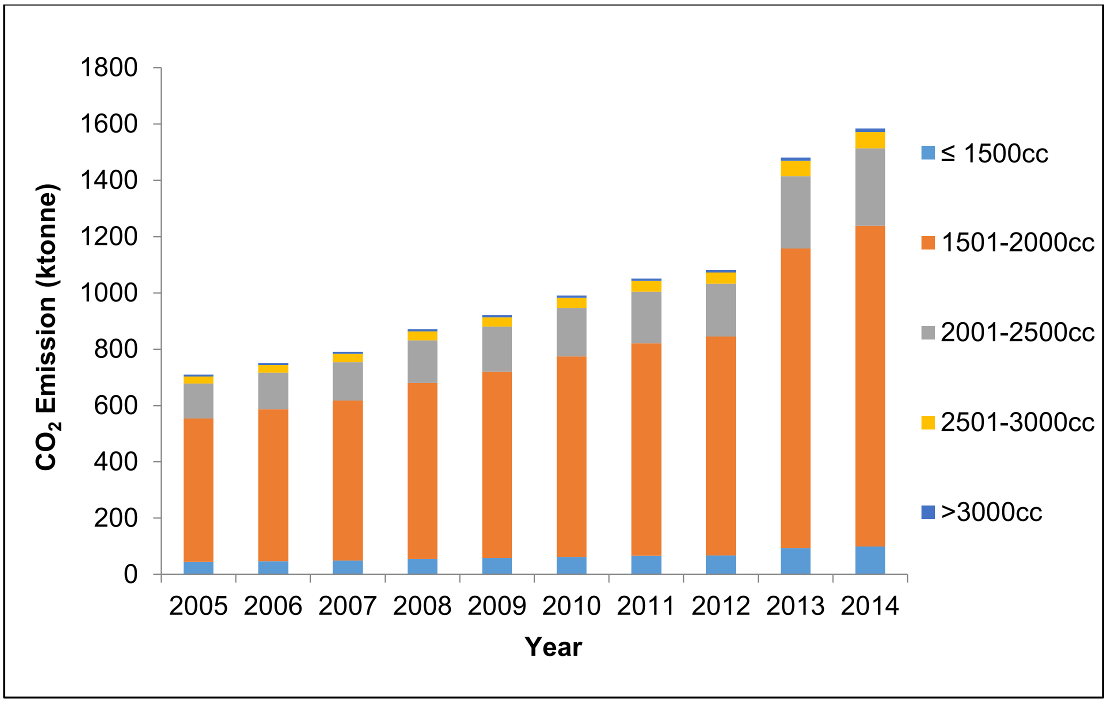


The CO_2 emission by taxis in Malaysia based on findings of the analysis is given in Table 6.44 from 2005 to 2014. In 2014, the total CO_2 emission, is 1,584ktonne, of which the 1501cc to 2000cc vehicles are the main contributor. The CO_2 emission growth trend by taxis in Malaysia is shown in Figure 6.27.

Table 6.44 Analysis and findings of CO_2 emission by taxis in Malaysia, (ktonne) 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 1500cc	39	41	44	48	51	55	58	60	82	88
1501-2000cc	514	544	573	631	668	718	762	784	1073	1148
2001-2500cc	124	131	138	152	161	173	183	188	258	276
2501-3000cc	26	28	29	32	34	37	39	40	55	59
>3000cc	6	6	7	7	8	8	9	9	12	13
Total	709	750	790	870	921	991	1,051	1,081	1,480	1,584

Figure 6.27 Analysis and findings of CO_2 emission growth trend by taxis in Malaysia by engine capacity, 2005 to 2014



6.3.15 Goods vehicles fuel consumption, energy consumption and CO_2 emission

Fuel consumption of goods vehicle is calculated by using the number of vehicles, engine types and mileage. The detail calculation process is described in Appendix A. Total fuel consumed based on findings of the analysis by different types of goods vehicle each year is presented in Table 6.45. Figure 6.28 shows the fuel consumption growth trend by different engine capacity. In 2005 total fuel consumption was 1,659.75 million litres and in 2014 it has been increased to 2,266.89 million litres. Vehicles with 4001-6000cc engine capacity consumed the highest amount of fuel as compared to others.

Table 6.45 Analysis and findings of total fuel consumption by goods vehicles in Malaysia (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	193.24	201.75	211.24	221.75	228.33	235.64	243.32	251.69	272.22	282.79
2001-4000cc	463.36	483.75	506.52	531.73	547.50	565.02	583.43	603.52	652.73	678.09
4001-6000cc	497.19	519.07	543.51	570.55	587.48	606.28	626.02	647.58	700.39	727.60
6001-8000cc	90.85	94.85	99.32	104.26	107.35	110.79	114.40	118.34	127.99	132.96
8001-10000cc	65.50	68.38	71.60	75.16	77.39	79.87	82.47	85.31	92.27	95.85
>10000cc	349.60	349.60	349.60	349.60	349.60	349.60	349.60	349.60	349.60	349.60
Total	1,659.75	1,717.40	1,781.80	1,853.05	1,897.66	1,947.20	1,999.23	2,056.04	2,195.21	2,266.89

Figure 6.28 Analysis and findings of fuel consumption growth trend by goods vehicles in Malaysia by engine capacity, 2005 to 2014

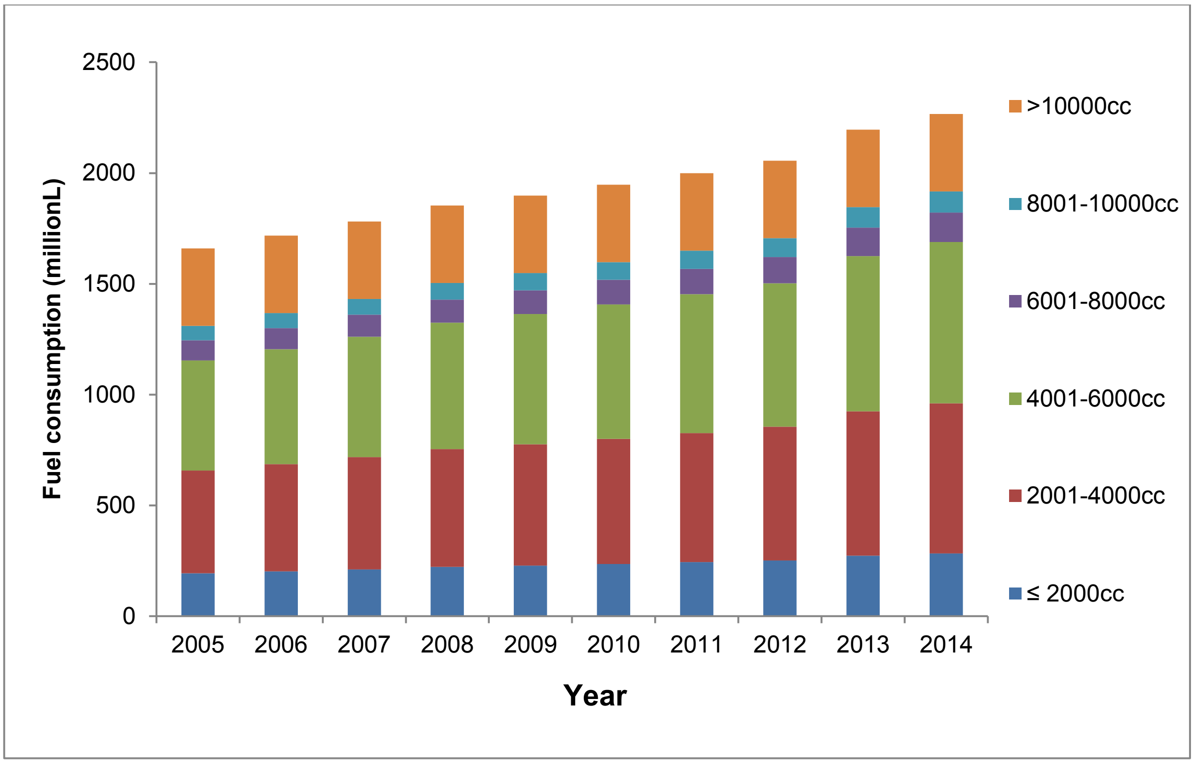


Table 6.46 summarises findings from the analysis on the energy consumption by goods vehicles. In 2005, total energy consumption by goods vehicle was 1,411.43ktoe, and in 2014, the total energy consumption was 1,926.99ktoe. The highest amount of energy consumed by engine capacity is the 4001-6000cc with the value of 425.10ktoe in 2005 and 622.10ktoe in 2014. Figure 6.29 shows the energy consumption growth trend by goods vehicles in Malaysia from 2005 to 2014. Engine capacity of 4001-6000cc and 2001-4000cc consumed more energy compared to others.

Table 6.46 Analysis and findings of energy consumption by goods vehicles in Malaysia (ktoe), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	157.57	164.50	172.25	180.82	186.18	192.14	198.40	205.23	221.97	230.59
2001-4000cc	396.17	413.61	433.08	454.63	468.11	483.09	498.83	516.01	558.09	579.76
4001-6000cc	425.10	443.81	464.70	487.82	502.29	518.37	535.25	553.68	598.84	622.10
6001-8000cc	77.68	81.10	84.92	89.14	91.79	94.72	97.81	101.18	109.43	113.68

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
8001-10000cc	56.00	58.47	61.22	64.27	66.17	68.29	70.51	72.94	78.89	81.95
>10000cc	298.91	298.91	298.91	298.91	298.91	298.91	298.91	298.91	298.91	298.91
Total	**1,411.43**	**1,460.39**	**1,515.07**	**1,575.58**	**1,613.46**	**1,655.52**	**1,699.71**	**1,747.95**	**1,866.12**	**1,926.99**

Figure 6.29 Analysis and findings of energy consumption growth trend by goods vehicles in Malaysia by engine capacity, 2005 to 2014

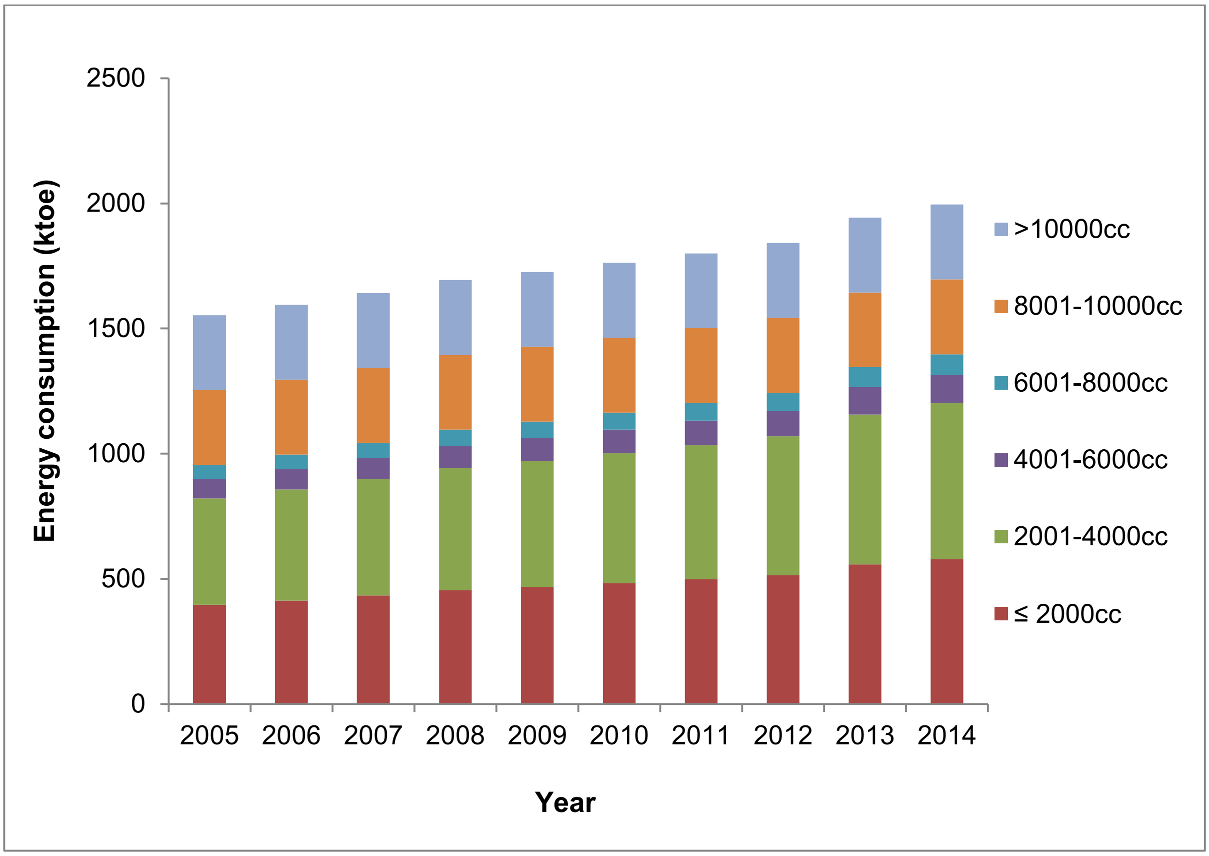


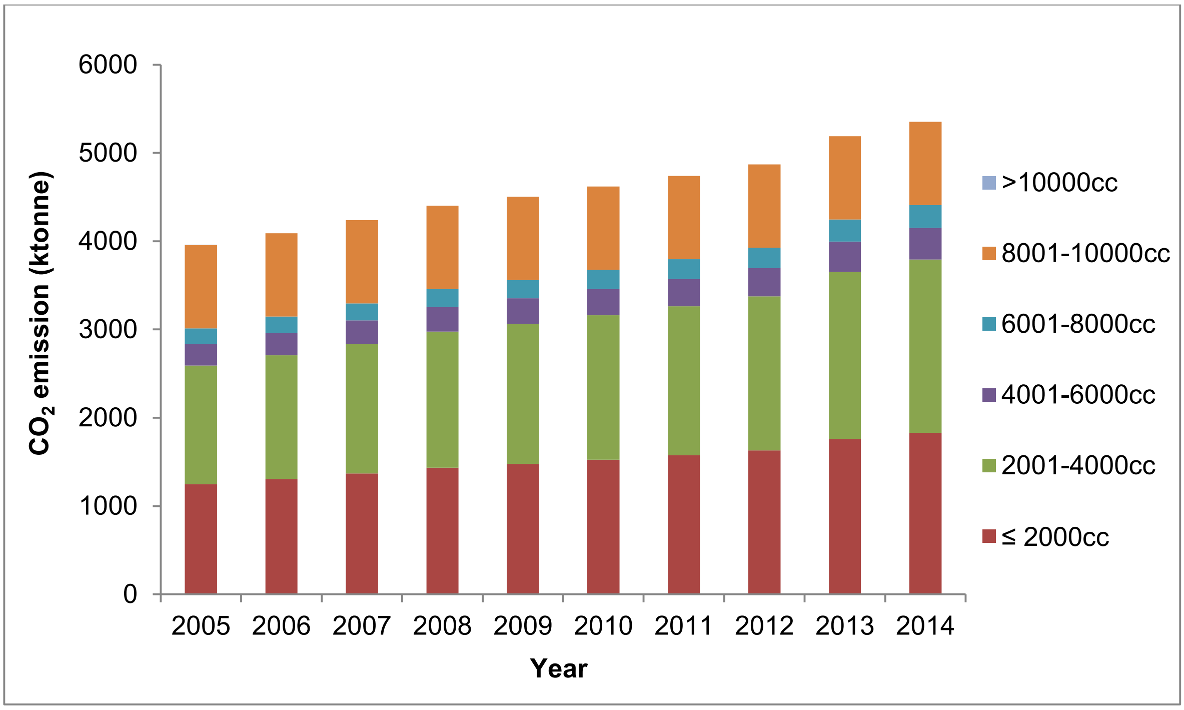
Table 6.47 shows the CO_2 emission based on findings from the analysis by goods vehicles in Malaysia from 2005 to 2014. In 2005 the total CO_2 emission by goods vehicles was 4,443ktonne and in 2014 the total figure was 6,065ktonne.

Table 6.47 Analysis and findings of CO_2 emission by goods vehicles in Malaysia, (ktonne), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	485	506	530	557	573	591	611	632	683	710
2001-4000cc	1,251	1,306	1,367	1,435	1,478	1,525	1,575	1,629	1,762	1,830
4001-6000cc	1,342	1,401	1,467	1,540	1,586	1,636	1,690	1,748	1,890	1,964
6001-8000cc	245	256	268	281	290	299	309	319	345	359
8001-10000cc	177	185	193	203	209	216	223	230	249	259
>10000cc	944	944	944	944	944	944	944	944	944	944
Total	4,443	4,597	4,769	4,959	5,078	5,211	5,350	5,501	5,873	6,065

Figure 6.30 reveals the CO_2 emission increasing rate at different years. The CO_2 emission increasing rate of the 4001-6000cc engine type vehicle is higher than that of other engine type vehicles with a contributing value of 1,342ktonne in 2005 and 1,964ktonne in 2014.

Figure 6.30 Analysis and findings of CO_2 emission growth trend by goods vehicles in Malaysia by engine capacity, 2005 to 2014



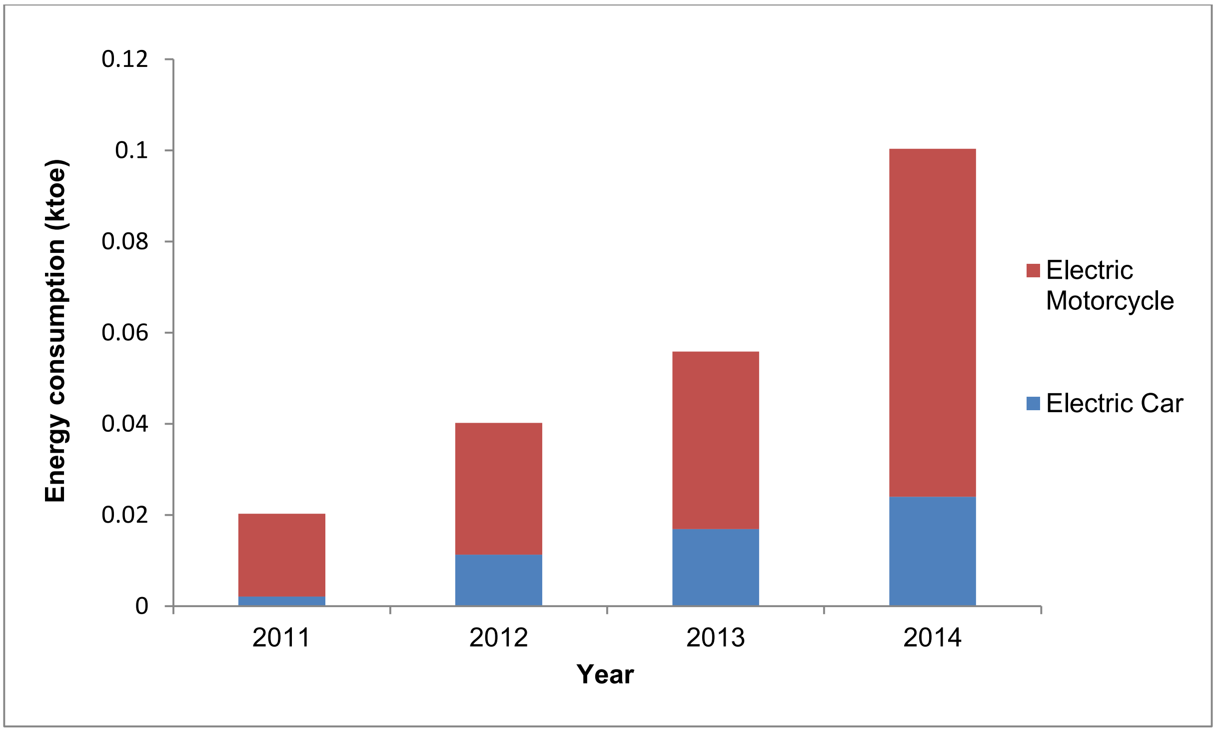
6.3.16 Electric vehicles energy consumption and CO_2 emission

Table 6.48 summarises findings from the analysis on the energy use trend of EVs in Malaysia for four (4) years from 2011 to 2014. In 2014, the total energy consumption by EVs in this country is 0.1004ktoe and the major contributor is the electric cars. Figure 6.31 shows the energy consumption growth trend by EVs in Malaysia from 2011 to 2014.

Table 6.48 Analysis and findings of energy consumption by electric vehicles in Malaysia (ktoe), 2011 to 2014

Year	2011	2012	2013	2014
Electric motorcycle	0.0182	0.0290	0.0389	0.0764
Electric car	0.0021	0.0113	0.0169	0.0240
Total	0.0203	0.0402	0.0559	0.1004

Figure 6.31 Analysis and findings of energy consumption growth trend by electric vehicles in Malaysia, 2011 to 2014

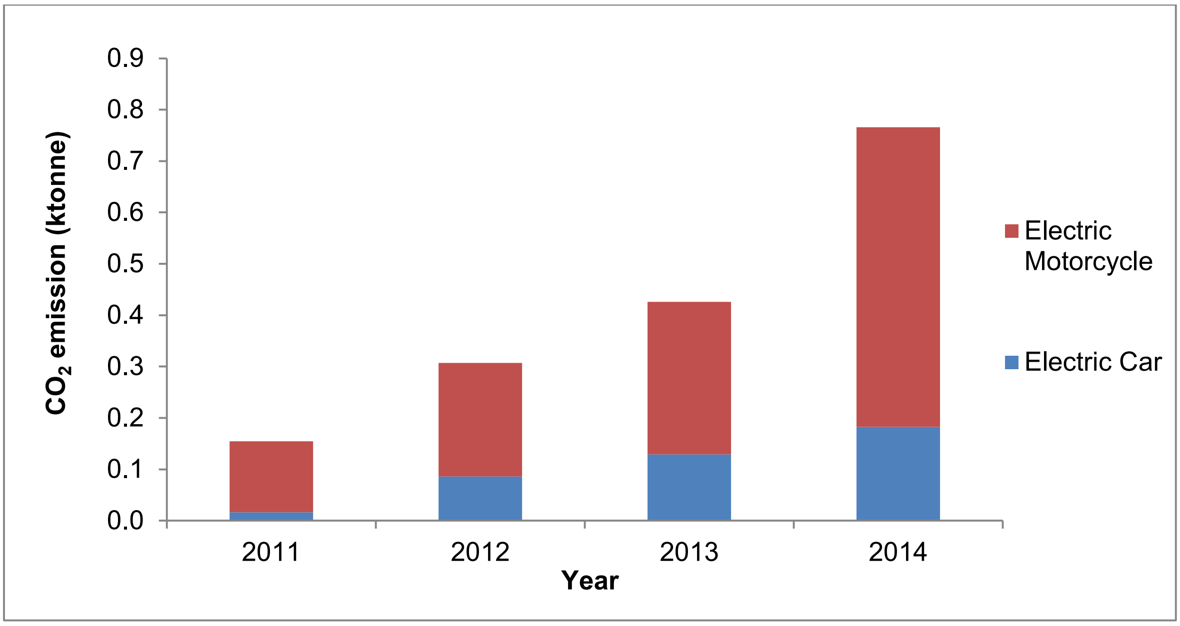


The CO_2 emission by EVs in Malaysia based on findings from the analysis is shown in Table 6.49. Total CO_2 emission in 2014 is 0.766ktonne which is almost five (5) times higher compared to 2011 which is 0.155ktonne. Figure 6.32 shows the growth trend of CO_2 emission by electric vehicles in Malaysia from 2011 to 2014.

Table 6.49 Analysis and findings of CO_2 emission by electric vehicles in Malaysia, (ktonne), 2011 to 2014

Year	2011	2012	2013	2014
Electric motorcycle	0.138	0.221	0.297	0.583
Electric car	0.016	0.086	0.129	0.183
Total	0.155	0.307	0.426	0.766

Figure 6.32 Analysis and findings of CO_2 emission growth trend by electric vehicles in Malaysia, 2011 to 2014



6.3.17 Other vehicles fuel consumption, energy consumption and CO_2 emission

Tables 6.50 and 6.51 summarise findings from the analysis on the data on the fuel and energy consumption of other vehicles in Malaysia from 2005 to 2014, for different engine capacities. In 2005, the total fuel consumption is about 822 million litres and increase to 1,189 million litres in 2014, while the energy usage is about 700ktoe and 1,010ktoe respectively. The fuel and energy growth trend of other vehicles is shown in Figures 6.33 and 6.34 respectively.

The CO_2 emission by other vehicles is shown in Table 6.52 and Figure 6.35, that also follows the patterns of energy consumption for different sort of vehicles.

Table 6.50 Analysis and findings of total fuel consumption by other vehicles in Malaysia (million L), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	134.66	139.21	144.95	151.59	157.52	164.70	172.18	180.19	187.62	194.66
2001-4000cc	285.71	295.38	307.54	321.63	334.23	349.46	365.34	382.32	398.09	413.02
4001-6000cc	211.40	218.55	227.55	237.98	247.30	258.57	270.31	282.88	294.55	305.60
6001-8000cc	110.81	114.56	119.28	124.74	129.63	135.53	141.69	148.28	154.40	160.19
8001-10000cc	31.06	32.12	33.44	34.97	36.34	38.00	39.72	41.57	43.28	44.91
10001-15000cc	43.25	44.71	46.55	48.69	50.59	52.90	55.30	57.87	60.26	62.52
>15000cc	5.81	6.01	6.25	6.54	6.80	7.11	7.43	7.77	8.09	8.40
Total	822.70	850.53	885.56	926.14	962.40	1,006.27	1,051.98	1,100.88	1,146.30	1,189.29

Figure 6.33 Analysis and findings of fuel consumption growth trend by other vehicles in Malaysia by engine capacity, 2005 to 2014

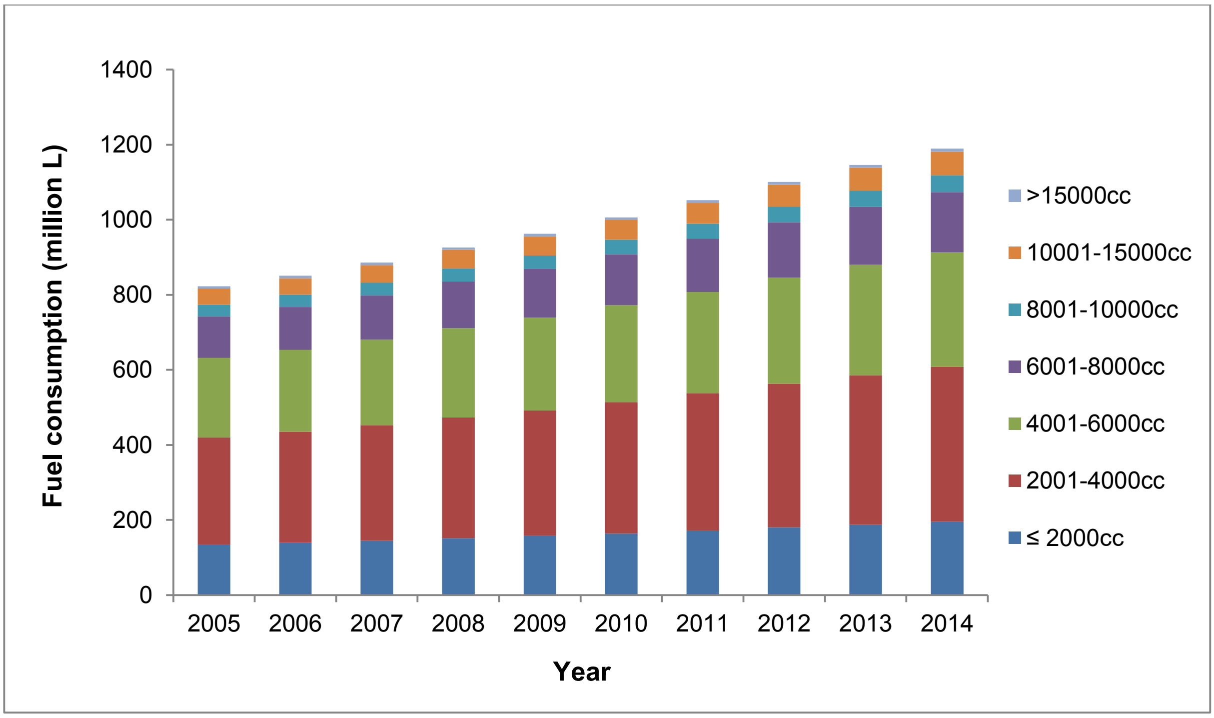


Table 6.51 Analysis and findings of energy consumption by other vehicles in Malaysia (ktoe), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	112.76	116.58	121.38	126.94	131.91	137.92	144.19	150.89	157.12	163.01
2001-4000cc	241.77	249.95	260.24	272.17	282.82	295.71	309.15	323.52	336.87	349.50
4001-6000cc	180.75	186.86	194.56	203.47	211.44	221.08	231.12	241.86	251.84	261.29
6001-8000cc	94.74	97.95	101.98	106.65	110.83	115.88	121.15	126.78	132.01	136.96
8001-10000cc	26.56	27.46	28.59	29.90	31.07	32.49	33.96	35.54	37.01	38.40
10001-15000cc	36.98	38.23	39.80	41.63	43.26	45.23	47.28	49.48	51.52	53.45
>15000cc	4.97	5.14	5.35	5.59	5.81	6.08	6.35	6.65	6.92	7.18
Total	698.52	722.15	751.89	786.35	817.14	854.38	893.20	934.72	973.28	1,009.78

Figure 6.34 Analysis and findings of energy consumption growth trend by other vehicles in Malaysia by engine capacity, 2005 to 2014

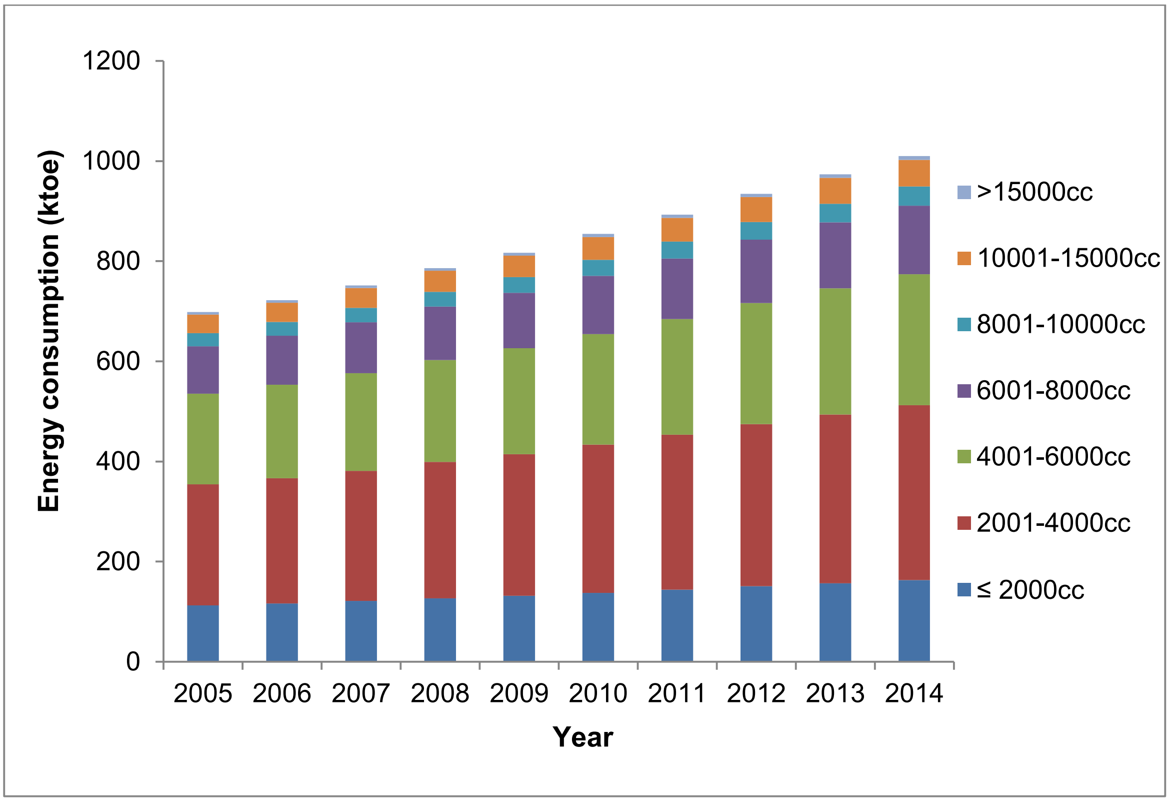
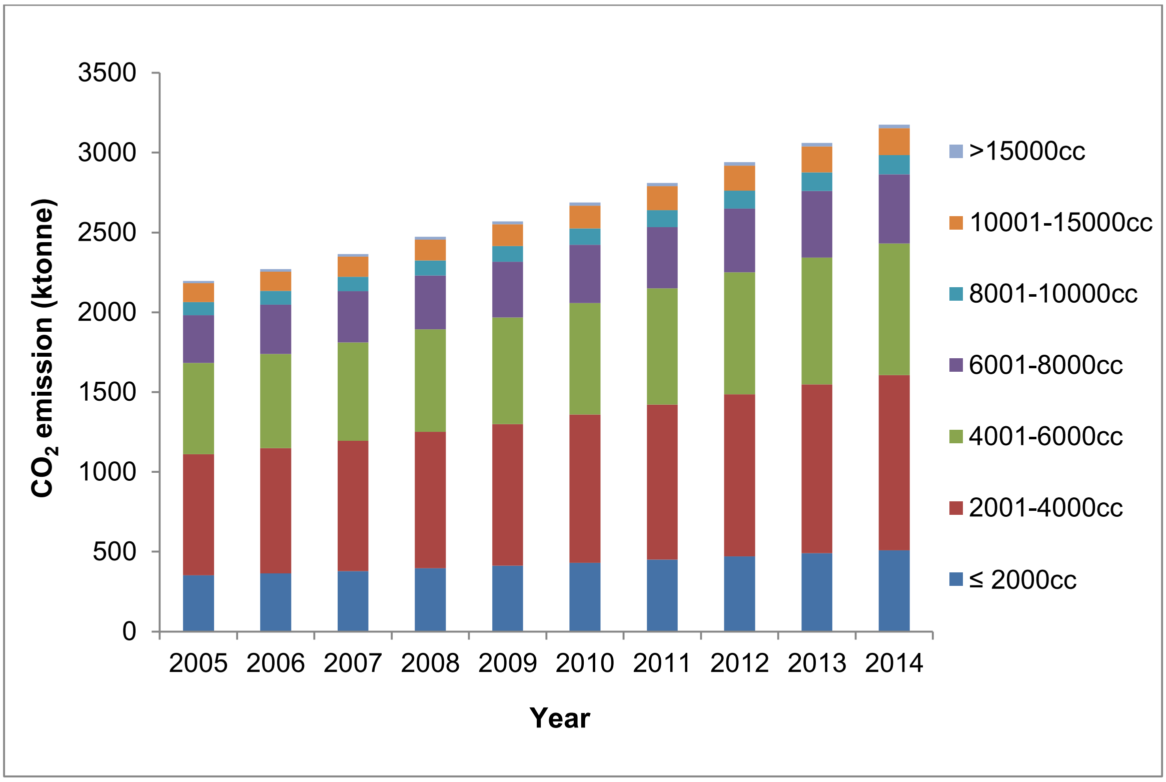


Table 6.52 Analysis and findings of CO_2 emission by other vehicles in Malaysia (ktonne), 2005 to 2014

Year/ cc	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
≤ 2000cc	352	364	379	396	412	431	450	471	491	509
2001-4000cc	759	785	817	855	888	928	971	1,016	1,058	1,097
4001-6000cc	571	590	614	642	667	698	730	763	795	825
6001-8000cc	299	309	322	337	350	366	382	400	417	432
8001-10000cc	84	87	90	94	98	103	107	112	117	121
10001-15000cc	117	121	126	131	137	143	149	156	163	169
>15000cc	16	16	17	18	18	19	20	21	22	23
Total	2,197	2,271	2,365	2,473	2,570	2,687	2,809	2,940	3,061	3,176

Figure 6.35 Analysis and findings of CO_2 emission growth trend by other vehicles in Malaysia by engine capacity, 2005 to 2014



6.3.18 Rail transport fuel consumption, energy consumption and CO_2 emission

Table 6.53 summarises findings from the analysis on the data on the fuel consumption of non-electric trains in Malaysia from 2005 to 2014. In 2005, the total fuel consumed is about 8.40 million litres and 7.73 million litres in 2014. In 2009, the fuel consumption by non-electric train in Malaysia was the highest, (8.59 million litres) because the number of locomotive train increased by 90 units compared to 88 units and 81 units in the year 2005 and 2014 respectively.

Table 6.53 Analysis and findings of fuel consumption by non-electric trains in Malaysia, 2005 to 2014

Year	Million (Litres)
2005	8.40
2006	6.96
2007	7.54
2008	7.06
2009	8.59
2010	7.82
2011	7.82
2012	7.82
2013	7.82
2014	7.73

Table 6.54 summaries findings from the analysis on the energy consumption of ET and non-ET (NET) in Malaysia from 2005 to 2014. In 2005, energy consumption by ET is 5ktoe which is lower than the energy consumption by NET, 7.18ktoe. However, at the end of 2014, ET consumes about four (4) times more energy than NET, due to the increase number of ET in Malaysia. Figure 6.36 shows the irregular energy consumption growth trend by train in Malaysia from 2005 to 2014. Table 6.55 and Figure 6.37 show the CO_2 emission of the rail transport in Malaysia from 2005 to 2014.

Table 6.54 Analysis and findings of energy consumption by rail transport in Malaysia, (ktoe), 2005 to 2014

Year	Electric train	Non-electric train	Total
2005	5	7.18	12.18
2006	5	5.95	10.95
2007	4	6.44	10.44
2008	15	6.04	21.04
2009	12	7.34	19.34
2010	18	6.69	24.69
2011	18	6.69	24.69
2012	21	6.69	27.69
2013	21	6.69	27.69
2014	22	6.61	28.61

Figure 6.36 Analysis and findings of energy consumption growth trend by rail transport in Malaysia, 2005 to 2014

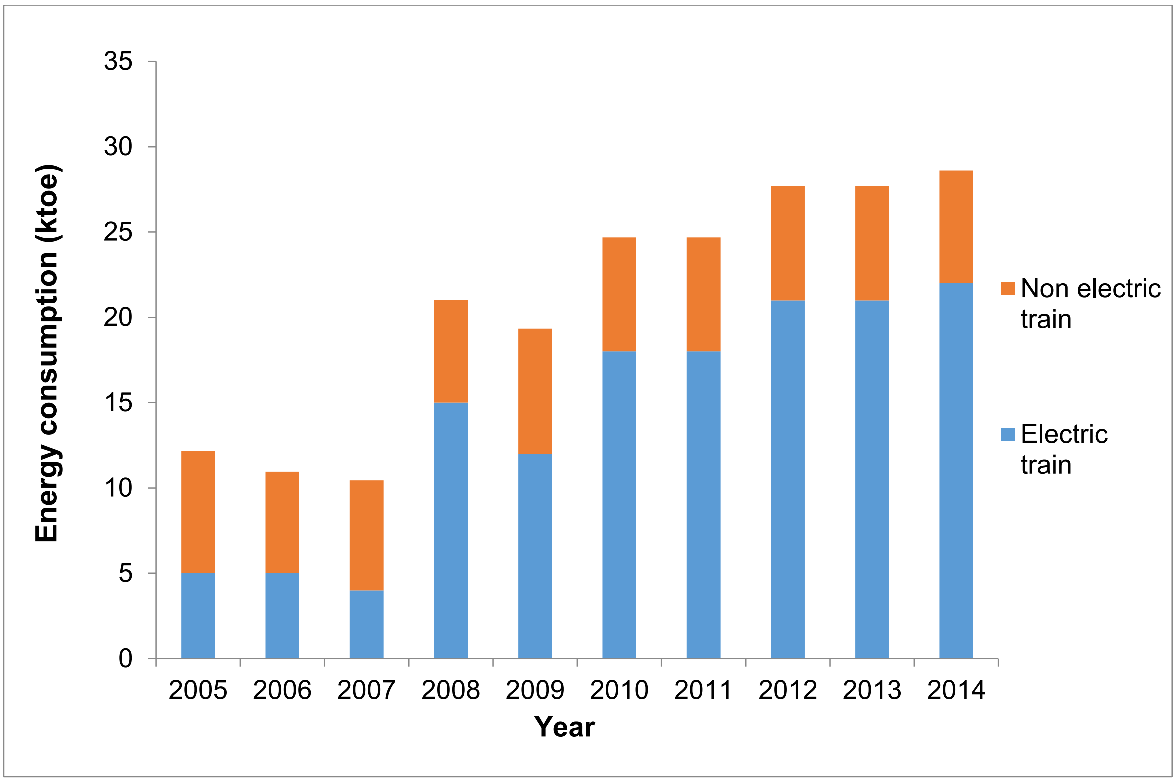
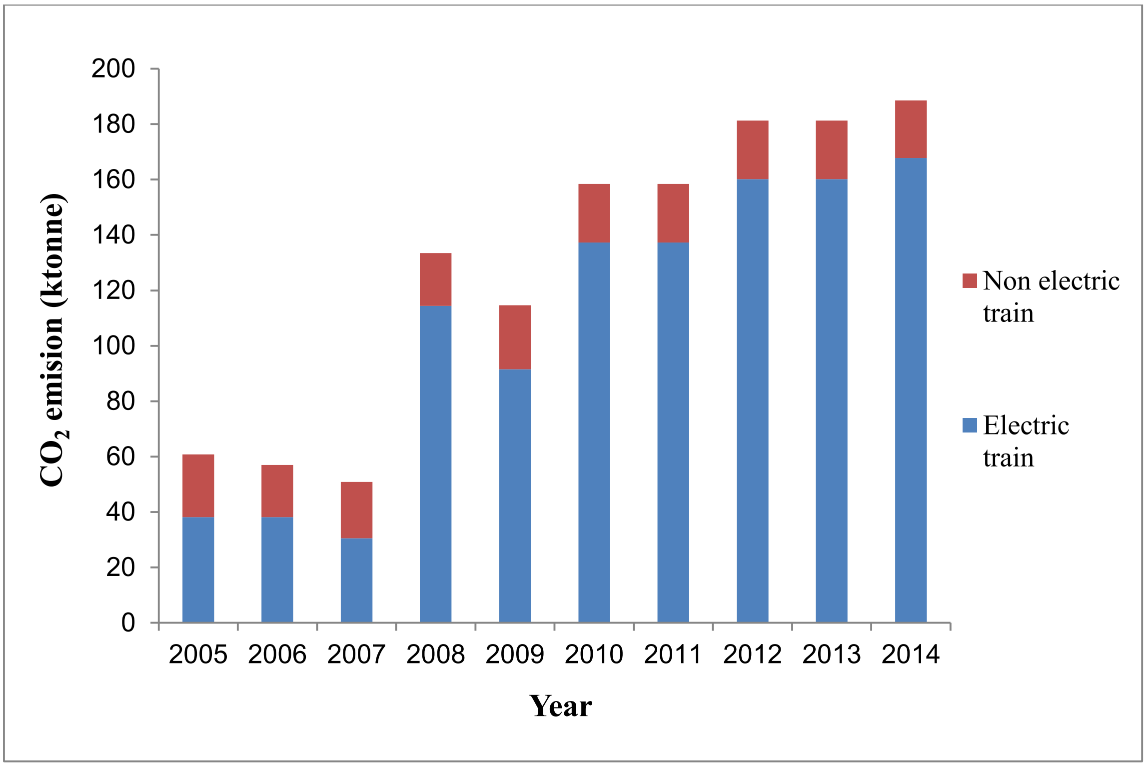


Table 6.55 Analysis and findings of CO_2 emission by rail transport in Malaysia (ktonne), 2005 to 2014

Year	Electric Train	Non electric Train	Total
2005	38	23	61
2006	38	19	57
2007	31	20	51
2008	114	19	133
2009	92	23	115
2010	137	21	158
2011	137	21	158
2012	160	21	181
2013	160	21	181
2014	168	21	189

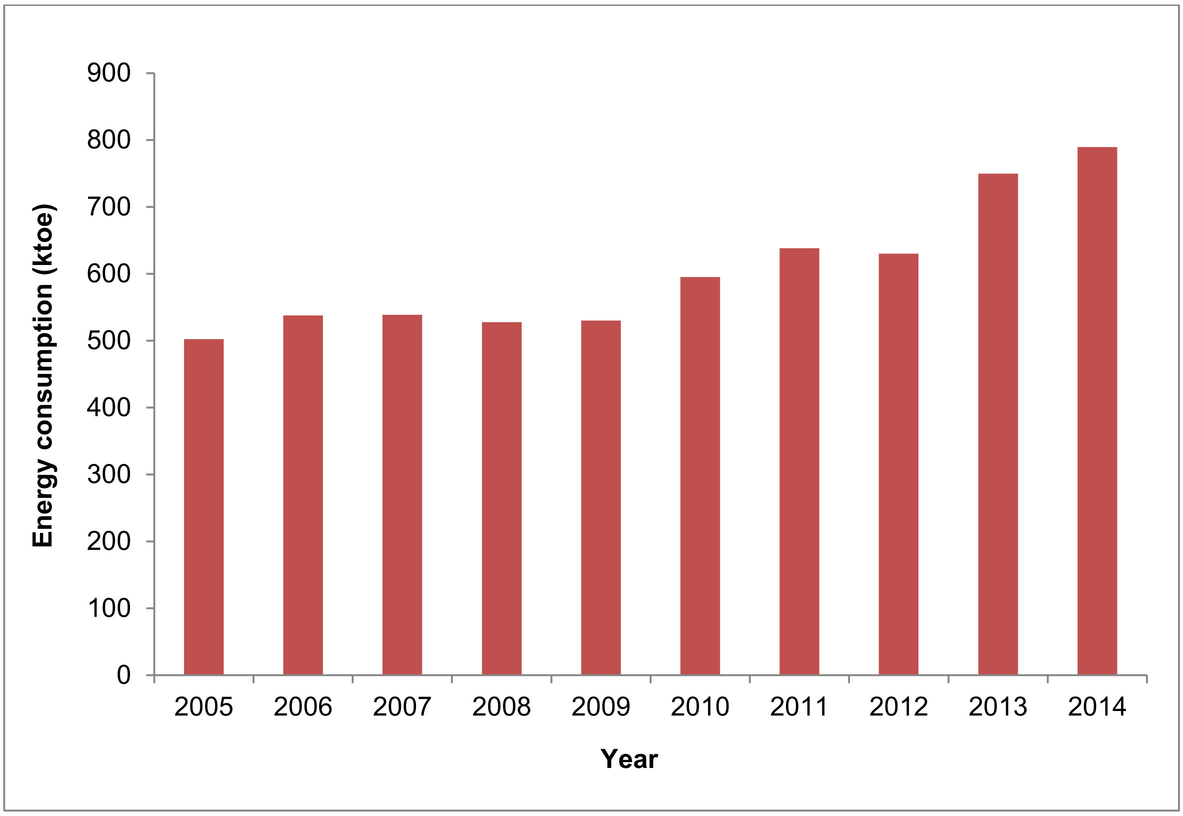
Figure 6.37 Analysis and findings of CO_2 emission growth trend by rail transport in Malaysia, 2005 to 2014



6.3.19 Air transport energy consumption and CO_2 emission

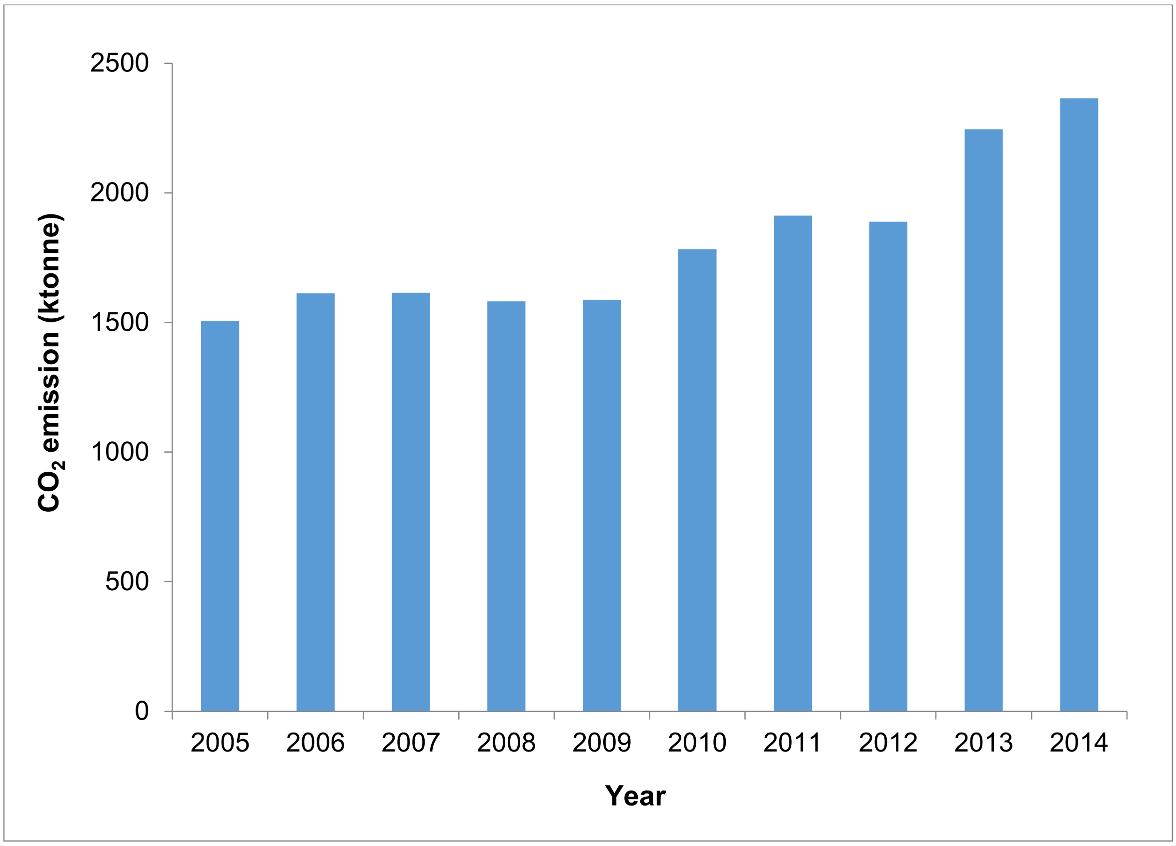
For domestic air transport, findings from the analysis are based on the information from MOT. According to MOT, about 25% of total Aviation Turbine Fuel (ATF) consumption as obtained from NEB is considered as domestic air transport energy usage. Figures 6.38 and 6.39 show the energy consumption and CO_2 emission by the air transport in Malaysia from 2005 to 2014 respectively. Both energy consumption and CO_2 emission irregular increasing from 2005 to 2009, and their changes are irregular.

Figure 6.38 Analysis and findings of energy consumption growth trend by air transport in Malaysia, 2005 to 2014



Source: Energy Commission, 2014

Figure 6.39 Analysis and findings of CO2 emission growth trend by air transport in Malaysia, 2005 to 2014



6.3.20 Water transport fuel consumption, energy consumption and CO_2 emission

Table 6.56 summarises findings from the analysis on the fuel consumption of water transport in Malaysia from 2005 to 2014. In 2005, the total fuel consumed is 1,017.66 million litres and increased to 1,144.22 million litres in 2014. The first category of transport consumed more fuel, about 604.80 million litres compared to other categories in 2014. From the Figure 6.40, it is seen that the growth trend of the fuel consumption increases slowly from 2005 to 2014.

Table 6.56 Analysis and findings of fuel consumption by water transport in Malaysia, (million L) 2005 to 2014

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Commercial (Inboard-diesel)	613.20	588.00	596.40	613.20	613.20	630.00	613.20	604.80	613.20	604.80
2. Traditional (Inboard-diesel)	232.80	264.00	261.60	247.20	252.00	244.80	237.60	235.20	237.60	235.20
3. Traditional (Outboard-petrol)	112.80	121.20	126.60	139.20	184.80	191.40	214.20	222.00	238.80	244.80
4. Ferry (diesel)	58.86	58.86	59.42	59.42	59.42	59.42	59.42	59.42	59.42	59.42
Total	1,017.66	1,032.06	1,044.02	1,059.02	1,109.42	1,125.62	1,124.42	1,121.42	1,149.02	1,144.22

Source: Fisheries Development Authority of Malaysia, 2014

Figure 6.40 Analysis and findings of fuel consumption growth trend by water transport in Malaysia, 2005 to 2014

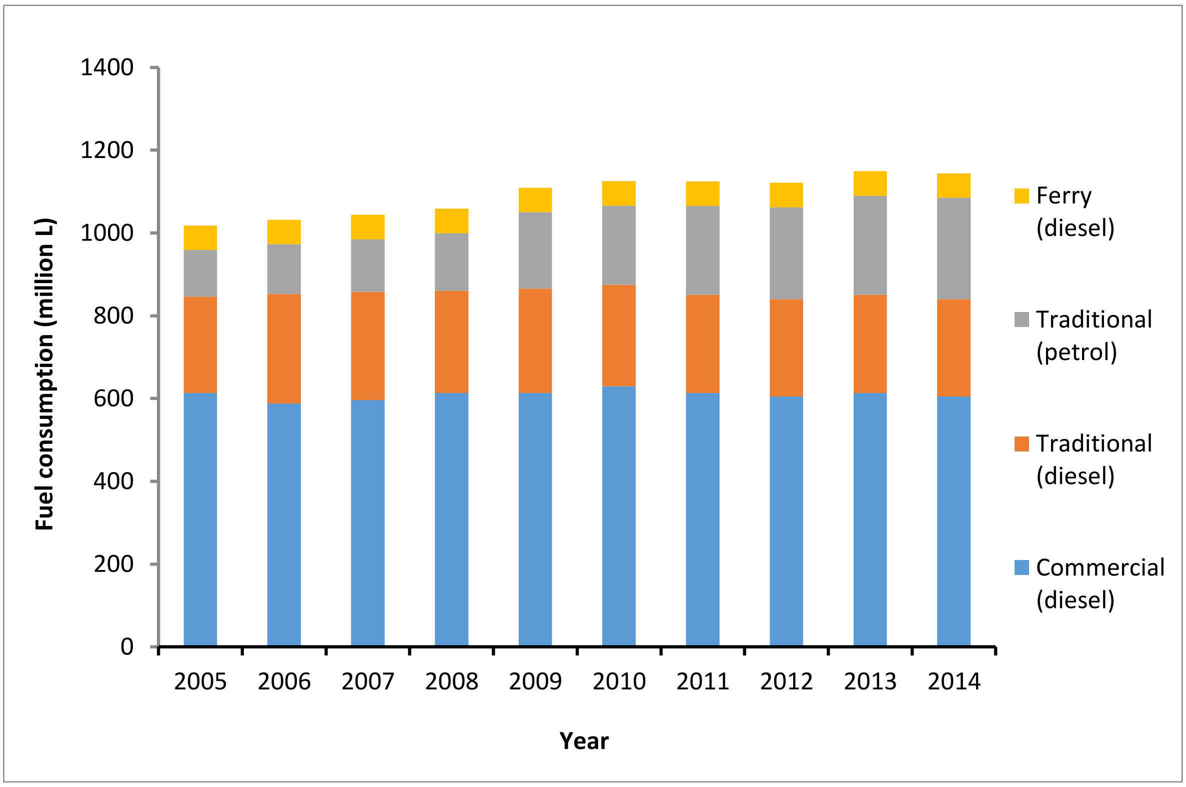


Table 6.57 summarises findings from the analysis on the energy consumption of water transport in Malaysia from 2005 to 2014. In 2014, energy consumption by water transport in

Malaysia is 956.76ktoe. Figure 6.41 shows that the trend of energy consumption from 2005 to 2014 is steadily growing.

Table 6.57 Analysis and findings of energy consumption by water transport in Malaysia, (ktoe) 2005 to 2014

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1. Commercial (Inboard-diesel)	524.29	502.74	509.92	524.29	524.29	538.65	524.29	517.10	524.29	517.10
2. Traditional (Inboard-diesel)	199.04	225.72	223.67	211.36	215.46	209.30	203.15	201.10	203.15	201.10
3. Traditional (Outboard-petrol)	86.52	92.96	97.10	106.77	141.74	146.80	164.29	170.27	183.16	187.76
4. Ferry (diesel)	50.32	50.32	50.80	50.80	50.80	50.80	50.80	50.80	50.80	50.80
Total	860.17	871.74	881.49	893.21	932.29	945.56	942.53	939.28	961.40	956.76

Figure 6.41 Analysis and findings of energy consumption growth trend by water transport in Malaysia, 2005 to 2014

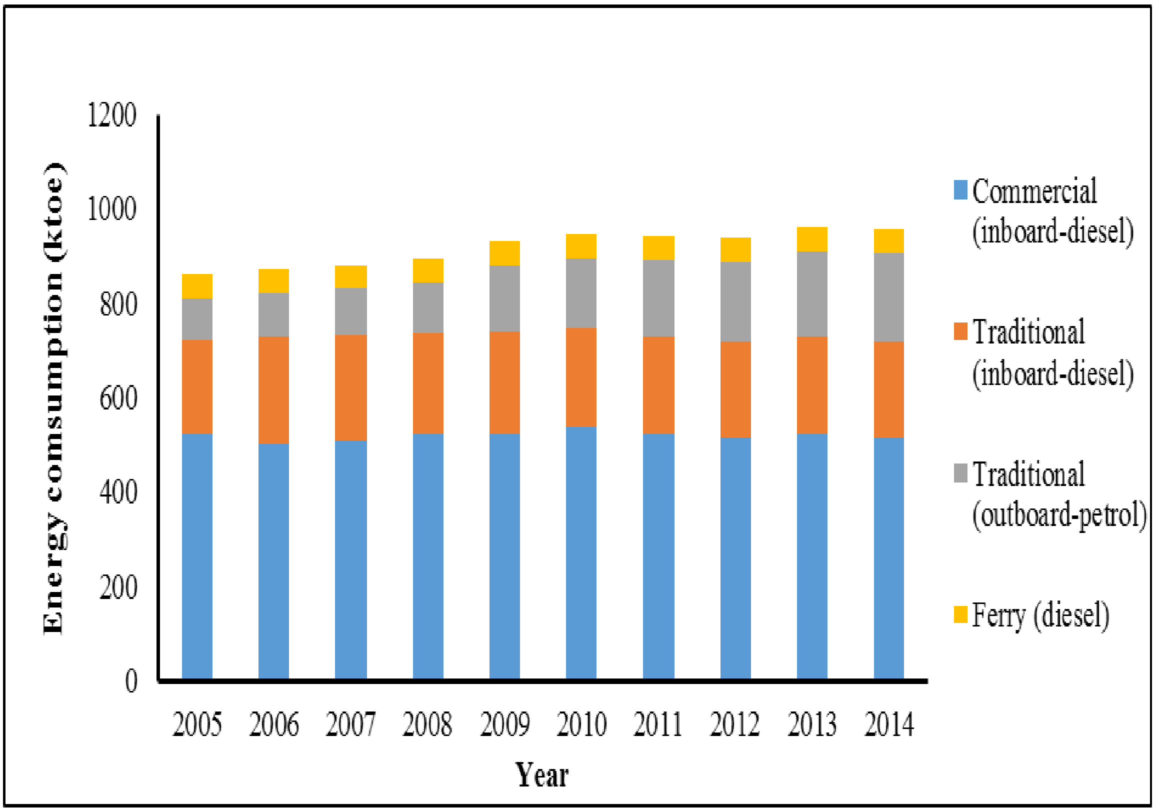
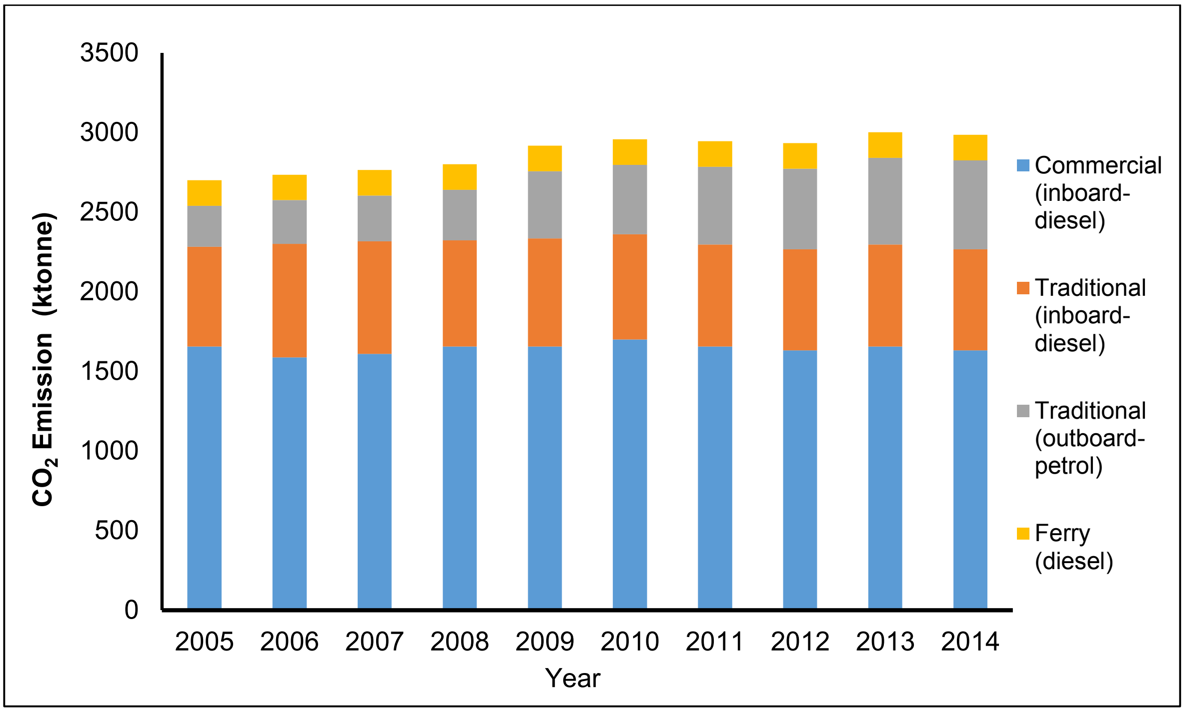


Table 6.58 Analysis and findings of CO_2 emission by water transport in Malaysia, (ktonne), 2005 to 2014

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1.Commercial (Inboard-diesel)	1,655	1,587	1,610	1,655	1,655	1,700	1,655	1,632	1,655	1,632
2. Traditional (Inboard-diesel)	628	713	706	667	680	661	641	635	641	635
3. Traditional (Outboard-petrol)	257	276	288	317	421	436	488	506	544	558
4. Ferry (diesel)	159	159	160	160	160	160	160	160	160	160
Total	2,699	2,734	2,764	2,800	2,917	2,957	2,945	2,933	3,001	2,985

The CO_2 emission based on findings of the analysis by water transport in Malaysia is shown in Table 6.58 from 2005 to 2014. The total CO_2 emission, in 2005 is about 2,699ktonne compared to 3,001ktonne and 2,985ktonne in 2013 and 2014 respectively. In 2014, the commercial (Inboard-diesel) is the main contributor of CO_2 emission by water transport in Malaysia with the total of 1,632ktonne. Figure 6.42 shows the CO_2 emission growth trend by water transport in Malaysia from 2005 to 2014.

Figure 6.42 Analysis and findings of CO_2 emission growth trend by water transport in Malaysia, 2005 to 2014



7.0 STUDY FINDINGS

This chapter describes about findings of the study based on the outlined outcomes expected for each energy using sector through data collection and analyses that have been performed.

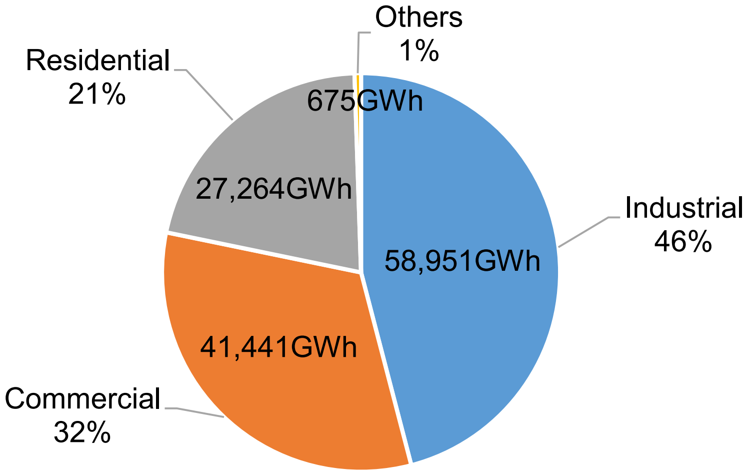
7.1 Electrical Energy

Figure 7.1 presents the percentage of final electricity demand for each sector. The industrial sector comprised of 46% energy demand consumption and followed by commercial sector with 32% and residential sector with 21%. The boundary of DSM study for electrical sector is confined to residential, commercial and industrial.

The transportation energy is excluded in this sector as there is a concurrent DSM study for energy use in transport sector. Besides, electricity usage in transport constitutes only 0.27% of the total final energy used as electricity. Agriculture also constitutes 0.73% of the total final energy of electricity and is therefore excluded from this study.

The findings show that the largest user of electrical energy is the industrial sector and followed by commercial and residential sector respectively. This will be the basis for the prioritisation for future intervention measures to be recommended in DSM programmes for electrical energy.

Figure 7.1 Final electricity demand by various sectors, 2014



Source: Energy Commission, 2014

Findings from the electrical energy data analyses indicate that the focus for DSM programmes should be prioritised according the most significant energy using sector namely industrial, commercial and followed by residential sectors.

This study recommends DSM programmes with a holistic implementation plan and strategies that will cover all the three (3) types of electrical energy users as described in detailed in Section 8.2.1.

7.2 Thermal Energy

Table 7.1 shows the summary of findings based on data analysis for industrial, combined commercial and residential as well as combined industrial, commercial and residential sectors in Malaysia for the period of 2010 to 2014. Comparison of the average yearly thermal energy consumption is also made with the corresponding sectors of the average final energy consumption (for the same period of 2010 to 2014) as reported in NEB 2014.

Table 7.1 Summary of thermal data analysis (2010-2014)

Description	Sector		
	Industrial Sector	Commercial and Residential Sector	Combined Industrial, Commercial and Residential
Average yearly thermal energy consumption (ktoe) - From data collected	8,634	1,362	9,996
Share of yearly thermal energy consumption based on data collected	86.4%	13.6%	100%
Average Final Energy Consumption reported in NEB 2014 (ktoe)	13,121	7,174	20,295
Share of thermal energy consumption in corresponding sectors of Final Energy Consumption reported in NEB 2014	65.8%	19.0%	49.3%

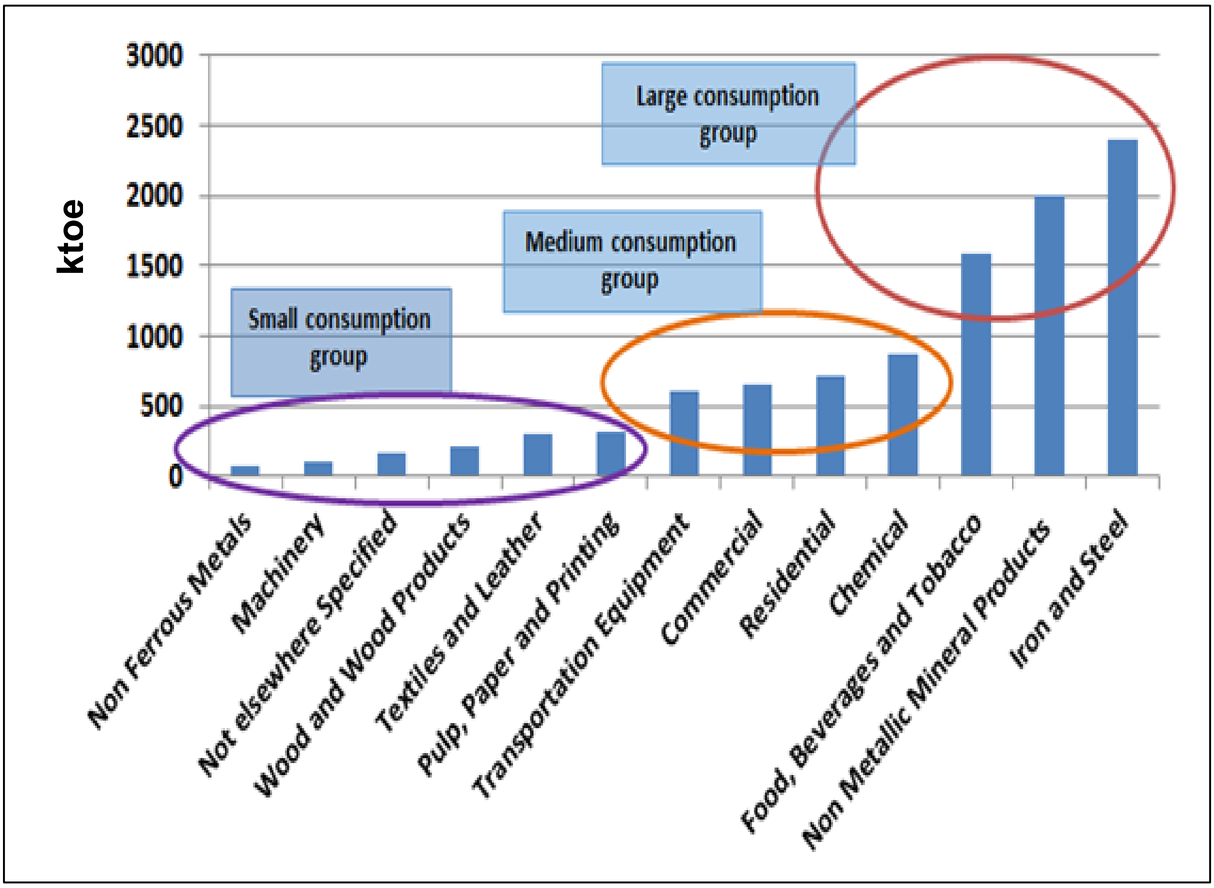
From Table 7.1, the combined average share of thermal energy consumption in the commercial and residential sector is at 13.6% (1,362ktoe) of the combined average total thermal energy consumption (9,996ktoe) in the country from 2010 to 2014. However, this value is comparatively less than that of the industrial sector with respect to the overall thermal energy consumption in the three (3) sectors, namely industrial, commercial and residential sectors.

The industrial sector takes up the majority share of 86.4% of the combined total thermal energy consumption in the industrial, commercial and residential sectors, and this share is a big proportion. Table 7.1 also shows the comparison of the average yearly thermal energy consumption (8,364ktoe) in the industrial sector with the respective average final energy consumption (13,121ktoe) as reported in the NEB 2014, the share of thermal energy consumption is 65.8%, which is a significant share of the final energy consumption. Therefore, it can be anticipated that there will be significant energy saving potentials in the DSM of thermal energy consumption in the industrial sector, which should be the focus area.

The last column in Table 7.1 shows the comparison of the combined average total thermal energy consumption of 9,996ktoe (from 2010 to 2014) with the average final energy consumption for the industrial, commercial and residential sectors as reported for the same period (2010 – 2014) in NEB 2014. This comparison shows that the share of the corresponding thermal energy consumption in the three (3) sectors (industrial, commercial and residential) with respect to the average final energy consumption is about 49.30%. This share of thermal energy consumption is lower because the energy source for the commercial and residential sectors is mainly electricity.

Similarly, based on the data collected with the average thermal energy consumption of 1,362ktoe for the commercial and residential sectors and the corresponding average final energy consumption as reported for the same period as reported in the NEB 2014, the average share of thermal energy consumption in these two (2) sectors is about 19%. In other words, the energy use by the commercial and residential sectors is mainly electrical energy.

Figure 7.2 Average yearly values of thermal energy consumption in industrial, commercial and residential sectors in Malaysia (ktoe), 2010 to 2014



Based on the above analysis and in terms of the extensiveness in thermal energy use, it can be categorised into three (3) groups from the highest to the lowest as illustrated in the Figure 7.2 and as follows:

i) Large consumption group (>1,500ktoe/annum): Iron and steel, non-metallic mineral products (incl. cement, concrete, ceramic and glass), and food, beverages and tobacco products;

ii) Medium consumption group (≥500ktoe/annum and ≤1,500ktoe/annum): Chemical, residential, commercial, and transportation equipment; and

iii) Small consumption group (<500ktoe/annum): Pulp, paper and printing, textiles and leather, wood and wood products, machinery, non-ferrous metals, and not elsewhere specified.

7.2.1 Study Finding 1: Baseline studies on DSM related initiatives

Much effort had been spent with stakeholders in defining thermal energy, formulating data format, identifying thermal energy consumption sectors and sub-sectors for data gathering. The stakeholder workshops and the follow-up efforts have contributed significantly to the project objectives. This has resulted in some interesting findings in the establishment of baseline studies for the purpose of DSM. The set of data gathered in this preliminary study has enabled an analysis of thermal energy consumption in the country to be carried out. This preliminary study was able to establish thermal energy consumption indicators by sectors and sub-sectors, expressed in percentage, i.e. share of the sectors or sub-sectors in the overall thermal energy consumption by the industrial, commercial and residential sectors.

Although study visits to model countries have not been possible, the activities and output of the Study Finding 1 have been fulfilled. The analyses have demonstrated that thermal energy use is a significant part of the whole spectrum of the consumption in the energy sector. The industrial sector takes up the majority share of 86.40% of the combined total thermal energy consumption by the three (3) main sectors, namely industrial, commercial and residential sectors in the country, and this share is a big proportion. In the overall context, the average share of thermal energy consumption by the industrial sector is at 65.80% of the average total final energy consumption over the period of 2010 to 2014.

It is anticipated that there will be significant saving potentials in DSM on thermal energy consumption in the industrial sector. On the other hand, the average share of thermal in the final energy consumption by the commercial and residential sectors is relatively much lower at 19% of the average final energy consumption. In other words, the energy consumption by the commercial and residential sectors is mainly electrical energy.

7.2.2 Study Finding 2: Identification of focus and boundary setting

Based on the data obtained, the most significant thermal energy consumption lies in the industrial sector which takes up the majority share at 86.40% of the combined total thermal energy consumption in the industrial, commercial and residential sectors. It has been identified that the focus area in terms of significant thermal energy consumption is the industrial sector.

Effective DSM plan and programmes in this sector will contribute significantly to energy savings and reduction in greenhouse gas (GHG) emission in the country. However, it is recognised that the combined share of thermal energy consumption of the commercial and residential sectors at 13.60% is significant and should be included in the detailed DSM study. It is anticipated that large-scale solar thermal heating installations may have significant energy saving potentials in commercial sector. In other words, a holistic development and effective implementation of DSM policies will generate significant impacts to the country's energy performance.

In line with the scope of thermal energy defined for the DSM study, the boundary is proposed to be confined to the demand of thermal energy from the following sources of energy:

i) Non-renewable: Fuel oil, natural gas, diesel, kerosene, petrol, coal and coke, LPG, etc.
ii) Renewable: Biogas, biomass, solar thermal energy, etc.
iii) Secondary thermal energy generated from other sources such as electricity through cogeneration and trigeneration.

7.2.3 Study Finding 3: Result framework and activities for the comprehensive DSM study

Terms of Reference

The terms of reference given below under the Framework for Comprehensive Study shall form the basis of the request for proposal (RFP), which stipulates the objectives, scope of study, deliverables and development requirements. The output will be used to formulate the DSM Master Plan and policy to elevate the level of energy-use efficiency for thermal energy in Malaysia. The proposed DSM master plan study is therefore a highly important blueprint that requires comprehensive and professional efforts from the successful Bidder.

From the deliberation with stakeholders the following areas are to be explored in the full DSM study:

- Methodology for effective implementation of DSM policies e.g. best-practice approach, industrial survey, measurements and verification, organisations alignment towards EE practices, recognition of EE efforts, education and promotion;
- Consolidated approach of data collection and harmonisation of industrial sub-sector classification to address the national needs and international reporting;
- Fiscal incentives (existing and future);

- Cost benefits analysis (for sub-sectors and nationwide levels);
- Barriers to implementation of DSM;
- Cogeneration and trigeneration on win-win basis;
- Establishment of EE indicators for energy performance monitoring;
- One-stop entity to be responsible for EE implementation; and
- Sustainable funding sources and mechanisms.

List of Key Stakeholders

Key stakeholders identified in this study are listed in the Table below.

No.	Ministry/Agency/Organisation
1	Department of Statistics Malaysia (DOSM)
2	Malaysia Palm Oil Board(MPOB)
3	Energy Commission
4	PETRONAS
5	Town and Country Planning Department of Peninsula Malaysia
6	Federation of Malaysian Manufacturers (FMM)
7	Malaysia Association of Energy Service Companies (MAESCO)
8	The Institution of Engineers, Malaysia (IEM)
9	Public Works Department (PWD) – Mechanical Engineering
10	Malaysia Investment Development Authority (MIDA)
11	ASHRAE Malaysia Chapter (MASHRAE)
12	Gas Malaysia Bhd
13	SME Corp
14	Malaysian Oil and Gas Services Council (MOGSC)
15	Malaysian Rubber Glove Manufacturers Association (MARGMA)
16	The Cement and Concrete Association of Malaysia
17	Malaysian Gas Association (MGA)
18	Sustainable Energy Development Authority (SEDA)
19	Malaysian Green Technology Corporation (MGTC)
20	Academy of Sciences Malaysia(ASM)
21	The Electrical and Electronics Association of Malaysia
22	Department of Occupational Safety and Health(DOSH)
23	Shell Malaysia Limited
24	SIRIM

Framework for Main Study

The DSM detailed study for thermal energy sector shall comprise six (6) tasks as detailed below. To achieve the project objectives of the DSM detailed study, the appointed consultant shall prepare an Inception Report, which shall outline the project approach, methodology, key activities and work flow for each of the Tasks, overall project management structure and schedule for approval prior to the execution of the six (6) tasks listed below. Consultation with stakeholders will be conducted for the each of the Tasks except for Task 4 on Cost-Benefits Analysis, for which the results of the consultant's analyses shall be presented and deliberated.

Task 1: Review existing institutional setup, regulatory framework, etc.

Supply of energy shall encompass the following:

i) Data collection from relevant sectors and sub-sectors which consume thermal energy;
ii) Use of thermal energy; technologies and alternative energy resources.

Governance structure:

- Policies, laws and regulations
- Executing/implementing agencies;
- Compliance and enforcement
- Data collection and repository;
  Prerequisites to utilisation of thermal energy: Environmental sustainability, health and safety;
- Competency of human resources;
- Investment and business potentials.

Review current scenario, targets and baseline benchmark values:

i) Establishment of energy performance indicator(s) of respective sectors and sub-sectors;
ii) Establishment of baseline benchmark value(s) of respective sectors and sub-sectors;
iii) Saving targets and estimated implementation costs;
iv) Funding requirements and mechanism;
v) Social and economic impacts.

Task 2: Propose counter-measures for the following but not limited to the identified shortfalls and barriers

The detailed study will be required to propose counter-measures for the shortfalls and barriers identified from the consultations with stakeholders. The following is a list of shortfalls and barriers identified by the stakeholders during the DSM preliminary study:

ii) No policy and legal requirements;
iii) Lack of clarity about the scopes and potentials of thermal energy utilisation;
iv) Data reliability and accuracy;
v) Uncertainty on energy data requirements for analysis;
vi) Multiple data owner and sources and non-uniform sector/sub-sector classification;
vii) Unavailability of a centralised entity for enforcement and data collection;
viii) No integration of thermal energy potentials and no thermal management programmes at different levels [e.g. cross references with existing planning documents (e.g. states / district strategic plans)];
ix) Spatial data (location);
x) The unavailability of mechanisms and templates of data collection and monitoring;
xi) Unavailability of any national carbon emission trading schemes;
xii) Location of existing and future major thermal energy use;
xiii) Lack of fiscal incentives and financing mechanism.

Task 3: Develop comprehensive strategies and measures

- To establish a consolidated approach to data collection so that accurate and comprehensive data can be established to help policy makers to develop effective and comprehensive DSM plan as well as to monitor and measure the effectiveness;
- To develop plans for the establishment of energy performance indicator(s), baseline value(s), saving targets and estimated implementation costs, and funding requirements/mechanism;
- Practical methodology for effective implementation of DSM initiatives through best-practice approaches, industrial survey, measurements and verification, align organisations / companies towards EE practices, recognition of EE efforts, education and promotion;
- Establish promotion of R&D activities on thermal energy utilisation and mechanism;
- Fiscal incentives;
- Provide technical assistance to SMI/SME on efficient utilisation of energy;
- Cogeneration and trigeneration potentials as low-carbon DSM measures;

- One-stop centre as the DSM initiatives implementation custodian and regulating body complete with resource requirements (human resource and budget planning);
- Thermal energy sourcing mechanisms;
- Funding sources, criteria and distribution mechanisms for the one-stop centre and DSM initiatives;
- Adoption of strategic and cost-effective technologies;
- Possible establishment of national carbon trading scheme; and
- Establishment of framework on EE&C Laws for efficient utilisation of thermal energy:
  - Towards self-regulation
  - Reporting in accordance with requirements to be identified
  - Funding governance

Task 4: Conduct Cost-Benefits Analysis

- Conduct cost-benefits analysis of the recommended strategies and measures;
- Identify and quantify the impact of Thermal energy saving strategies and measures to the national energy intensity; and
- Conduct macro-economic modelling.

Task 5: Identify and recommend collection and management of thermal energy data

- Identify and recommend sector and sub-sector classification for harmonisation and adoption for national and international reporting;
- Determine and recommend the size of thermal energy users that require data collection and monitoring;
- Recommended measurements, monitoring, verification and analysis methodology;
- Recommended format of data analysis presentation; and
- Identify and recommend the entity responsible for the collection and management of thermal energy data

Task 6: Develop a comprehensive DSM policy for Malaysia to realise the benefits of DSM strategies and measures.

Based on the outcomes of Tasks 1, 2, 3, 4 and 5, the Consultant shall develop:

- A comprehensive DSM policy (for the Thermal Energy Sector) incorporating, but not limited to the following:

- Policy Statement;
- Objectives;
- Scope of Policy;
- Implementation plan, strategies and methodologies / approach including legal framework for major thermal energy consumption sectors;
- The plan shall be SMART [Specific, Measurable, Achievable, Realistic, Time-tagged targets up to the year 2035 (short, medium and long-terms)].

7.3 Transport Energy Use

7.3.1 Comparative energy consumption and CO_2 emission by different transport system

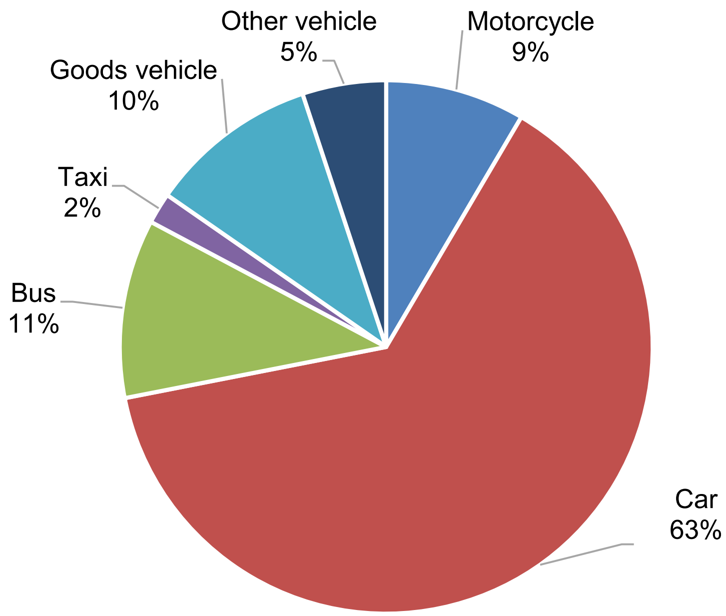
Comparative study on energy consumption between road transportation in Malaysia from 2005 to 2014 is shown in Table 7.2. Figure 7.3 (a) and (b) shows that car transportation consumes highest in energy consumption with an increase of 4.73% from 2005 to 2014. Electric vehicles can be seen slowly growing into the market as it consumes less energy consumption.

Table 7.2 Comparative energy consumption by different road transports in Malaysia (ktoe), 2005 to 2014

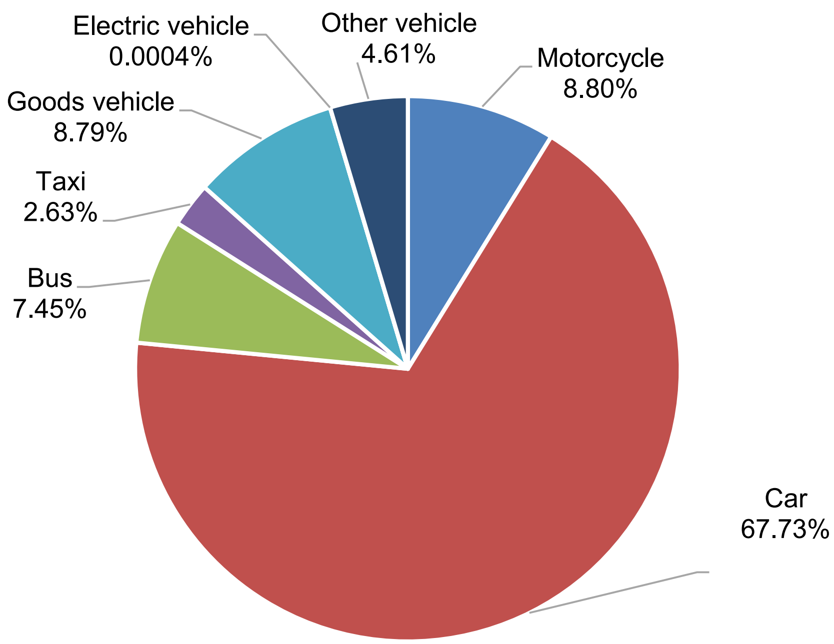
Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motorcycle	1,164	1,238	1,319	1,408	1,483	1,566	1,656	1,757	1,839	1,929
Car	8,721	9,353	9,992	10,726	11,452	12,272	13,088	13,941	14,184	14,848
Bus	1,491	1,532	1,563	1,607	1,671	1,735	1,801	1,845	1,575	1,632
Taxi	258	273	287	316	335	360	382	393	538	576
Goods Vehicle	1,411	1,460	1,515	1,576	1,613	1,656	1,700	1,748	1,866	1,927
Electric vehicle	-	-	-	-	-	-	0.020	0.040	0.056	0.100
Others	699	722	752	786	817	854	893	935	973	1010
Total	13,743	14,579	15,428	16,419	17,371	18,443	19,521	20,618	20,977	21,921

Source: Ministry of Transport Malaysia, 2014

Figure 7.3 Energy consumption ratios of different types of road transports in Malaysia, (a) 2005 and (b) 2014



(a) Energy consumption in 2005



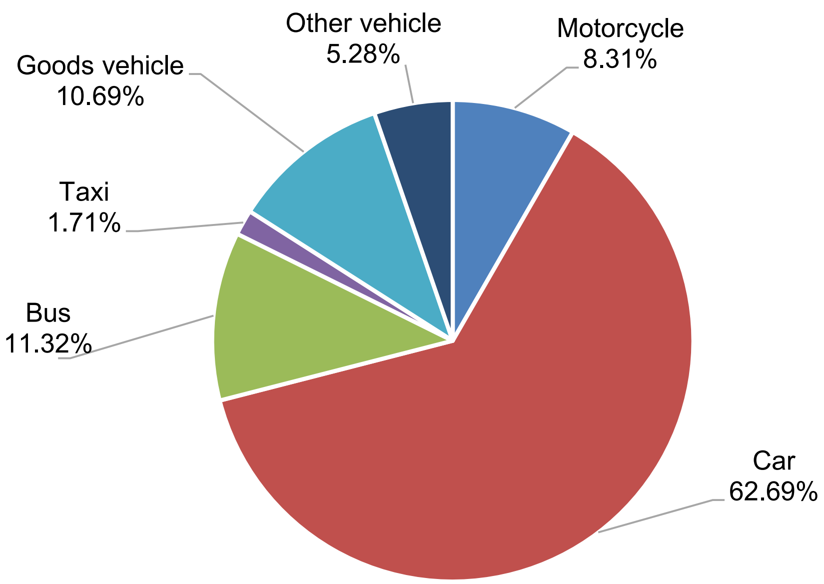
(b) Energy consumption in 2014

The trend in CO_2 emission by different types of road transport is tabulated in Table 7.3 and demonstrated in Figure 7.4 (a) and (b). The CO_2 emission has increased from 62.69% in 2005 to 67.15% in 2014 for cars which is subversive to the environmental goal of Malaysia.

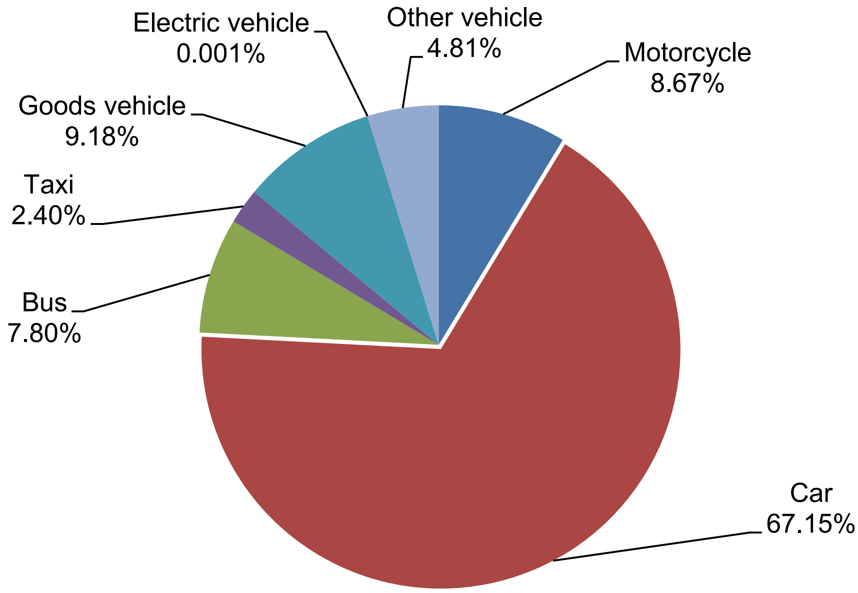
Table 7.3 Comparative CO_2 emission by different road transports in Malaysia (ktonne), 2005 to 2014

Category	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Motorcycle	3,457	3,679	3,918	4,183	4,406	4,653	4,921	5,219	5,464	5,731
Car	26,065	27,953	29,863	32,056	34,227	36,677	39,118	41,666	42,393	44,376
Bus	4,706	4,837	4,934	5,073	5,274	5,477	5,686	5,825	4,973	5,152
Taxi	709	750	790	870	921	991	1051	1081	1480	1584
Goods vehicle	4,443	4,597	4,769	4,959	5,078	5,211	5,350	5,501	5,873	6,065
Electric vehicle	--	--	--	--	--	--	0.15	0.31	0.43	0.77
Other vehicle	2,197	2,271	2,365	2,473	2,570	2,687	2,809	2,940	3,061	3,176
Total	41,577	44,088	46,640	49,615	52,477	55,696	58,935	62,232	63,246	66,084

Figure 7.4 CO_2 emission ratios of different types of road transports in Malaysia, (a) 2005 and (b) 2014



(a) CO_2 emission in 2005



(b) CO_2 emission in 2014

There is no accurate data available on active and non-active vehicles for individual vehicle types. In cases of individual vehicle types, the total number of vehicles is used to calculate energy consumption and CO_2 emission. Based on MOT, the ratio of active to non-active vehicles for all vehicle types as a whole are 71.80% in 2014, 72.20% in 2013, 72.90% in 2012, 74.30% in 2011, 74.50% in 2010, 75.10% in 2009 and 75.50% in 2008. To calculate the energy consumption and CO_2 emission for all active road vehicles, an average of 73% are considered to produce precise estimation. All the figures and data presented henceforth are based on this estimation.

Table 7.4 shows the comparison between resultant energy consumption as found in the present study with that obtained from the report submitted to *Kementerian Perdagangan Dalam Negeri, Koperasi dan Kepenggunaan* (KPDNKK) on annual fuels sold by the petrol operators. The equivalent energy in ktoe of the fuel sold per year is seen to be slightly greater than the ktoe values as found in this study. This slight discrepancy is because although all the major transportation sectors have been considered in the present study, there are still some other fuel consumers like construction machines, generator sets, etc. which were neglected as they are not categorised in the transportation sector (refer section 7.3.2)

Table 7.4 Comparison of the road transport energy consumption with KPDNKK, 2005 to 2014

Year	Energy consumption by transport (KPDNKK) (ktoe)	Energy consumption by road transport (Present study) (ktoe)	Percentage Difference
2014	20,260.82	16,002.76	21.01
2013	19,070.27	15,313.02	19.70
2012	17,468.60	15,051.40	13.84
2011	15,879.96	14,250.27	10.26
2010	14,520.46	13,463.53	7.28
2009	13,470.47	12,681.00	5.86
2008	-	11,985.97	-
2007	-	11,262.48	-
2006	-	10,642.60	-
2005	-	10,032.50	-

Energy consumption by sector is demonstrated in the Table 7.5. Figure 7.5 to 7.6 shows that road transport is the single largest contributing factor in energy consumption at 88.73% in 2005 and 90.02% in 2014. Land transport contributes almost 90.18% of energy consumed by the transportation sector in 2014. Water sector is the second largest consumer of energy with a share of 7.61% in 2005 and 5.38% in 2014.

Table 7.5 Energy consumption by all transportation system in Malaysia, (ktoe) 2005 to 2014

Year	Road	Rail	Air	Water	Total
2005	10,032.50	12.18	502.50	860.17	11,407.36
2006	10,642.60	10.95	538.00	871.74	12,063.29
2007	11,262.48	10.44	538.75	881.49	12,693.17
2008	11,985.97	21.04	528.00	893.21	13,428.22
2009	12,681.00	19.34	530.00	932.29	14,162.63
2010	13,463.53	24.69	595.00	945.56	15,028.78

Year	Road	Rail	Air	Water	Total
2011	14,250.27	24.69	638.25	942.53	15,855.73
2012	15,051.40	27.69	630.25	939.28	16,648.62
2013	15,313.02	27.69	749.50	961.40	17,051.60
2014	16,002.76	28.61	789.50	956.76	17,777.63

Figure 7.5 Energy consumption growth trend by all transportation system in Malaysia, 2005 to 2014

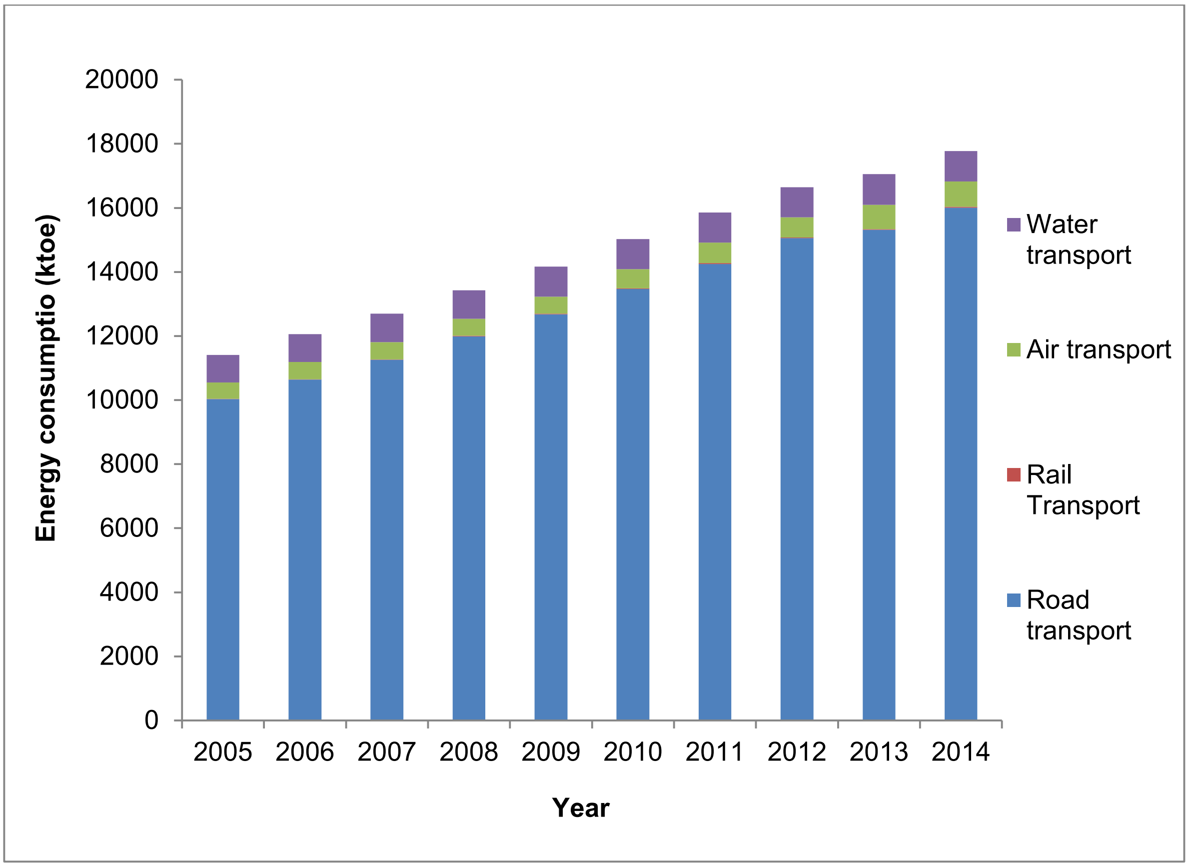
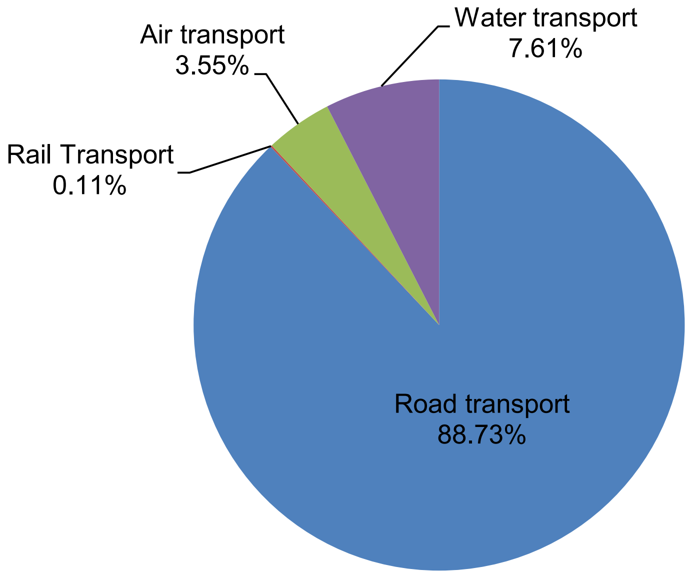
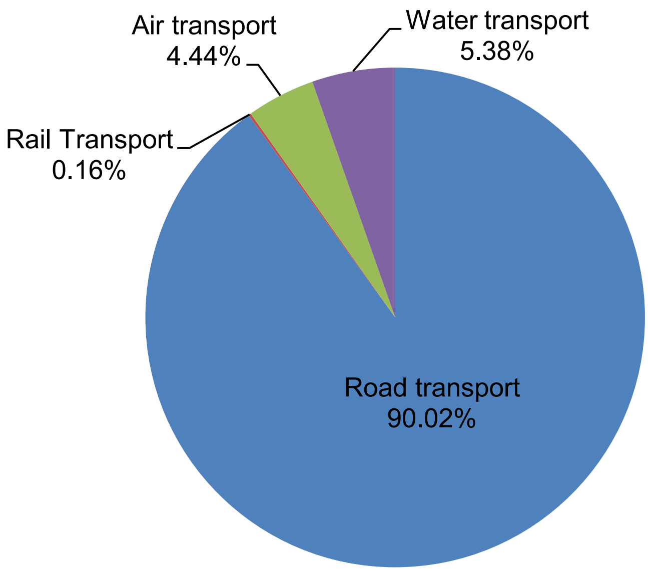


Figure 7.6 Percentage of energy consumption of different transport system in Malaysia, (a) 2005 and (b) 2014



(a) Percentage of energy consumption by all transportation system in 2005



(b) Percentage of energy consumption by all transportation system 2014

Table 7.6 and Figure 7.7 show the ratio of CO_2 emission by different transportation sector. The result shows that road transport occupies a major place in emitting CO_2 emission with a share of 87.68% in 2005 and 89.70% in 2014.

Table 7.6 CO_2 emission by all transportation system in Malaysia (ktonne), 2005 to 2014

Year	Road transport	Rail Transport	Air transport	Water transport	Total (BOP)	Total (BOIPCC)	Percentage Difference
2005	30,351	61	1,506	2,699	34,617	33,882	2.12
2006	32,184	57	1,612	2,734	36,588	35,809	2.13
2007	34,047	51	1,614	2,764	38,476	37,656	2.13
2008	36,219	133	1,582	2,800	40,734	39,859	2.15
2009	38,308	155	1,588	2,917	42,927	42,004	2.15
2010	40,658	158	1,783	2,957	45,557	44,573	2.16
2011	43,022	158	1,912	2,945	48,038	46,999	2.16
2012	45,429	181	1,888	2,933	50,432	49,338	2.17
2013	46,170	181	2,246	3,001	51,597	50,477	2.17
2014	48,241	189	2,366	2,985	53,781	52,613	2.17

Note: BoP: Based on Petronas, BoIPCC: Based on Intergovernmental Panel on Climate Change

Figure 7.7 CO_2 emission growth trend by all transportation system in Malaysia, 2005 to 2014

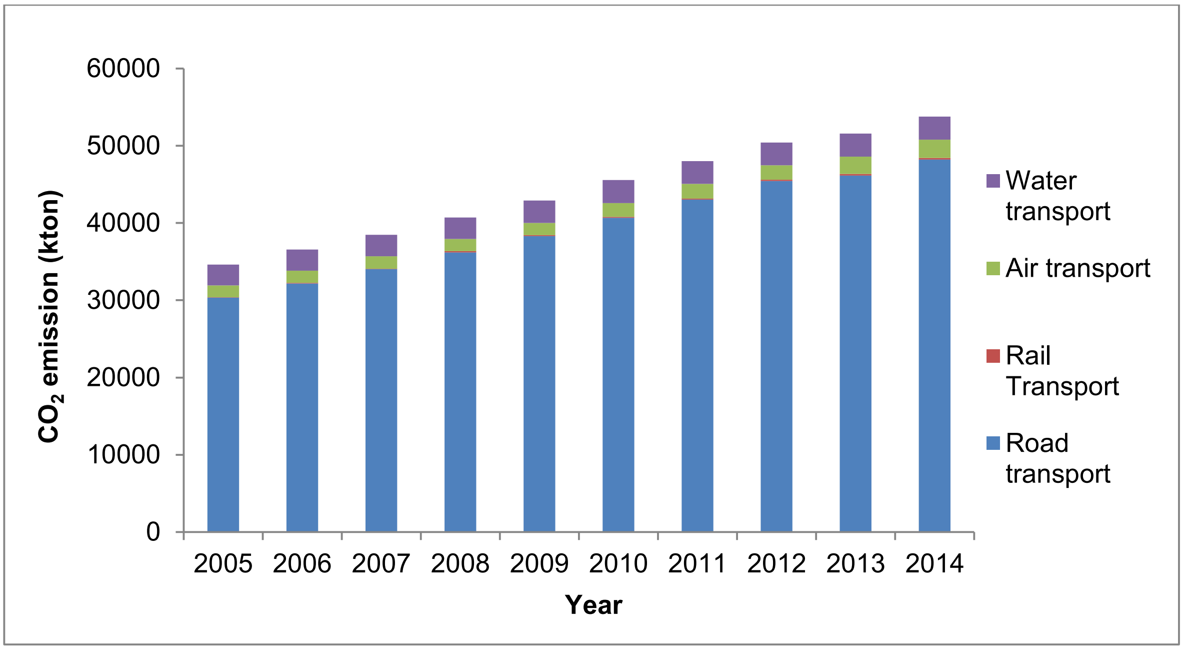
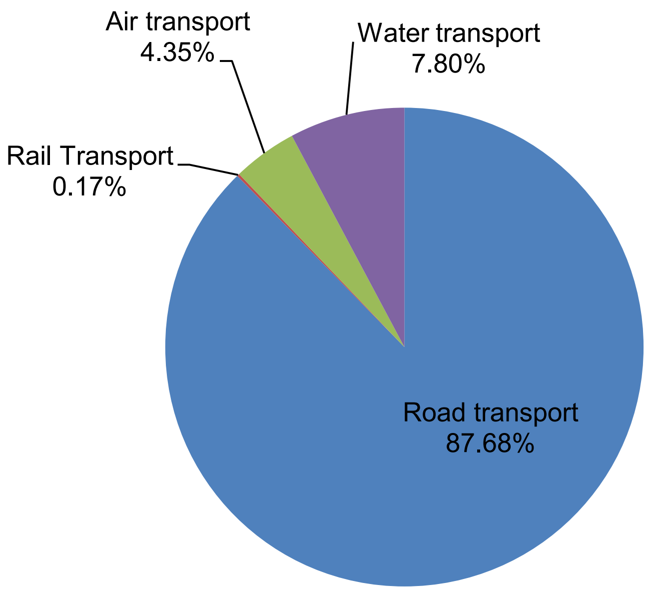
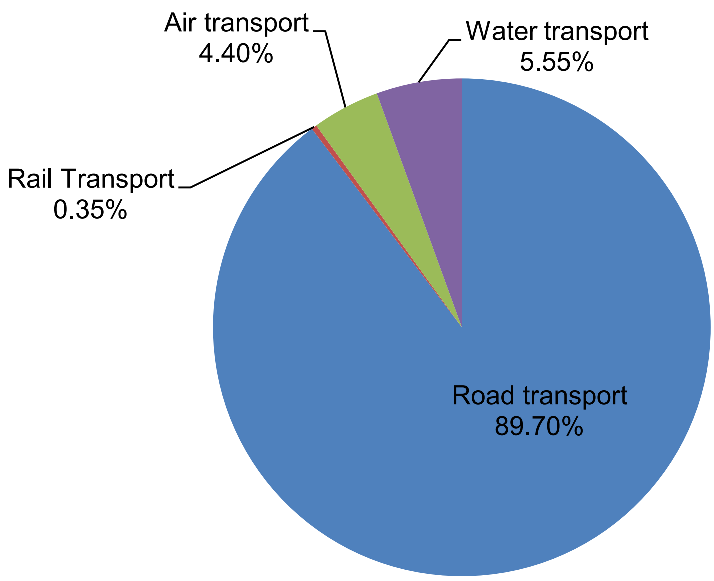


Figure 7.8 CO_2 emission ratios of different transport system in Malaysia (a) 2005 and (b) 2014



(a) CO_2 emission by all transportation system in 2005



(b) CO_2 emission by all transportation system in 2014

Table 7.7 shows total energy consumption by fishery in Malaysia (excluding energy consumption by other water transports) as estimated by the present consultant presented by NEB Report 2014 and MESH 2015. The percentage difference between the two (2) findings of the analysis is about 10% to 13%.

Table 7.7 Total energy consumption by fishery in Malaysia, 2005 - 2014

Year	National Energy Balance (MESH, 2015, NEB 2014) (ktoe)	Present study (ktoe)	Percentage Difference
2014	1,009	905.96	10.21
2013	1,013	910.59	10.11
2012	1,016	888.47	12.55
2011	-	891.73	-
2010	-	894.76	-
2009	-	881.49	-
2008	-	842.41	-
2007	-	830.69	-
2006	-	821.42	-
2005	-	809.85	-

7.3.2 Study Finding 1: Baseline studies on DSM related initiatives

Baseline data and indicators

Baseline data has been established in the preliminary DSM study. The types of transportation in Malaysia is classified as land (road and rail), air, and water which are further divided into types of vehicles.

In Malaysia, petrol is used mainly by cars, motorcycles, and light trucks (goods vehicles). Diesel fuel is used mainly by medium and heavy vehicles, buses, and trains. Aviation turbine fuel and aviation gasoline are used in jet airplanes, and residual fuel oil is used in ships. Natural gas and liquid petroleum gas are used in all types of vehicles, but they are used predominantly in heavy duty vehicles such as buses and other large transportation vehicles.

Most of the electricity used in Malaysia for transportation is used by public mass transit systems i.e. intra-city and intercity trains.

Data from KPDNKK which is obtained from petrol stations (operators) are mostly for land road transport. Data obtained from KPDNKK does not include jobbers for year 2014. Based on NEB 2014 and KPDNKK reports, the total energy consumption by transportation sector and road transport are 24,327ktoe and 20,260.82ktoe for the year of 2014 respectively. This shows that road transport contributes almost 83.28% of energy consumed by the transportation sector. In addition, data collection for road transport is the most challenging due to its broad type of modes as compared to water and air.

Indicators that are required to be established to set baseline and carry out scenario studies including other considerations are listed as follows:

- Trends, types and distribution of main fuels for energy used in transportation sector in Malaysia (2005 to 2014);
- Definition of the transport modes and technologies in various sectors, such as, land (road and rail), air and water;
- Indicators include transport activity data, energy intensity data, transport load factors, and transport mode shares such as:
  - Vehicle stock by vehicle modes and technology;
  - Annual vehicle kilometres travelled modes and technology;
  - Specific fuel consumption litre/100 km;
  - Passenger-km and tonne-km; and
  - Engine capacity of the vehicle modes and technology.

  Note: Vehicle kilometres travelled are used extensively in calculating energy fuel consumption and CO_2 emission, and it is always estimated;

- Calculation of fuel consumption, energy consumption and CO_2 emission in various transport sectors;
- The data obtained from MOT only highlighted regional variations in the characteristics of the vehicle fleet across Malaysia for two-three wheelers and private car (for road transport);
- The average annual distance travelled by lightweight vehicles differs by state in Malaysia.

Note: This difference is due to variations which exist in the vehicle model, engine capacity, road and transportation alternative and number of vehicle owner. Other factors which may influence these variations include gender, age, geography, age of vehicle and style of driving. There is no exact information on distance travelled in rural area, which uses a higher proportion of old vehicle, stakeholders have agreed that information will be standardised on assumptions;

- The average annual distance travelled by medium and larger trucks (goods vehicles) varies.

  Note: Numerous factors may contribute to the observed variations in distance travelled among regions for medium and heavy trucks. These factors include structure of the economy, geographic size, geographic range of trucking operations and vehicle ownership rate. Heavy trucks travel less distance on average but have the highest consumption rates. Their higher fuel consumption rate could be partly explained by a lower ratio of highway driving relative to city driving (fuel economy tends to be greater for highway driving than for city driving). About 80% of the containers trucks will return empty and proper coordination for return trip is needed. In this baseline study, the annual distance travelled is based on the stakeholder experiences;

- JPJ has all the registration for trucks and trailers in Malaysia. However, there is different costing for containers and general trucks. Containers only need one (1) road tax, while general trucks require two (2) road taxes (the head and the tail). This creates unnecessary number of trucks in the road, thus, creating congestion and double counting in the analysis;
- Any data with duplicate vehicle identification numbers, vintage/classic, scrapped or salvaged vehicle and out of scope vehicles are removed, leaving the record that was updated most recently;
- For freight forwarders, according to FMFF, the movement of containers are mostly with import and export shipments within the radius of 75km distance travelled; though occasionally inter-port movements may be involved but they are certainly less than a couple of percentage of the total volume;
- For air transportation, the total jet fuel consumed in aviation industry is available and compiled by the ST. However, it only provides the total jet fuel consumed without breakdown by sectors or regions. According to MOT, only 25% of total ATF consumption is considered as domestic air transport energy usage. All the data are directly obtained from ST;

- For water transportation, the challenges include accuracy of data, sources of data, data on trading boats and passenger's ferries. There are about 4,000 units of boats operating mainly in Sabah and Sarawak that the whereabouts and actions are not accounted for. Another challenge is that the data is scattered all over Malaysia under different agencies or ferry operators. The data were collected from visits to the ferry operators and through website which is based on assumption;
- The amount of subsidised fuel consumed by fishing boats can be obtained from DoF and *Lembaga Kemajuan Ikan Malaysia* (LKIM). However, this is not considered to the total amount of fishing boats as some of them do not receive any subsidised fuel; and
- Data's are obtained from various government agencies (e.g. KPDNKK, MOT, JPJ, SPAD, ST, *Projek Lebuhraya Utara Selatan* (PLUS) Malaysia Bhd, DoF, LKIM, *Lembaga Lebuhraya Malaysia* (LLM), *Jabatan Laut Malaysia* (JLM) and etc.). The data which will be needed includes transport activity data, energy intensity data and transport load factors, and transport mode shares. Table 7.8 shows the list of transportation types, the source agency and data provider.

Table 7.8 List of transportation types and the source agency and data provider

No	Transportation Types	Agency and Data provider
1.	**Land (Road)**	KPDNKK, Petroleum Services Station Dealers such as Petronas, Shell, Petron, BHP & Caltex. Overall data on the country's fuel consumption obtained from retail fuel station such as Petronas, BHP, Shell and Petron.
2.	**Overall**	ST Comprehensive annual primary fuel consumption data on NEB report.
3.	**Overall**	KETTHA Data on study conducted on Efficiency of Transport
4.	**Land (Road)**	Malaysia Automotive Institute Some information related to road transport.
5.	**Land (Road & Rail)**	SPAD provides data on public mode share and commercial vehicles from year 2013 to 2016. Data requested/provided are as follows: - - Number of buses/taxi/trucks - Number of passengers-km for bus, - Number of passengers-km for train - Number of freight tonne-km for trucks & trains. - Types of trains, buses, taxi, trucks - Distance travelled by bus, taxi, train and trucks - Freight trucks above 5 tonnes. - Types of fuels

No	Transportation Types	Agency and Data provider
6.	Land (Road)	MOT/JPJ provide data on land, air and water transportation from year 2005 to 2014. Data requested/provided are as follows: - - Number of buses/taxi/trucks - Number of passengers-km for bus, - Number of passengers-km for train - Number of freight tonne-km for trucks & trains. - Types of trains, buses, taxi, trucks - Distance travelled by bus, taxi, train and trucks - Freight trucks. - Types of fuels
7.	Land (Road)	*Lembaga Perlesenan Kenderaan Perdagangan*/ Commercial Vehicle Licensing Board for vehicles in Sabah and Sarawak
8.	Land (Road)	Highway concessionaires LLM, PLUS etc.) Provide information on traffic flows on for all highways sections (toll plaza to toll plaza) in Malaysia according to classes such as car, lorry, container, taxi and bus)
9.	Land	Transport Associations (Malaysia Ship Owners' Association (MASA), Maritime Institute of Malaysia (MIMA), Malaysia Offshore Support Vessel Owners' Association (OSV Malaysia), *Persatuan Lori-Lori Malaysia*). Average fuel consumption rate according to: - Model - Fuel Types - Number of Containers and Lorry - Engine Capacity - Annual Distanced Travelled - Number of tonne-km
10.	Air	DCA, MAHB, Airlines (e.g. MAB, Airasia and Malindo), Provide information regarding the total number of airplanes and helicopters and average fuel consumption rate within Malaysia according to: - Types of Fuel - Distance travelled - Number of passenger-km, tonne-km - Total cargo movement - Total passenger movement - Number of outgoing domestic flights per day - Type of flights and aircraft, - Total fuel consumption by airline (domestic flights only)
11.	Water	*Jabatan Laut Malaysia* Average fuel consumption rate according to: - Model - Engine Capacity - Types of Fuel - Number of vessels registered in Malaysia - Number of Passengers-km - Gross register tonnage - Rated fuel usage litre/hour - Annual travelled hours
12.	Water	*Jabatan Perikanan Malaysia* (DoF), *Lembaga Kemajuan Ikan Malaysia* Total fuel consumption for fisheries. Average fuel consumption rate according to: - Model - Engine Capacity - Fuel Types - Number of vehicles - Gross register tonnage - Rated fuel usage litre/hour - Annual travelled hours

No	Transportation Types	Agency and Data provider
13.	Water	Respective Ports operators such as *Lembaga Pelabuhan Kelang, Pelabuhan Tanjung Pelepas Sdn Bhd*, Penang Port Commission, *Lembaga Pelabuhan Kuantan* etc. under MOT. Only for domestic cargo movement. Average fuel consumption rate according to: - Model - Rated fuel usage litre/hour - Number of Containers - Marine services (tug boat & boat operators) - Engine Capacity - Gross register tonnage - Annual travelled hours
14.	Water	Sarawak Rivers Board (LSS) and Ferry operators such as Langkawi Ferry Line Ventures Sdn. Bhd, Blue Water Express, Duta Pangkor Express Ferry Sdn. Bhd, and etc.) Average fuel consumption rate according to: - Model - Engine Capacity - Rated fuel usage litre/hour - Number of vehicles - Number of Passengers-km - Gross register tonnage - Annual travelled hours

The basic templates for data collection as attached in Appendix B has been used to collect data and information as a guidance to the respective agencies.

7.3.3 Study Finding 2: Identification of focus and boundary setting

The types of transportation are classified as land (road and rail), air, and water. It is further categorised down into types of vehicles such as two-three wheelers, private and commercial car, buses, vans, taxis, goods vehicles, electric vehicles and others vehicles (road), LRT/MRT/Monorail, passenger trains and freight trains (rail), airplanes and helicopters for domestic flights and water within the boundary of Malaysia maritime only. The population of vehicles identified is based between year 2005 to 2014 using information obtained from the state and territory transport authorities and agencies. The population information identified is referred to as the baseline framework.

The scope and boundary of the baseline study comprises of all types of vehicles including Land, Water and Air that were registered with a Department of Road Transport under MOT for vehicle road use, SPAD, DCA, and other related transport agencies. All kinds of moving transportation modes (private, public, mass, commercial, freight) will be considered except caravans, tractors, plant and equipment, airport ground handler, vehicles belonging to the defence (military & police) services, infrastructure transport and vehicles with diplomatic or consular plates. Inactive vehicles, vintage/classic, scrapped or salvaged vehicles are also excluded from this study. Unregistered vehicles were not considered in the scope of this study as well.

Foreign cars that fuelled in Malaysia was considered in this study as they consume fuel designated for this country. The fuel consumption by foreign cars figure could be approximately offset by the same amount of fuel consumed by Malaysian vehicles that fuelled in those countries. Foreign transport i.e. ships, and airplanes (non-Malaysian registered vehicles) that refuelled in Malaysia were not be considered in this baseline study. Marine bunkers were also not included in the study since they were also categorised in a different category i.e. international consumption.

There were numerous boats (small tourist boats) used for transiting passengers from the mainland to islands for vacationing, snorkelling, sightseeing etc. It has been understood that these boats obtained their fuels from the normal petrol stations. These boats which might or might not fall within the purview of the port authorities, were not included in this baseline study since there were no specific data available and the amount of fuel consumption was small. This study would generate total transportation sector in Malaysia and individual classification of types of vehicle in the form of fuel of consumption, ktoe and CO_2 emission, ktonne.

7.3.4 Study Finding 3: Results framework and activities for the comprehensive DSM Study

Terms of Reference

These terms of reference shall form the basis of this request for proposal (RFP), which stipulates the objectives, scope of study, deliverables and development requirements. The output will be used to formulate the DSM Master Plan and policy to elevate the level of energy-use efficiency in Malaysia. The proposed master plan study is therefore a highly important masterplan that requires comprehensive and professional efforts from the successful Bidder.

Task 1: (a) Review existing studies and programmes/projects that have been implemented since 2005 which were identified with rational use of energy in land transport sector and to conduct the following data mining tasks among others, for statistical analyses:

i) Review relevant studies that have been conducted in the period specified;

ii) Collate measured vehicle stock data by vehicle modes and technology in the rational use of land transport energy use within Malaysia boundary;

iii) To classify goods transportation into light duty vehicles (LDV), medium duty vehicles (MDV) and heavy duty vehicles (HDV) or any classification according to those used by MOT/JPJ and SPAD (ex: gross vehicle weight or axles);

iv) Collate survey and the measured sampling data indicators shall include transport activity data, energy intensity data, transport load factors and mode shares for land transportation in Malaysia;
   - Vehicle stock by vehicle modes and technology;
   - Annual vehicle kilometres travelled modes and technology;
   - Specific fuel consumption litre/100km or km/litre
   - Passenger-km and tonne-km; and
   - Engine capacity of the vehicle modes and technology.

   Note: used extensively in calculating fuel consumption, energy consumption and CO_2 emission.

v) Perform calculation of fuel consumption (curb weight and fuel consumption litre/100km), energy consumption and CO_2 emission in various types of land transport;

vi) Perform survey/data collection on commercial vehicles (buses, trains and LRT/MRT/Monorail) based on passenger-km;

vii) Perform walk through survey that gives better information and data collection on foreign vehicles that fuelled in Malaysia. To conduct study on fuel consumption for foreign cars that fuels in Malaysia (boundary of Malaysia) since they consumed the fuel designated for the country;

viii) Perform survey and measured data on the average annual distance travelled in rural and urban area by lightweight vehicles by state in Malaysia;

ix) Perform survey/data collection on data:
   a) based on average annual distance travelled and tonne-km by medium and heavy goods vehicles. Numerous factors may contribute to the observed variations in

distance travelled among regions for medium and heavy goods vehicles travelled in rural and urban area;

b) for EEVs that includes hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs).

c) for freight forwarders based on the movement of containers that includes import and export shipments and inter-port movements;

x) Consider and assess relevant data and information on land transportation sector from relevant transportation agencies or associations;

xi) Perform study based on the effectiveness of CO_2 reduction of using EURO 4M RON 97, B7 and B10 biodiesel; and

xii) Assess the impact of the studies/programmes/projects that have previously been implemented.

Task 1: (b) Review existing institutional setup, regulatory framework, legislation and financial mechanisms and resource allocation in Malaysia to achieve rational use of energy

i) Identify and review the existing institutions/agencies in DSM transport energy use activities.

ii) Assess the various policies, laws and mechanisms administered and provided by those institutional bodies. They will also be required to identify the success, weaknesses and limitations about the rational use of energy consumption, CO_2 measures, in all types of land transport in Malaysia after considering the results of Task 1(a).

iii) Consider the need for a dedicated legislation that empowers a centralised entity to oversee the implementation and monitoring the progress of DSM initiatives and to collect relevant data as a central repository through a sustainable funding mechanism for land transportation sector.

Task 2 (a): Identify shortfalls and barriers in land transport energy use that currently hinder the adoption of DSM initiatives in Malaysia and to propose mitigating measures and their impacts.

Following the review activities in Task 1, then to analyse and draw conclusions with regards to barriers hindering the adoption of land transport energy use initiatives in all the sectors.

This review should identify the obstacles among others, fiscal, legal, institutional, organisational, centralised repository body, awareness, multiple agencies, human capital or technical that have obstructed the adoption of DSM land transport energy use.

Initiatives and derive mitigating measures to overcome them to realise the desired DSM benefits.

Task 2 (b): Identify examples of successful DSM land transport energy use efforts in selected countries.

Identify and assess/evaluate key success factors and mechanisms that have been employed for the successful implementation of DSM transport energy use measures in countries such as Japan, Thailand, Singapore, Korea, Germany and China and draw relationships between barriers and success factors.

Task 3: Develop comprehensive strategies and measures

a) To establish a consolidated approach for data collection so that more accurate and comprehensive data can be analysed, plan, monitor and measure.
b) To provide a sample size of all types of road transport vehicles that is useful to understand variations, correlations, and other aspects of sample.
c) To consider factors that may affect the reliability of estimates such as survey methodology, sampling error or non-sampling error.
d) To obtain data by direct observation and survey questionnaires regarding vehicle distance travelled in rural and urban areas, states in Malaysia, travel activities, energy use, etc.
e) To obtain data collection and survey questionnaires on commercial vehicles (taxis, buses, trains and LRT/MRT/Monorail) based on passenger-km;
f) To obtain data collection and survey questionnaires on freight vehicles (trains and goods vehicles) based on tonne-km;

g) To ensure that the completeness and accuracy of the data.
h) To analyse land transport energy use data and provide recommendations on actionable plans to achieve the desired outcome identified from the study.
i) To ensure the adjustments in the estimation process are done and to account for the actual cumulative active vehicles registered after the survey population was identified.
j) To provide methodology for data measurements, monitoring, verification and analysis.
k) To forecast (medium and long-term) energy consumption and CO_2 emission for Malaysia land transportation sector. Estimates from information reported in each collection period is produced and will be aggregated into annual estimates relating to the use of vehicles. This is to meet the compliance in line with Malaysia INDC in Paris agreement by year 2030.

Task 4: Conduct Cost-Benefits Analysis.

a) Conduct cost-benefits analysis of the recommended strategies and measures;
b) Identify and quantify the impact of land transport energy use saving strategies and measures to the national energy intensity; and
c) Conduct macro-economic modelling.

Task 5: Develop a comprehensive DSM land transport energy use policy for Malaysia to realise DSM transport energy use benefits in the country.

Based on the outcomes of Tasks 1, 2, 3 and 4 the Consultants shall develop:

i) A comprehensive DSM transport energy use policy incorporating, among others;
    a) Policy statement;
    b) Objectives;
    c) Scope of Policy;
    d) SMART (Specific, Measurable, Achievable, Realistic, Time tagged) targets for short, medium and long-terms; and
    e) Identify major thrusts for DSM transport energy implementation (e.g. awareness raising, modal share, CO_2 emission reduction, human capital development, R&D and technology development, etc.).

ii) An Action Plan and projection in reference to the major thrusts and barriers identified consisting of among others:
   a) List of initiatives, programmes and projects;
   b) Timeline for achieving targets;
   c) Resources & Policy instruments (mandatory and voluntary) (financial, human capital, institutional and legislative framework); and
   d) Cost effectiveness (Benefit/Cost Ratios) of the initiatives.

iii) Monitoring progress, centralised data repository and achievement of targets
   a) Identify criteria; and
   b) Develop mechanisms for monitoring, evaluation and verification.

The summary of the study findings is as shown in the table below.

Study Finding	Descriptions	Details

1	Baseline data and indicators	• Trends, types and distribution of main fuels for energy used in transportation sector in Malaysia (2005 to 2014);
		• Identify transportation types and the source agency and data provider;
		• Definition of the transport modes and technologies in various sectors, such as, land (road and rail), air and water; and
		▪ Categorised down into types of vehicles such as two-three wheelers, private and commercial car, buses, vans, taxis, goods vehicles, electric vehicles and others vehicles (road), LRT/MRT, passenger trains and freight trains (rail), airplanes and helicopters, and
		▪ Indicators include transport activity data, energy intensity data, transport load factors, and transport mode shares such as:
		  • Vehicle stock by vehicle modes and technology;
		  • Annual vehicle kilometres travelled modes and technology;
		  • Specific fuel consumption litre/100km;

Study Finding	Descriptions	Details
		• Passenger-km and ton-km; and • Engine capacity of the vehicle modes and technology
2	Identification of focus and boundary setting	▪ Identify types of transportation are classified as land (road and rail), air, and water registered in Malaysia; ▪ Vehicles limits to domestic transportation including air and water within the boundary of Malaysia maritime only; ▪ All kinds of moving transportation modes will be considered except caravans, tractors, plant and equipment, airport ground handler, vehicles belonging to the defence (military & police) services, infrastructure transport and vehicles with diplomatic or consular plates. ▪ Inactive vehicles, unregistered vehicles vintage/classic, scrapped or salvaged vehicles are also excluded from this study; ▪ Foreign cars that fuelled in Malaysia are considered; ▪ Foreign transport i.e. ships, and airplanes (non-Malaysian registered vehicles) that refuelled in Malaysia were not be considered; ▪ Marine bunkers are not included; and ▪ Numerous boats (small tourist boats) used for transiting passengers from the mainland to islands for vacationing, snorkelling, sightseeing etc. (no specific data available and the small amount of fuel consumption usage)
3	Results framework and activities for the comprehensive and detailed DSM Study	▪ Basis of request for proposal (RFP), which stipulates the objectives, scope of study, deliverables and development requirements agreed by the stakeholders to formulate the DSM Master Plan and policy.

List of key stakeholders

The roles of key stakeholders are for consultation sessions and to receive feedback through direct interviews, meetings and workshops that are to be held throughout the study period. These groups will provide inputs and recommendations related to technical and other matters of the study. Members of the key stakeholders may include related government agencies, industry associations, Non-Government Organisations, industry experts and subject matter experts as and when required. The stakeholders have been identified as follows:

No.	Ministry/Agency/Organisation
1	Department of Statistics Malaysia
2	Energy Commission
3	Land Public Transport Commission (SPAD)
4	Road Branch, Public Works Department (JKR)
5	Department of Road Transport (JPJ)
6	Department of Civil Aviation (DCA)
7	Marine Department Malaysia
8	Pusat Pemeriksaan Kenderaan Berkomputer (PUSPAKOM)
9	Department of Fisheries Malaysia (DoF)
10	Petroliam Nasional Bhd
11	Keretapi Tanah Melayu Bhd (KTMB)
12	Centre for Environment, Technology and Development Malaysia
13	Malaysian Green Technology Corporation
14	Malaysia Palm Oil Board (MPOB)
15	The Institution of Engineers Malaysia (IEM)
16	Prasarana Malaysia Bhd
17	Academy of Science Malaysia
18	Federation of Malaysian Freight Forwarders (FMFF)
19	Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp)
20	Chemical Industries Council of Malaysia
21	Malaysian Aviation Commission (MAVCOM)
22	Malaysia Ship Owners' Association (MASA)

23	Maritime Institute of Malaysia (MIMA)
24	Malaysia Offshore Support Vessel Owners' Association (OSV Malaysia)
25	Chartered Institute of Logistics and Transport Malaysia (CILTM)
26	Malaysia Automotive Institute (MAI)
27	Malaysia Institute of Transport (MITRANS)
28	Malaysia Highway Authority(LLM)
29	Centre for Transportation Research (CTR)
30	PLUS, Malaysia Bhd
31	Automobile Association of Malaysia (AAM)
32	Malaysia Airports Holdings Bhd (MAHB)
33	Persatuan Pengusaha Dan Pemandu Lori Malaysia (PPPLM)
34	Malaysian Institute of Road Safety Research (MIROS)
35	Lembaga Perlesenan Kenderaan Perdagangan Sabah dan Sarawak
36	Sarawak Rivers Board (LSS)
37	Shell Malaysia
38	PETRON Malaysia
39	Chevron Malaysia Limited
40	BH Petrol

8.0 CHALLENGES AND RECOMMENDATIONS

8.1 Challenges and Issues

8.1.1 Electrical Energy

Malaysia has undertaken various EE initiatives to promote the adoption of EE measures and strategies with international assistance programmes since the early 1990s. However, the approaches taken were not holistic and outcomes of those initiatives on the nation's energy supply and demand have not been monitored, quantified and reported. Those initiatives have been on project-based approaches and there has been a lack of synergy among the various parties involved in the projects, as well as no integrated plan for the continuation of the activities after the project periods ended.

The consultation with stakeholders under this study have deliberated and identified five (5) critical key barriers that have prevented wide-spread adoption of EE practices as follows:

- Lack of comprehensive EE&C Law;
- Lack of supports from financial system for EE initiatives implementation;
- Fragmented overall national plan for EE initiatives;
- The absence of a dedicated EE&C entity; and
- Limited availability of thermal energy consumption data.

The following are some of the principal findings and recommendation for each type of energy use from consultations with stakeholders and data collected and analysed:

i) Lack of comprehensive EE&C Law

The lack of legal oversight and powers under the current acts and regulations has hampered the EE initiatives in promoting DSM activities. The DSM programmes could be accelerated if a comprehensive EE&C Law has been gazetted and duly enforced. Since there is no legal framework to place the responsibility for EE within the government, there is also no avenue to provide the necessary powers to government agencies to implement mandatory EE initiatives.

A comprehensive EE&C Law does not need any exceptional investment to formulate and enact. Several countries have already enacted their own legislation over the years, including the three (3) model countries that have been engaged in this exercise, i.e. Denmark, Japan and Thailand. A model from any of these countries can be used as a template that can be customized to suit the specific and special need for Malaysia. It is understood that the Japanese legal template was used for Malaysia to prepare preliminary draft of the legislative instrument may still be available with the government agency then in charge of the project, KeTTHA. If that is so, then the original draft could possibly be expedited to accelerate the legislative process.

Stakeholders strongly believe that the EE&C Law is one (1) of the fundamental requirements for any successful DSM programme at national level.

ii) Lack of supports from financial system for EE initiatives implementation

A dedicated financing scheme for EE from financial institutions has been difficult to obtain, as the banks have not been equipped with sufficient capacity to deal with EE project evaluation and project financing schemes. Loans for EE projects are normally given based on collaterals from the applying companies only and not based on the project feasibility. Similarly, there are no loan schemes for EE for individual consumers and the financial institutions will normally recommend traditional loan schemes such as e.g. term loans, credit card loans (which carry much higher interest rate burdens), if an individual wish to purchase energy-efficient appliances.

In the absence of any relevant legislative framework, there is no sustainable funding mechanism for, grants and rebates or financing for EE initiatives. Funding in the form of grants and rebates for energy efficient technologies will encourage consumers to choose to purchase high efficient technologies to be for their needs. The government has provided some fiscal incentives for the adoption of EE initiatives but there has been very limited financial support from financial institutions for investments in large scale EE projects.

As energy, efficient technologies carry higher capital cost than inefficient technologies, this increases the investment burden for any party who is interested to do so. Coupled with relatively low electricity and energy prices, most of the energy users choose the less efficient technologies to avoid spending more.

At the same time, there have been few financial institutions which are willing to provide loans for EE projects with conditions that suit the business models and nature of the industry players such as Energy Service Companies (ESCOs). The financial institutions currently are not in favour of financing EE businesses unless the loans are backed by adequate collateral. There is no dedicated mechanism for finance for EE from commercial lending institutions and it also has been difficult to obtain because banks have not built sufficient capacity and know-how to deal with EE project evaluation and project financing schemes.

The lack of understanding and awareness about investment potentials among decision makers in public and private sectors have been the major hurdles in the adoption of EE initiatives.

iii) Fragmented overall national plan for EE initiatives

EE has been a part of every Malaysian Plan since 8MP, but there has not been any underlying road map or strategic action plan for the whole spectrum implementation of EE programmes. The activities are, therefore, driven by individual short-term projects, without a clear coordination among the activities and a clear medium term and long-term objectives among agencies within the government, private organisations, non-government organisations an etc.

iv) The absence of a dedicated EE&C entity

EE initiatives have been implemented by various agencies and institutions on their own individual efforts. However, there has not been a dedicated entity with clear authority to oversee ensuring that EE plays a pivotal role in Malaysia's energy planning. The energy planning is still very much based on generating capacity planting up to match the demand and thus other agenda issues like EE and DSM have not been given due attention.

It is very important to have a dedicated agency to drive EE efforts in Malaysia, with legal provisions to enforce the laws and regulations relating to EE, engage all stakeholders and oversee all issues and activities related to EE in medium and long-term. The commendable experience of SEDA in promoting the development of RE technologies in Malaysia since 2011 provides a good example of what can be achieved if a suitable institutional framework is established to execute the strategies that government policy decisions require.

v) Lack of EE funding sources and financing mechanisms

High-impact EE initiatives require some investments from private and public sectors. The lack of a continuous and guaranteed annual EE budget for EE activities has somehow been the limiting factor for the intended growth.

For the private sector, the availability of funding options with business-friendly financing mechanisms will enable them to invest in large scale EE projects within their facilities that will contribute to their business profitability and sustainability in current and future markets.

The lack of funding options that can be offered especially by local banks has hindered the implementation of EE projects by the facilities owners themselves or by the service providers such as ESCOs through the Energy Performance Contracting (EPC) business model which could be further explored.

This has also contributed to the very slow progress of the EPC projects for government buildings that has been promoted by the government under the ETP from 2011.

vi) Low energy prices

The Malaysian electricity supply industry needs to ensure electricity prices are affordable to industrial, commercial and residential consumers and as such, the electricity and fuel prices have been kept below the actual cost of energy generation with the existing fuel subsidies. These subsidies were in the best interests of the national economic development, especially to enable local manufacturers to compete on the world stage.

These low energy prices have discouraged efforts on promoting EE as energy users do not find the cost savings from adopting EE attractive compared with developing their core business. Many types of prospective EE investments are not seen as viable as the returns in terms of energy cost savings are not attractive enough for the users, although in themselves, they are good business options.

8.1.2 Thermal Energy

This study has identified some key challenges for thermal energy as listed and described below.

i) Limited Availability of Thermal Energy Consumption Data

Thermal energy consumption data for industrial sub-sectors were only made available from 2010 to 2014 as they were based on the ST's manufacturing survey conducted in 2013. The set of data obtained from ST comprised of fuel oil, natural gas, LPG, kerosene, petrol, diesel, and coal & coke only. Biogas and biomass data were not available in the set of data from ST.

It was learned that such data may not continue to be monitored and reported as such collection of industrial sub-sector data is not a regular programme. To formulate and implement effective DSM policy strategies and measures, it is imperative to institute a continuous and effective MRV programme. Without data, it is difficult to formulate and optimise EE policies and monitor progress and failures.

It was also learned that GMB could readily provide natural gas consumption data under the 15-identified industrial sub-sectors. This was because they could identify and categorise their clientele's manufacturing operations. For the thermal energy consumption data for other fuel sources, it was fortunate that ST has conducted an energy consumption survey for the manufacturing sector in 2013, and hence, it was possible to collect the required data for the identified industrial sub-sectors. Although the manufacturing survey conducted by ST only covers Peninsular Malaysia, the set of thermal energy consumption data provided by ST includes Sabah and Sarawak.

In other words, except for natural gas, thermal energy consumption data for each industrial sub-sector is not normally available. If there were no continuous programmes to monitor the thermal energy consumption in the industrial sub-sectors, effective formulation and implementation of DSM will become a challenge. Having reliable end-use energy statistics will be crucial in monitoring and evaluating the energy saving targets and action plans and in conducting a robust analysis of energy saving potential.

ii) Energy Efficiency Indicators

EE indicators for industrial sub-sectors provide an overall indication of EE in manufacturing processes. They are usually composed of energy consumption as numerator and an activity data as denominator. There are exceptions, such as the fuel economy of cars, which can be expressed in volume (litres, gallons) and not converted into energy units. Energy consumption can be expressed in various units (kWh, joule, tonnes of oil equivalent, etc.), while activity data cover a wide range of activities, viz. tonnes for production of cement, steel, etc. Such activity data should be determined and declared by the respective industrial sub-sectors.

The data collected in this preliminary study are insufficient to be analysed to provide EE indicators for the various industrial sub-sector. Firstly, this was because activity data are not mandatory to disclose by manufacturing industry and are not prioritised to collect such data by the relevant authority such as ST. Secondly, such data are often guarded as internal manufacturers' information and industries are reluctant to disclose such data and information to external parties on voluntary basis.

Unlike the industrial sector, the commercial sector has established building energy intensity (BEI) as an EE indicator. BEI has been found to be a useful tool to gauge the efficiency in energy usage of commercial buildings. It will be a challenge to establish EE indicator for the industrial sectors. It is recommended that the detailed DSM study will investigate this further and make suitable recommendations for DSM policy formulation and implementation.

8.1.3 Transport Energy Use

- Transport data – lack of data from each transport sector related to activity data, intensity data and fuel data (especially for commercial vehicles such as distance travelled, number of vessels travelled, fuel consumption litre/100 km and cubic capacity of the vehicle).
- Lack of historical data.
- Estimation of vehicle kilometres travelled – the estimation of vehicle kilometres travelled is not as straightforward as the traffic flow. Vehicle kilometres travelled is not measured directly, rather it is always estimated.
- Topography data – not all division of data based on states are available (i.e. bus, car, taxi, goods and other vehicles are not available).
- Data tracking inconsistency – difficulties in understanding differences of data sets reported by each agency (ex. year 2014, total number of taxi: according to MOT is 105,688 compared to SPAD 85,742).
- Data completeness – not all transport sectors were covered to satisfaction due to technical and data gaps. Some of the lorries were not registered and used for some purposes such as for construction and plantations areas.
- Sole agency in charge of country's transportation sector on DSM – data for transport scattered and every data collected for each agency were for different purposes and did not relate to energy use.
- For water transport, the challenges include accuracy of data, sources of data, data on trading boats and passenger's ferries. There are about 4,000 units of boats operating mainly in Sabah and Sarawak that their whereabouts and actions are not accounted for. Another challenge is that the data is scattered all over Malaysia under different agencies.
- For air transport, the total jet fuel consumed in aviation industry is available and compiled by the ST. However, it only provides the total jet fuel consumed without breakdown by sectors or regions.
- Factors which may influence these variations includes gender, age, geography, age of vehicle and style of driving. Since there is no exact information on distance travelled in

rural areas, which use a higher proportion of old vehicle. stakeholders have agreed that information will be standardised on assumptions;

- Irregular data – record on the energy data with irregularities data must be verified.

8.2 Recommendations

8.2.1 Electrical Energy

The study recommends a holistic approach needed for the implementation of DSM programmes for electrical energy. The recommended approach consists of five (5) strategic thrusts, policy measures, EE initiatives and supporting measures needed at the national level.

(a) Strategic Thrusts

The five (5) strategic thrusts with action plans to support cost effective implementation of EE in all sectors with socio-economic benefit savings for the nation was mooted from the working group discussion. The building blocks for sustainable EE for fundamental EE foundation are as follows.

Strategic Thrust 1: Energy Security and Sustainable Energy

To maintain energy security and sustainability effect:

- To incorporate DSM as part and parcel of energy security and sustainable energy development framework;
- To gradually rationalise energy pricing towards global market prices where DSM can be one (1) of the key mitigation factors; and
- To promote research and development (R&D) in EE&C techniques, technologies, equipment and appliances.

Strategic Thrust 2: Social Development

- To instill EE awareness through effective communication efforts for specified target groups and regularly disseminate information on EE&C to the public via mass media;
- The proposed education and awareness programmes would cultivate the culture in the social development process to realise the need to use energy efficiently for

national economic development. Such social development will have far reaching results as a socially-aware citizenry will also be encouraged to apply such socially responsible behaviour in all other aspects of their living habits;

- These initiatives can also enhance the skills upgrading of industry workers to delve into gaining higher skills relevant to the energy management and energy audit employments. It is envisaged that the DSM initiatives can lead to the need for up to 1,000 energy auditors by the end of the DSM programme; and
- Increasing awareness and adoption of EE in day-to-day living can also generate efforts from local entrepreneurs to develop and manufacture more energy efficient appliances or IT applications to capitalise on the consumer desires for easy to use or apply technologies to be more energy efficient and to save energy costs.

Strategic Thrust 3: Low Carbon Economy

To achieve a low-carbon economy and move the economy up the value chain:

- The promotion of efficient use of energy will contribute to reduced GHG emissions at the national level;
- To achieve a low-carbon and high-income economy through heightened competitiveness with increased private funding, Foreign Direct Investments (FDI) and Domestic Direct Investment (DDI);
- To pump-prime the implementation of the proposed energy saving initiatives in lowering energy consumption and intensity in all sectors through effective financial incentives; and
- To establish sub-sectoral benchmarks as basis to lower unit cost of doing business through continual EE&C implementation.

Strategic Thrust 4: Human Capital Development

To build human capacity in various roles playing such as:

- To intensify technical capacity building for implementation of EE&C measures as enacted in the EE&C Law through training, examination and certification mechanism for energy managers, certified energy auditors and ESCOs;
- To build a pool of trainers, lecturers, economists, planners, financial and legal practitioners conversant with EE&C to support the implementation of EE&C policy; and

- To introduce a curriculum on EE&C at all levels of the education system including at professional and sub professional levels, to inculcate the sustainable practice of EE&C.

Strategic Thrust 5: Global Climate Commitment

To leverage DSM initiatives to ensure Malaysia complies with global climate change commitments for a sustainable environment:

- To promote EE initiatives leading to optimisation of final energy consumption and progressively improve energy intensity in tandem with sustainable development;
- To meet national and global commitment in reducing CO_2 emission to combat global climate change;
- To conserve depleting primary energy resources and reduce final energy demand without affecting national economic growth and competitiveness while at the same time boosting energy security; and
- To encourage development of clean and green technology appliances for more efficient usage

(b) Implementation Strategies

To support the above-mentioned strategic thrusts, the following strategies are proposed as policy instruments to provide the conducive eco system for sustainable EE initiatives implementation as described as follows:

i) Introduction and enforcement of EE&C Law

The priority under the DSM initiatives is to establish a comprehensive legal EE framework to govern, administer and implement DSM programmes.

Currently there is no overall law on rational and productive use of energy in place in Malaysia. Also, there are only limited references to EE in laws governing the energy sector, the main act being the Electricity Supply Act 1990. As EE is mainly focusing on the end-users and not the suppliers of energy and covers all energy forms and uses, it is difficult to ensure a coordinated legislative framework by revising existing laws related to energy.

The absence of a comprehensive legislation on EE&C Law is a barrier for successful implementation of DSM EE measures in the nation. It is noted that most of the developed nations and even some emerging economies have specific legislation of their own on EE being their ingredient to successful reduction of energy intensity, albeit with varying success rates.

The Government to ensure intensive electricity energy installations use energy efficiently had enforced a Regulation Efficient Management of Electrical Energy Regulations 2008. This Regulation mandates any installations using more than 3 million kWh in six (6) months will need to engage an Energy Manager who will have the duty of ensuring the premise is using energy efficiently. This regulation only targets intensive energy users thus others are not regulated.

Therefore, a comprehensive and dedicated EE&C Law must be enacted in Malaysia. This Act will ensure a proper framework for the powers that governs EE and outlines the responsibilities for managing EE initiatives and achieving the targets. The EE&C Law shall be designed to define the overall framework for EE and comprise subsidiary legislation in terms of regulations, standards and guidelines for specific areas, such as energy performance standards for equipment, industrial and buildings facilities and requirement for energy management in all facilities.

A dedicated EE&C Law must be enacted and enforced effectively which will ensure a proper framework for the powers that govern and outline the responsibilities for managing EE programmes and achieves the targets in those initiatives. The legal and regulatory framework will encompass processes and obligations for energy users in the residential, industrial and commercial sectors as well as for equipment and appliances. The primary aim is to ensure rational use of energy and contribute to energy security through EE&C Law.

The EE&C Law shall be designed to define the overall framework for EE and comprise of subsidiary legislation in terms of regulations, guidelines and directives for specific areas, such as high energy performance standards for efficient appliances, industrial energy utilisation, low energy usage building sector and practice requirements for EnMS in all facilities.

The main aim of enacting the EE&C Law is to increase efficiency in using energy sources by using energy effectively, avoiding wastage, easing energy costs on the economy and protecting the global environment. The stakeholders collectively acknowledged that a comprehensive EE&C Law is a major lever to the success of any DSM aspirations for the nation.

Several countries have already enacted their own legislation over the years, including the three (3) model countries that were engaged in this exercise, i.e. Denmark, Japan and Thailand. A model from any of these countries can be used as a template that can be customised to suit the specific and special need for Malaysia.

In this respect, the RE Act 2011 can also be a suitable template as it incorporates the multiple provisions for a sustainable funding mechanism as well the relationship to an implementing agency (SEDA, which was established under a separate SEDA Act 2011 in conjunction with the RE Act 2011).

The EE &C Law shall promote rational and efficient use of energy among consumers and shall ensure:

- Awareness of EE options is widely disseminated among all the consumers.
- EE initiatives are identified, evaluated and prioritised for implementation.
- Concerted implementation of the initiatives is promoted and coordinated among all stakeholders.

The principal features of the proposed legislation include *inter alia*, the following:

- There should be a single law dealing with all aspects of EE&C.
- This law could and should be amplified and/or augmented by the necessary subsidiary or delegated legislation in the form of Regulations to make it flexible and complete. The latter could also cater for new or changing EE standards, benchmarks and other requirements.
- The law should be a Federal Laws covering the whole of Malaysia, Sabah and Sarawak inclusive to ensure uniform adoption and enforcement throughout the country.
- To ensure proper coordination and effectiveness all EE legislation should be under the control and supervision of the same governmental ministry and/or authority.
- The governmental ministry and/or authority entrusted with the implementation of EE&C shall be tasked to review all the EE&C laws and regulations on a continuous basis.
- The government ministry or agency as identified should be adequately empowered for the enforcement of the targets set, inclusive of the powers of prosecution. Realistic EE&C targets should be set in the proposed regulations and commensurate sanctions or penalties for non-compliances or breaches should be prescribed.

- The legislation should also suitably address other incidental issues such as training, certification, registration, promotion of EE&C, funding mechanism for EE&C, etc. which impact directly on the ultimate objectives of the government's policy or policies pertaining to EE&C.

Among the mandatory requirements for the proposed legislation are listed below:

- Designated industrial and building users;
- A central data and information repository;
- Guidelines for building EE (Energy Conservation Building Code):
- A standardised BEI computation;
- Standards for energy efficient appliances;
- Administrative mechanism for EE be empowered to a single ministry;
- Sourcing and distribution mechanism for funding to implement EE&C measures;
- Manifestation of EE budget to realise the full potential of the various EE programmes;
- Amendment of the "Efficient Management of Electrical Energy Regulations 2008" as the short-term measure and with the enactment of the new EE&C Law as a long-term measure;
- Setting up of a one-stop centre which can implement the nation's policy or policies on EE and conservation in line with the proposed legislative enactments;
- The enactment of the relevant EE, conservation and labelling laws;
- Provision of a broad definition to the term "energy" and not merely confining it to electrical energy only;
- Implementation of a "carrot and stick" policy; and
- Need for legislation to be on a federal basis but with a level of state involvement.

The proposed legislation is a comprehensive law on EE and conservation. Like other EE laws around the world, the proposed law will function as a tool to support the development and implementation of EE in Malaysia. It should have four (4) main constituent parts as follows:

- Measures for industrial facilities;
- Measures for building;
- Measures for equipment; and
- Measures for domestic users.

Each part will define the obligation of the related parties to ensure EE issues are taken seriously. On top of that, the law also addresses the financial support system, Government responsibilities, rewards and breach settlement.

For the EE&C law, key principal contents that need to be defined are as follows:

- Definition of the key terms

  The key terms such as primary energy, secondary energy, EE, energy conservation, primary energy, secondary energy, etc. must be clearly defined.

- Empowering authorities

  KeTTHA shall be empowered to delegate its agency to:
  - ➢ assume every responsibility for enforcing the provisions of the law including directing prosecution for any defaults;
  - ➢ establish and announce fundamental policies aimed at the comprehensive promotion of the efficient use of energy in the designated fields;
  - ➢ promulgate the relevant rules and regulations in the form of subsidiary or delegated legislation;
  - ➢ oversee the one-stop centre;
  - ➢ be responsible in all aspects for the implementation of the provisions of the legislation.

- Key measures and provisions for energy users

  The legislation must include the following principal provisions governing the rational usage of energy for the main energy users:
  - ➢ Measures for industrial facilities
    - EE codes of practice for factory operators
    - Guidance and advice
    - Designated facilities
    - Certified energy manager system
    - Certified energy auditor system
  - ➢ Measures for buildings
    - Obligation of building owners
    - Guidance and advice
    - Designated Buildings
  - ➢ Measures for equipment
    - Obligation of manufacturers/importers
    - Energy Efficiency Labelling

- Measures for consumers
  - Provision of information

- Prosecution of Offences

  The law must incorporate appropriate provisions for the prosecution of offences committed under the Act such as the giving of false information/reports, failure to achieve target values, etc. For administrative convenience, the KeTTHA and/or the EE&C Entity should be empowered to initiate and conduct such prosecutions on their own. Only where the sanctions are of a custodial nature should the power be transferred to the office of the Attorney General.

- Sanctions for breaches/non-compliances

  The legislation must accommodate at least 3 levels of sanctions depending on the nature of the breach classified as trivial nature and/or offences of a moderate to severe. Sanctions should be premised on the so-called "sliding scale" of severity.

- Appeal Procedure

  Procedures should be in tandem with the rules of natural justice with adequate provisions for the appellant to be properly heard.

- Funding

  There must be provision to cover the setting up and the governance of an EE Fund for the implementation and promotion of EE&C to be used as working capital and as grants or subsidy and/or revolving fund in carrying out the EE&C work.

- Financial Support and incentive schemes

  The legislation should either directly or in relation to other pieces of legislation e.g. the Income Tax Act 1967 (Rev. 1971), etc. provide for tax, subsidies and financial incentives to accelerate the introduction of energy efficient technologies and equipment in all the relevant sectors e.g. industrial, commercial, residential, etc. It is also to promote measures to raise the awareness of the public and consumers at large.

- Scope of responsibility

  The scope of responsibility in enforcement of the provision of the Act should be applied comprehensively in all States of Malaysia. Federal Government should ensure that there is uniformity in legislation and scope of responsibility between the different states if a need arises.

- Application of other laws

  Notwithstanding the primordial objective of making the EE&C Act as the main source of legislation pertaining to EE&C, it is undeniable there are other energy related legislation such as the Electricity Supply Act 1990, Energy Commission Act 2001, etc. which though dealing with some common areas may not be readily amenable to amendment or revision in time.

- Moratorium

  The legislation must contain provisions to enable the centralised entity to be brought into effect in an orderly fashion by allowing the relevant targeted parties enough time to put the EE&C measures in place. Hence, a moratorium period of between 1 to 3 years should be built into the Act to enable this to be done. Special allowances should be given to those designated industrial facilities and buildings which have had implemented EE&C measures over the years.

ii) Implementation of Key Energy Efficiency Initiatives

This study recommends key EE initiatives to achieve the intended energy saving targets throughout the implementation period.

Based on the consultation with stakeholders, it is agreed in principle that the EE initiatives (EEI) to be proposed will consider existing initiatives planned and implemented under NEEAP. Table 8.1 summarises the proposed EE programmes and initiatives under each programme.

Table 8.1 Proposed Key EE initiatives

EEI	Programme	Initiative
1	Promotion of High Efficiency Performance Standards (HEPS) Appliances	Labelling of appliances is an effective tool to inform consumers about the energy consumption of the goods. Existing MEPS labels have already been applied for refrigerators, fans, air conditioners, lamps and TV's. Promotion of 4-star above rated appliances for the existing MEPS based on the labelling is the focus in this initiative.

EEI	Programme	Initiative
2	Expansion of MEPS	The MEPS will set the minimum energy performance for energy consuming equipment to be sold in the market. By introducing MEPS to equipment, it can ensure that low efficient technologies are not dumped in the market. Currently, MEPS has been introduced for refrigerators, fans, air conditioners, televisions and lamps. MEPS will be extended for more household appliances and industrial equipment under the DSM measures
3	Sustainable EE Implementation for Industrial and Commercial Sectors	Energy audits are consultancy services for identification of energy wastage potentials in facilities. It has been demonstrated in earlier studies that savings of 10% to 25% are readily available at low or no cost, by introducing technology best practices, EnMS etc. Energy audits, energy efficient technologies retrofit and energy management will be done in commercial buildings and industries. As a kick start activity, public facilities will be subjected to energy audits and energy management practice as well.
4	Promotion of In- House Cogeneration Facilities	As cogeneration, can have high thermal conversion efficiencies, it will be promoted. This will be done by reducing barriers to an increased uptake of cogeneration process, including by having revised top up and standby rates for cogeneration installations.
5	Energy Efficient Building Codes Regulatory and Compliance	For new buildings, programmes will be undertaken to demonstrate energy efficient design features. This will be in the form of demonstration and showcase projects within various building types e.g. shopping centres, hotels and dwellings, development of guidelines and enhancement of the Uniform Building Bye-Laws.

EEI 1: Promotion of High Efficiency Performance Standards (HEPS) Appliances

A HEPS programme to promote more efficient appliances than 5-Star category appliances under the existing MEPS for refrigerators, air condition system and efficient lighting is proposed for refrigerators, air condition system and efficient lighting, which will be introduced on a voluntary basis in 2020 onwards.

The HEPS programme will be targeting the increase of the share of more energy efficient new refrigerators, air conditioners and lighting to transform the market with more energy efficient appliances. After the EE&C Law is enacted, the HEPS penetration rate into the market will be enhanced through the long-term promotion campaigns.

These HEPS would be like the EU (European Union) classifications such as the ‘A+’ and ‘A++’ classifications which go beyond their ‘A’ classification (equivalent to the Malaysian 5-Star rating). HEPS would thus equate to amending the Star rating system to incorporate ‘6-Star’ and ‘7-Star’ categories, or to introduce additional ‘5-Star+’ and ‘5-Star++’ ratings. The projected saving target is shown in the Table 8.2.

Table 8.2 HEPS energy cost saving analysis

No	HEPS Programme	Projected Target
1	Electricity Savings	6.221TWh
2	Total Expenditure	RM5.791 billion
3	Cost Saving	RM9.579 billion
4	Benefit Cost Ratio (BCR)	1.65

EEI 2: Minimum Energy Performance Standards

Industrial MEPS for Electric Motor - Current MEPS activities

Motors are widely used in industrial processes and machinery, and can either be purchased as stand- alone motors or integrated in equipment. ST has adopted the international European Committee of Manufacturers of Electrical Machines and Power Electronics (CEMEP) standard for energy rating of motors, which classifies motors in three (3) classes according their EE with the most efficient class being EFF1, followed by EFF2 and EFF3 as the lowest class. The CEMEP scheme is to be changed after the adoption of the latest International Electro Technical Commission (IEC) standard for motor performance, which classifies the most energy efficient motors as IE3, whereas IE1 is the low efficient class.

EU is currently in the process of implementing minimum performance standards for motors, which is expected to be minimum class IE2. This minimum standard is planned to be effective in 2018 and in the period till 2030, awareness and promotion campaigns will be carried out to inform the industries about the benefits of EE motors (IE2/IE3) and the slowly phasing out of low efficient types (IE1).

Hence, electric motors importer and equipment importers with integrated motors will be targeted for promotion and awareness campaigns. Table 8.3 shows the preliminary tabulation of MEPS programme for industrial electric motor.

Table 8.3 MEPS energy cost saving analysis

No	Industrial Motors - MEPS Activities	Projected Target
1	Electricity Savings	1.044TWh
2	Total Expenditure	RM0.963 billion
3	Cost Saving	RM2.245 billion
4	Benefit Cost Ratio (BCR)	2.33

Based on the success of the original MEPS, stakeholders also suggested to expand the current MEPS to the following new appliances as part of the DSM as follows:

- Domestic appliances: Rice cooker, electric oven, washing machine, water heaters; and
- Industrial appliances: Industrial fans and cooling towers

EEI 3: Sustainable EE Implementation for Industrial and Commercial Sectors

Often the energy audit exercise will reveal no-cost measures such as energy wastage from equipment that is left on, but not being used or improvements in the processes that leads to energy savings. The outcome of an energy audit is recommendations on EE measures to be implemented and an evaluation of their costs and benefits. Energy audits are typically done by external consultants with expertise in energy auditing methods and the facility. The outcome of energy audits is the recommendations, based on their cost-effectiveness, on EE measures that can be implemented.

Energy audits will be supplemented with energy management practice, in accordance with EnMS based on MS ISO 50001, that is recommended for daily operational activities monitoring and management for the energy consumption in targeted facilities. Such programmes will be initiated to mandate facilities to implement EnMS and certified energy manager will manage the operations and prepare energy management reports for reporting to the owners and EE&C agencies. Furthermore, the EnMS requirements will be improved to ensure that EE measures and practices are being continuously implemented and monitored.

Currently, the EMEER 2008 prescribes that large facilities which consumed 6 Million kWh/annum need to implement energy management programmes. This Regulation should be amended to cover medium sized facilities by lowering the threshold to cover consumers who use 3 Million kWh/annum.

The energy audit programmes to be implemented will target the following types of facilities:

- Government / public facilities;
- Medium and large commercial facilities; and
- Medium and large industrial facilities.

The number of energy audits that can be conducted will depend heavily on the number of competent & trained auditors. It is therefore a necessity to support the training of sufficient energy auditors for this purpose, so that the resource base can be increased and the number of site audits can be intensified. The total requirement for auditors will gradually increase to 1,000 full-time energy auditors in 2030 and the work load will be maintained until the end of the plan.

EnMS based on MS ISO50001 is the system that is recommended for daily operational activities monitoring and management for the energy consumption in targeted facilities. Such programmes will be initiated to mandate facilities to implement EnMS, with certified energy manager to manage the operations and prepare energy management reports for reporting to the owners and EE&C agencies. Furthermore, the EnMS requirements will be improved to ensure that EE measures and practices are being continuously implemented and monitored.

For large government buildings, energy management could be made compulsory by directives in the form of Treasury circulars. This will allow the government sector to show the leadership in EE implementation as well as benefiting from the cost reduction measures. A part of the energy management will be procurement procedures ensuring that the government facilities purchase 5-Star rated equipment.

The campaign for introducing the mandatory energy management will focus on providing guidelines and training to the energy managers to increase awareness of EE options available to their facilities. The energy management in facilities will also indirectly support other programmes in the DSM plan such as the energy management programmes, energy audit and MEPS/HEPS programmes as it is expected that the facilities with energy management will demand energy-efficient technologies.

When the EE&C Law is enacted in the long-term measures, it is anticipated the penetration rate into the market will be increased via sufficient private funding and public fund to roll out this measure.

Table 8.4 shows the preliminary cost saving projection through sustainable EE implementation for industrial and commercial sectors.

Table 8.4 Sustainable EE implementation and energy cost saving analysis

No	Sustainable EE Activities	Projected Target
1	Electricity Savings	18.345TWh
2	Total Expenditure	RM2.029 billion
3	Cost Saving	RM33.613 billion
4	Benefit Cost Ratio (BCR)	17.00

EEI 4: Promotion of In-House Cogeneration Facilities

Generating electricity and thermal energy using cogeneration can achieve thermal conversion efficiencies of over 80% as compared with conversion efficiencies of about over 50% to less than 30% in combined cycle gas turbines and open cycle gas turbines respectively. To promote an uptake of cogeneration, barriers such as the high top up and standby rates need to be overcome in this DSM plan.

The cogeneration system's primary function is to meet the heating or cooling demand in the facility and the power generation will be secondary. The stakeholders opined that the key barriers to the wider use of cogeneration are administrative, as below, and need to be addressed:

- "Non-attractive" standby and top up charges;
- Rigid tariff penalties in the contract;
- Lack of suitable incentives;
- Technical hurdles – lack of capability to locally manufacture some energy supply equipment which leads to higher investments;
- Connection to the grid – implication on the reserve margin for the utilities; and
- Lack of awareness on benefits of cogeneration.

This Study recommends that key strategic measures be taken to overcome the specific barriers identified by implementing the following:

i) Review the charges and penalties related to cogeneration activities (e.g. reducing the quantum of standby charges);
ii) Set standby, top up and load connected charges that are user friendly;
iii) Promote the existing incentives such as low cost financing by EE&CA entity etc.;
iv) Enhance local manufacturers' capacity building; and
v) Increase awareness on the benefits of cogeneration.

Table 8.5 shows the preliminary tabulation of the energy cost saving and more detail will be elaborated in the final report outcome.

Table 8.5 Cogeneration energy cost saving analysis

No	Cogeneration Activities	Projected Target
1	Electricity Savings	0.113TWh
2	Total Expenditure	RM1.452 billion
3	Cost Saving	RM1.200 billion
4	Benefit Cost Ratio (BCR)	0.83

The stakeholder final workshops also agreed that widespread and expeditious adoption of cogeneration and trigeneration for generation of electricity, heat and cooling would be a significant initiative in national efforts to use energy efficiently and to reduce carbon emission for the future.

The biggest hurdle to greater adoption of cogeneration and trigeneration is institutional or administrative, especially the stand-by charges which have been seemingly non-attractive stand-by charges that have been imposed by the utilities.

It is strongly recommended for key stakeholders led by the assigned agencies and ministries such as ST, KeTTHA and MITI together with utility companies and industry associations to find *win-win* solutions to ensure all issues related the implementation of cogeneration to be resolved and Malaysia can tap the full economic potentials of cogeneration especially for the industrial and commercial sectors.

Strategies and approaches used by other countries in promoting cogeneration systems for their markets should be examined to explore the possible adoption with some changes that will suit our local market.

EEI 5: Energy Efficient Building Codes Regulatory and Compliance

The commercial sector consumes about one-third of electricity consumption in the country and a large share of this is used in buildings for cooling, ventilation, lighting, appliances etc. The future increase in energy consumption in the commercial sector will come from new buildings and additional consumption in existing buildings due to increasing load installation. Therefore, a programme is needed to ensure that these new buildings are designed and built with consideration of energy efficient building concept.

Surveys have shown that new buildings are consuming energy around 200-250kWh/m^{2}year, which could be reduced to about 135kWh/m^{2}year by applying the Code of Practice MS1525:2014 on EE and use of RE for non- residential buildings. The BSEEP project has determined specific standards and recommendations to improve the efficient use of electricity in buildings, and these recommendations should be incorporated in any legislation required and strictly enforced.

At present the MS1525:2014 is a voluntary code of practice and it is therefore purely up to the developers to use it. As many buildings are occupied by tenants or other owners rather than by the developers, the building design often does not take EE into consideration as this might increase the building cost and the savings will not benefit the developer.

This Energy Efficient Building Code Programme is planned to enforce the provision of MS1525 through the UBBL with the cooperation from various parties and support with future

EE&C Law to facilitate this exercise. The Table 8.6 shows the preliminary tabulation of the energy cost saving and more detail will be elaborated in the final report outcome.

Table 8.6 Efficient building codes energy cost saving analysis

No	Efficient Building Codes Programme	Projected Target
1	Electricity Savings	1.848TWh
2	Total Expenditure	RM0.890 billion
3	Cost Saving	RM0.283 billion
4	Benefit Cost Ratio (BCR)	3.17

The adoption of the MS1525 requirements under the UBBL requires the proper strategies and approaches since it will involve policies, legal jurisdictions and powers of approval for new building construction and retrofitting projects by many parties such as KPKT and its agencies, state governments and local authorities.

The other important factor that need to be addressed is the capacity building of the personnel at the design, evaluation, approval and monitoring stages at all approving entities and industry players such as design, testing and commissioning consultants and developers or contractors of building related projects. This is due to among the key barrier highlighted in consultations with stakeholders are the lack of allocation of budget for the development of the human capacity at the approving entities such as the local authorities.

iii) A dedicated and centralised EE&C entity

This is another priority under the proposed DSM plan as a dedicated and centralised EE&C entity to be accountable to administer and implement DSM programmes.

The centralised EE&C entity may be established as a one (1) stop centre for DSM activities. It is undoubtedly a well-accepted view by all stakeholders. This entity would act as a focal point or champion responsible for the implementation of the EE plan and oversee the initiatives are undertaken and the expected impact is achieved. This one (1) stop centre for EE&C activities with the main function to effectively coordinate and engage itself with the industrial, commercial and residential sectors. This centralised entity should also provide technical inputs on equipment and appliances issues to fully utilise and recognise existing resources and infrastructure in performing its functions empowered under the EE&C Law. The primary responsibilities of an EE&C entity are:

- To be responsible for application and approval procedures in relation to obtaining EE&C qualifications (e.g. Certified Energy Managers, Certified Energy Auditors, ESCOs);
- To conduct all preliminary planning activities to enable the DSM programmes to be implemented, including formulating and pursuing the enactment of the necessary legislation;
- To carry out EE&C educational and promotional activities for the industrial, commercial, residential sectors and other energy users;
- To disseminate information relating to EE measures, including encouraging energy-efficient lifestyles;
- To create new avenues for international cooperation between nations through further development of EE&C strategies;
- To carry out effective and efficient implementation of the DSM programmes;
- To perform MRV on EE initiatives continuously; and
- To maintain a database with necessary information and data on energy use and EE gathered from the programmes.

The main function of the proposed EE&C entity is to effectively coordinate and engage itself with the industrial, commercial and residential consumers for EE programmes to fully utilise and recognise existing resources and infrastructure in performing its functions as empowered under the EE&C law. EE&C is proposed to have an optimum capacity of 80 employees with budgetary operation and administration cost of RM575 million for period 2016 to 2030 as shown in the Appendix I.

For the first year, the EE&C entity will need a minimum of 30 personnel and the number is expected to increase to 45 persons in the second year and subsequent year to 60 persons in the third year. The full establishment of EE&C entity is anticipated to take four (4) years with an initial total budget requirement of RM100 million with the forecast staff strength of 80 personnel. The proposed organisation setup of EE&C entity with functions as shown in the Figure 8.1 below.

The following functions of the proposed governance structure are expected to be expanded to perform duties of the centralised entity at its branches or regional offices:

- Regulatory and compliance;
- Advisory and technical support; and
- Awareness and promotion.

Other functions are expected to be performed from the central office of the entity. The expansion of the human resource capacity and its presence at the branch or regional level is solely depending on the needs to ensure the smooth implementation of all proposed programmes and initiatives and to perform its regulatory and advisory roles at the targeted group in the industrial, commercial and residential sectors.

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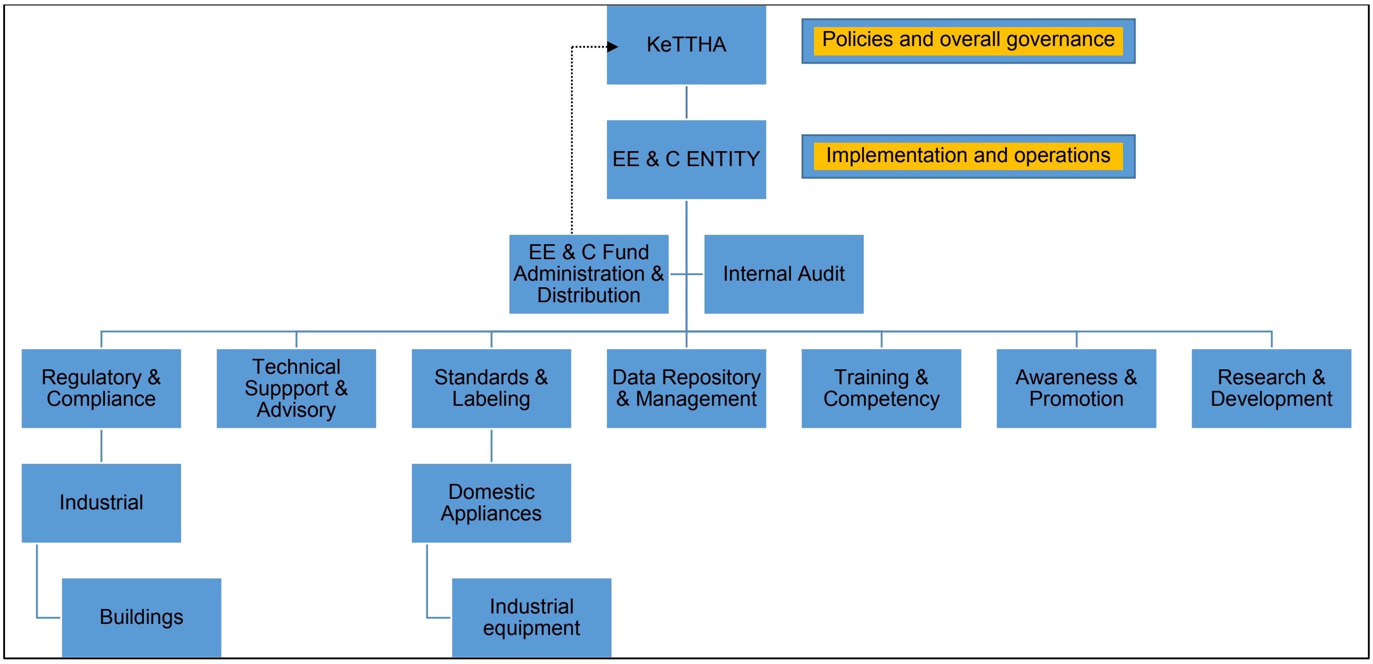
Figure 8.1 The Proposed EE&C Entity Governance Structure



With the existing governance of electrical energy sector in policies, enforcement and EE & C implementation, it is anticipated KeTTHA would play the role as the overall guardian of DSM programmes. The establishment of the centralised EE&C entity is recommended by enhancing and empowering the suitable existing agency under the purview of KeTTHA such as ST, SEDA Malaysia and MGTC. This entity will be the one-stop centre for DSM programmes implementation with the proposed functions as outlined in the organisational structure above.

Another key role, which is expected to be played by KeTTHA, is the overseeing of administration of the EE&C fund allocated from sources that approved by the government according to the agreed methods of collection and distribution mechanisms.

For more effective planning of funding and human resources for the proposed EE&C entity, its establishment should consider the findings and recommendations of the planned full DSM studies for thermal energy and transport energy use sectors under the 11th Malaysia Plan.

It is also anticipated that both sectors might have common requirements for the governance of DSM programmes and initiatives at the national level in each sector where funding and resources could be streamlined and consolidated for specified roles and responsibilities.

(c) Sustainable Energy Efficiency Funding

Successful DSM implementation includes the need for adequate and sustained funding mechanism for the designated implementing agency to operate and to finance the relevant incentive programmes. The success of any EE initiatives depends on the timeliness and adequacy of the financial source in meeting the DSM budget requirement for the following: The necessary funding for the implementation of the DSM initiatives will utilise available EE fund to enable the private sector to invest in EE technologies and campaigns.

The EE fund is budgeted for three (3) main purposes:

- Administration of the plan by the centralised EE&C entity including the implementation of proposed EE programmes and initiatives, capacity buildings of human resources, MRV and on-going awareness raising and communication activities;

- Financial support and incentives as catalyst to implement EE technologies and energy projects for all sectors such as energy audits and loans for investment by facility owners and industry players to implement EE projects; and

- Financial system with funding sources and business friendly mechanisms to encourage investments by the private sector for EE projects implementation.

Energy Efficiency Public Funding Sources

Funding is always a very difficult issue when solving the financial requirement of any policy and DSM plan implementation. It is anticipated, for the period of 2016 to 2030-year plan, Implementation of the DSM programme would require a total investment of RM10.325 billion out of which, RM1.050 billion would be from public funding while the remaining RM9.275 billion will be from the private sector.

In other countries, such as Thailand the Fund for Promotion of Energy Conservation (ENCON) in 1992 was introduced. This Fund is collected as a small levy on sale of petroleum products, such as petrol, diesel, fuel oil and kerosene with total collection of more than USD200 Million/year. The proceeds are used to support EE and RE initiatives for sectors of energy use in Thailand.

The stakeholders of this study have agreed in principle that the possible options to be considered by the government that have been adopted by other countries in obtaining the sources of funding for EE implementation which could also be considered for the establishment of the EE&C Fund in Malaysia. Table 8.7 below summarises the proposed options that consist of the combination of multiple funding sources from the government and private sectors for EE programmes implementation.

Table 8.7 Possible options of EE public fund sources and mechanisms

No	Method	Option 1	Option 2
1	Source	Budget from federal government sourced from agreed funding option(s).	Total budget from federal government
2	Mechanism	Combination of: ▪ Annual allocation by the federal government to the centralised EE entity ▪ Approved amount by the funding parties to the centralised EE entity	Annual allocation to the centralised entity by the federal government.
3	Distribution & administration of fund	Through provisions in the EE&C Law and its subsidiary legislations by the designated entity	

Below are the proposed funding options that should be considered by the government: -

i) Levy from the sale amount of fossil fuels

The option proposed for the contribution from the government is through the sale amount of the fossil fuels which are petrol and diesel. This contribution will indicate the commitment of the government through "leadership by example" to all energy using sectors on the importance of achieving the DSM targets which also require stronger monetary commitment and investments from the private sector.

From the options, available, the study proposed the fund based on the sale of petroleum and diesel as a more viable option as the source of contribution from the government. The study has learned from the Thailand's experience that collecting a levy from the sale of petroleum and diesel is much more palatable to the end consumers compared to other means. However, due to the final selling prices for petrol and diesel in Malaysia, reallocation of certain amount of petrol sales would not involve additional payment from energy users to the government such as levy that is being imposed in Thailand.

From the Table 8.8 data obtained from the KPDNKK the total sales of petrol and diesel in 2014 are as follows:

Table 8.8 Petrol and diesel sales quantity, 2014

Fuel type	Amount sold (litre)
Petrol	16,238,359,054
Diesel	8,807,010,143
Total	**25,045,369,198**

Source: *Kementerian Perdagangan Dalam Negeri, Koperasi dan Kepenggunaan,* 2014

From the option, it is proposed an initial a minimal allocation of RM0.01/litre from the volume of fuel petroleum and diesel as agreed from the working group stakeholders. This will enable sufficient fund to be allocated to support EE initiatives in the DSM plan for the 15-year period. From the quantity of annual sales of petrol and diesel at the pumps, it is estimated that the total allocation to the EE&C public fund will be at RM162 million and RM88 million respectively.

The EE&C Fund is essential because it will be a catalyst to promote higher private investment in EE. Measures in EE often require a higher capital expenditure than traditional investments. Thus, the EE&C Fund will be able to facilitate more initiatives and implementation of the strategic plan and be used to offset the incremental cost that need to be undertaken. The total fund which can be collected from the allocation from the petrol and diesel for a 15-year period is approximately about RM3.76 billion as shown in the Table 8.9. The total fund required to be allocated by the government under DSM plan for 15 years is at RM3.76 billion including the operating costs for the EE&C central entity to implement the planned EE programmes.

Table 8.9 Proposed sources EE&C fund from the petrol and diesel levy

Amount collected from the levy of petrol and diesel sales for EE&C fund	RM0.01 / litre	
	Petrol	Diesel
Fund collected in a year (RM)	162,383,590	88,070,101
Fund collected in 15 years (RM)	2,435,753,858	1,321,051,521
Total Fund collected in 15 years (RM)	3,756,805,379	
Total Fund needed in 15 years (RM)	1,625,000,000	
Balance (RM)	2,131,805,379	

The stakeholders have agreed to consider various possible alternative funding options such as those adopted by other countries such as Thailand to obtain the funding for the implementation of the DSM programme.

This could be adequate for all the three (3) forms of energy covered by the DSM programme, i.e. electricity, thermal and transport. At a levy of RM0.01 (1 sen) per litre, the levy would amount to about RM250 million a year. This amount would be sufficient for the estimated funding required not only for the electricity, but also for the thermal and transport sectors.

ii) A levy on electricity sales by utility companies

This would be similar to the current levy of 1.6% imposed on the affected electricity consumers for FiT implementation for RE. Based on a levy, with the only 0.25% additional levy on top of the existing 1.6% amount collected, the levy collected would amount to about RM100 million a year (excluding Sarawak) for DSM programmes implementation.

iii) Reallocation of a portion of the GST charges on electricity sales

GST is fund for the national Treasury, so any reallocation of a portion of the sum collected to fund the national DSM programmes implementation would be equivalent to the provision of federal funds for the programmes. The main difference in using this mechanism would be the assurance of sustained funding as the GST is not expected to be repealed. A 5% share of the GST collected on electricity sales is estimated to amount to RM120 million per year.

iv) The introduction of "Green Tax" concept

This concept will force consumers to pay for the pollution their energy consumption causes, i.e. a "polluter pays" principle. Green tax or carbon tax on users is a complex mechanism if certain groups of consumers are to be exempted, as is the case for the RE Levy as applied in Malaysia. A more realistic mechanism would be to impose this burden on the electricity generators so that they would be compelled to minimise emission from their power plants. While this is a fair option, it goes against the current national provision of fuel subsidies to moderate the energy costs to the consumers. A green tax can be a viable option to consider after the subsidy mechanism has been eliminated.

v) The allocation of fund from Malaysian Electricity Supply Industry Trust Account

The Malaysian Electricity Supply Industry Trust Account (MESITA) which administered by KeTTHA receives contributions from electricity generators, whether the utilities or IPPs.

The MESITA fund is dedicated to be used for programmes in the following areas: -

- Rural Electrification Programme;
- R&D Programmes and New Renewable sources of energy projects;
- Human resource development programmes in the industry;
- EE projects;
- Development and promotion of the electricity supply industry; and
- Advanced Programmes Approved by Trustees of Electricity Trust Fund.

It is understood that the fund receives annual contribution in the order of RM80 million a year, of which a substantial portion is reserved for the RE and R&D programmes. Hence, the potential finance available from the MESITA fund is limited.

vi) Annual Budget from the Federal Government

This would depend on sustained allocation from the Treasury in the annual budget proposal.

The study has learned from the Thailand's experience that collecting a levy from the sale of petroleum and diesel is much more palatable to the end consumers compared to other means. However, due to the final selling prices for petrol and diesel in Malaysia, reallocation of certain amount of petrol sales would not involve additional payment from energy users to the government such as levy that is being imposed in Thailand.

The stakeholders generally oppose the imposition of any further levy on electricity tariffs. The larger consumers represented by FMM, feel that their current burden from the RE levy and the GST is already too severe.

The above potential options for the funding source is recommended for the government to consider with further deliberation with the key stakeholders from all segments such as the government, industry players and consumer groups. The most important things are, the recommended strategic implementation plan with programmes and projected energy saving targets for each energy efficiency initiative for outlined implementation period in this study, require sufficient and sustainable funding to be implemented.

The Table below summarises some key characteristics of the proposed options to be considered by the government for EE&C fund.

No	Category	Annual Government Budget	Levy on liquid fuels	Levy on electricity tariff	Reallocation of a part (5%) of GST on electricity sales	Green tax	Reallocation from MESITA fund
1	Assurance of sustenance	No	Yes	Yes	Yes	Yes	No
2	Adequacy of revenue	Possible	Yes	Yes	Yes	Subject to rate imposed	No
3	Escalation of amount with time	Possible	Yes	Yes	Yes	Possible	Unlikely
5	Possibility of blocking approval	Yes	No	No	No	Yes	Yes
6	Overall assessment	Unlikely	Positive	Positive	Positive	Uncertain	Very Unlikely

Deliberations at the final Technical Committee (TC) and National Steering Committee (NSC) meetings concluded that EE&C administration options are not realistically viable for the proposed options below:

- Levy on electricity sales by utility companies;
- The allocation of fund from Malaysian Electricity Supply Industry Trust Account (MESITA);
- Reallocation of a portion of the GST charges on electricity sales; and
- Annual government budget

Options Energy Efficiency Private Funding Sources

The investment from the private sectors is expected from the internal funds of companies or from the loans from a special fund such a revolving fund created by the government and other funding organisations such as commercial banks. Studies and energy conservations projects that have been implemented have shown that potentials of energy savings are enormous in industrial and commercial buildings sectors with very attractive payback period.

With the clear targets, strategic actions and the support measures which will provided by the government in the implementation of EE initiatives, it is expected the private sectors with energy intensive operations will be playing their roles in implementing EE initiatives to improve their business profits and to remain competitive from producing products or delivering services at lower costs by using less energy.

Below are the proposed options for private funding: -

i) Energy Efficiency Funding Scheme

The Energy Efficiency Funding Scheme (EEFS) is proposed to be created to boost the implementation of EE&C projects implementation by the private sectors. The main aim of the fund would be to provide low interest loans for EE&C projects implementation to industrial and commercial users with a guarantee from government and disburse through a designated entity. The outcome of this would ultimately yield support for many EE&C projects implementation, to increase investment and generate significant energy savings. In addition, this incentive would be able to facilitate the role of financing institutions in supporting government's efforts in EE&C initiatives.

The proposed fund is with an allocated amount (i.e. RM500 million) with the following conditions: -

- With maximum loan amount and repayment period according to the type of category or business type of the applicants;

- Interest at 2-3% per annum; and
- Eligible targeted groups for private companies to implement EE projects for their own new and existing building or facilities and private companies registered with the EE centralised agency which provide EE services and to implement EE measures at private and government buildings or facilities such as ESCOs registered with ST.

This scheme also allows for more co-financing to come from banks and in turn, banking officers would need to be trained on fundamentals to evaluate EE&C projects.

In the same time the government through the EE&C centralised agency will provide the supporting measures to banks in evaluating EE&C projects. The procedure will be developed where the EE centralised agency will be the competent agency to perform the technical evaluation for the technical viability of EE&C projects to be considered for the scheme and the next step is for banks to assess the financial viability of the projects based on agreed criteria and conditions.

The other option for the private funding source is from the creation of a scheme of funding with similar approach like the existing fund under the Green Technology Financing Scheme (GTFS) to the EEFS. As such, the Government does not require to allocate additional funds from its budget. The proposed fund scheme to have an allocation with the starting value at RM500 millions for funding of EE projects from the total amount required based on the current RM5 billion allocated under the GTFS 2.0 as announced by the government after the meeting of the Green Technology and Climate Change Council on 2 March 2017. The application to fund EE projects under the proposed EEFS will be evaluated with specified criteria for EE project assessment by the competent agency authorised by the government.

ii) Energy Performance Contracting Model

Another recommended alternative for the implementation of EE measures for large energy users among building and industrial facilities is the adoption of Energy Performance Contracting (EPC) model through the private funding mechanism.

EPC concept for energy conservation measures implementation is through direct investments by the private sector or by ESCOs with "Zero Upfront Costs" concept to the owner of building or industrial facilities in private and government sectors. The returns from the investments will be used to pay back the ESCOs only from the actual energy savings achieved from the implementation of energy conservation measures by ESCOs based on shared- saving contract with conditions agreed by both parties.

EPC projects are performed by ESCOs which develop and implement turnkey, comprehensive EE projects. ESCOs offer performance-based contracts (i.e., contracts that tie the compensation of the ESCO to the energy savings generated by the project) as a significant part of their business.

The adoption of EPC has been widely practiced in the private sectors and in many countries, such as United States, Thailand, Taiwan and Japan which offers the following benefits:

- Ability to implement energy saving measures with “ZERO” investment from the facilities owners through performance based concept and to invest savings achieved into other projects;
- To ensure sustainable mechanism and funding sources to implement energy saving measures for more efficient management of energy;
- One (1) single contract to tackle multiple energy-saving projects through implementation of each energy saving measure identified from detailed energy audits;
- Risks transferred to competent third parties on profit sharing basis with proven technologies and expertise; and
- Effective measures to implement energy saving measures to promote energy conservation in government and private facilities by market mechanisms-private investments

For organisations that have limitations in allocating budget for big scale energy saving projects that will bring significant savings in energy cost, EPC is an attractive option available in the market to stimulate faster implementation of big scales EE projects.

For the government sector, the adoption of EPC concept will ease the financial burdens of the government spending to implement sustainable energy saving measures in its buildings and the money would be able to be spent for other important purposes such as education, healthcare and infrastructure development needs for the people.

For the private sector, the EPC will enable competent third parties to identify and implement energy saving measures while they can focus on their core businesses. In both sectors, the EPC mechanism will allow them to transfer the financial commitment and risks to invest in EE projects to the third party and in the same time to be assured the savings which will benefit the in a long run.

ESCOs must also demonstrate the ability to provide the full range of services required for a comprehensive EE project covering the followings:

- Project financing for implementation;
- Detailed or investment grade energy audit;
- Consultancy in EE projects;
- Design of energy efficient systems and solutions;
- Implementation and project management;
- Construction management;
- Testing and commissioning;
- Operation and maintenance; and
- Energy performance measurement and verification and energy performance reporting.

To have a workable EPC implementation, the procurement process must suit the EPC business model and process flow and to have that the government officers and decision makers responsible to manage EPC must understand what EPC is and how it can work. The facilities owners cannot treat EPC like a typical conventional procurement of products or services.

Secondly, feasible EPC projects are only about installing new energy efficient equipment or installing energy saving devices and thirdly, the sharing from the achieved savings between the ESCO and the facilities owner must be from the actual and measured performance rather than from the calculated quantity when the proposal was made and agreed.

The government has started to promote the implementation of EPC model under the ETP from 2011. However, the progress of the implementation for the government owned building facilities has been delayed due to some issues related to the government's procurement procedures that needed some changes. It expected to be finalised and introduced once key stakeholders such as MoF, KeTTHA, ST and other ministries involved have agreed on the implementation procedures and guidelines.

Another key factor of the successful implementation of EPC model in Malaysia is the availability of suitable financing schemes by the financial institutions for ESCOs to be able to secure loans for investments in EPC projects. This also requires awareness and capacity development programmes for financial institutions to play their roles to stimulate EE implementation with bigger involvements by the private sectors.

The proposed EE&C entity is expected to play the critical roles to promote the adoption of the EPC model through the following actions:

- The development the implementation guidelines covering items such as the process flow in the procurement and standardised contract documents be followed and used by ministries and agencies within the government for potential building facilities such as offices, hospitals, universities and external public lighting systems;

- To initiate and plan awareness and capacity building programmes for local financial system in understanding the EPC investment models and market potentials to expand their financing schemes; and

- To building the human capacity with the required competencies within the industry players for energy auditing, EPC projects implementation and energy performance measurement and verification mechanisms through suitable certification programmes in collaboration with professional bodies and industry associations.

(d) Capacity Building Development Programmes

To overcome common EE barriers, human capacity development is crucial and shall not be overlooked. The capacity building of individuals and organisation in EE will be part of the implementation of the EE DSM programmes such as, energy auditing activities and energy management practice.

It is important that the educational institutions can produce qualified individual with relevant knowledge and qualifications in EE such as energy engineers and energy economists. Educational institutions will be encouraged to enhance the resources for EE training of students to meet the expected demand for such qualified personnel in the future.

(e) Competency Development Programmes

Professional institutions will be encouraged to upgrade and develop EE module by introducing courses and workshops for engineers, architects, energy economists, accountants etc. Some of the training can be outsourced to other professional bodies and approved training centres of Ministry of Human Resource, Institute of Engineers Malaysia (IEM), Small and Medium Industries Development Corporation (SMIDEC), Malaysia Association of Energy Service Companies (MAESCO) and another related EE training house.

This activity will increase EE training for professional and semi-professional. Enhancing the resources and capacity development to deliver and support EE, will form an integral part of its skill development needs. Lack of capacity building is one (1) of the few root causes for the limited advancement of EE to date.

(f) Research and Development in Energy Efficiency Technologies and Applications

Existing research institutions such as universities and private entities e.g. SIRIM Bhd, manufacturers etc., will be encouraged to enhance research in the field of EE. Potential area of interest may include the development of energy-efficient technologies as well as studying the impact of various EE practices and behaviours. As the EE initiatives are targeting market transformation towards energy- efficient technologies, it is critical that local manufacturers capable to upgrade and develop their products in meeting the stringent requirement of EE and play a major role in the market.

This will not only enable them to market their products in Malaysia, but also enhance their competitiveness to export their technologies, as EE is an important parameter for buyers in the developing and developed world. This is also in line with the government's policy on developing a knowledge based economy with the development of more intelligent, advanced and green technologies.

In this context, the government is also considering the implementation of smart grid. It is also planning to have enhanced time of use tariffs. Such tariffs, together with the implementation of smart grids and the use of smart meters, will enable consumers to better understand their own energy needs and help them identify energy saving potentials and implement them in a more effective manner. It will also assist utility companies to identify, evaluate and implement energy saving potentials in their transmission and distribution systems.

(g) On-Going Awareness and Communications Programmes

It is also a vital tool to promote and create awareness to change social behaviours towards environment protection as well as conserving resources and eliminating wastage across the nation. This can be communicated to the public via mass or alternative media. A comprehensive, persuasive, awareness campaign is needed to spur both public and decision makers' interests into EE activities. Effective communication must therefore be implemented through various forms:

- Develop a series of advertising and promotion campaigns, workshops, talk shows by EE practitioner
- Utilise web-based information and training materials
- Marketing and promotion of existing MEPS or HEPS labelled products
- Best practice success stories of EE implementation in three (3) sectors; residential, commercial and industrial complete with EE improvement details.

Another strategy that could be adopted is by giving recognition and awards for EE efforts. Awards and/or recognition are to be given to agencies and personnel who have achieved outstanding results in implementation of EE initiatives under several categories. The winners will be a show case or model for the public or various sectors and industries to follow. Among the award categories should include:

- Industrial Sector
- Commercial Sector
- Residential Sector
- Public Sectors
- High Efficient Energy Appliances

To facilitate and improve public perception towards EE&C, simple and easy administrative processes for speedy application of EE&C incentives need to be established. This will allow the end-users to see the benefits sooner, thereby encouraging speedy and visible change in human behaviour towards energy savings and reduced wastage.

Preliminary Planning Activities

The development of the EE&C Law requires comprehensive supports from policy makers together with legal and regulatory experts. It is critical that the EE&C Law is drafted within the three (3) years' period starting from 2017 to 2020 for endorsement by the Malaysia government for eventual implementation and enforcement by the central entity. EE&C targeted to be ready to roll out in 2020 in alignment with high income nation.

This DSM study is planned to be implemented over 15 years' period and would be categorised into short, medium and long-term plan. A short-term plan would cover a five (5) years' period from 2016 to 2020, medium term for 2020 to 2025 period and the long-term would cover entire 15 years' period.

Anticipated Benefits from the DSM Programmes

The benefits expected from the Short-Term (2016 – 2020), Medium-Term (2021 – 2025) and Long-Term (2025 – 2030) are summarised in Table 8.10 below, conditional upon the expectations as detailed below.

The Short-Term period coincides with the bulk of the 11MP period (2016 to 2020) and involves mainly voluntary adoption of existing EE measures form the NEEAP.
The Medium-Term period covers the 12MP period (2021 - 2025) and is based the enactment of the EE&C Law as scheduled, i.e. by 2020, to benefit from the cumulative effects of the savings over the period concerned.

The Long-term period covers the 13MP period (2026 - 2030) and is based the assumption that the enactment of the EE&C Law by 2020 will accelerate the adoption of the DSM initiatives with the EE&C Law being strictly enforced by 2025.

Table 8.10 Projected Impacts and Benefits from the DSM Programmes

No	Item	Short-term (2016 - 2020)	Medium-term (2021 - 2025)	Long-term (2026 - 2030)
1	Impacts (Electricity Savings[1]) of Programmes	3,701GWh	9,266GWh	7,362GWh
2	Cumulative Electricity Savings[2]	7,406GWh	45,628GWh	85,736GWh
3	Capacity Savings	754MW	1,889MW	1,501MW
4	Demand Savings	604MW	1,511MW	1,201WW
5	Cumulative CO_2 Avoidance[3]	5,498 ktonne	32,489 ktonne	58,221 ktonne
6	Public Funding	RM260 million	RM285 million	RM505 million

Note:
1. The electricity savings is the total of respective yearly electricity savings excluding the carryover savings from the previous year within the corresponding period.
2. The cumulative electricity savings in the accumulated electricity savings including the carryover savings from the previous year of the corresponding period.
3. The cumulative CO_2 avoidance is the accumulated CO_2 avoidance achieved including the carryover savings from the previous year of the corresponding period.

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Short-Term (2016- 2020): Existing EE Initiatives Voluntary Measures

The short-term preliminary target is coinciding with the beginning term review of the 11MP (2016 to 2020) and existing EE key initiatives measures are voluntary basis taken up by demand side. The short-term DSM existing measures for the five (5) years' period (2016 to 2020) are maintaining the current NEEAP key initiatives activities that are being implemented for the nation before the proposed EE&C Law is enacted and enforced. From the NEEAP energy forecast study, the tabulation of the energy conservation is shown in the Table 8.11

Table 8.11 Short-term EE Measures with absence of EE&C law

No	Item	Projected Target
1	**Electricity Savings**	3,701GWh
2	**Capacity Savings**	754MW
3	**Demand Savings**	604MW
4	**CO_2 Avoidance**	5,537ktonne
5	**Public Funding**	RM260 million

Medium Term (2021 - 2025): EE&C Law Implementation Period

A mid-term target in 2021 to 2025 shall be defined to ensure the implementation of EE&C Law is kept on track. This period is expected to produce the most significant impacts with the full enforcement of the EE&C law and coupled with higher penetration rates of the proposed EE initiatives, especially the sustainable EE implementation for industrial and commercial sectors. These two sectors have also been identified in this study as the largest users of electrical energy.

This translates into power plant capacity savings of about 1,889GW. The total savings over the period from 2021 to 2025 shall be about 9,266GWh. This would translate to 32,725ktonne CO_2, which could be avoided by 2025. To meet the mid-term target, it is crucial that EE initiatives are started as early as possible in the plan period, as the cumulative effects of the savings are necessary to achieve the target. The total public funding required for the medium-term programmes is RM285 million. The summary of the medium-term implementation outcomes and investment is as follows in the Table 8.12.

Table 8.12 Medium term EE measures with EE&C law introduction

No	Item	Projected Target
1	**Electricity Savings**	9,266GWh
2	**Capacity Savings**	1,889MW
3	**Demand Savings**	1,511MW
4	**CO_2 Avoidance**	32,725ktonne
5	**Public Funding**	RM285 million

Long-term (2026 - 2030): Accelerated EE Initiatives with EE&C Law

The planned long-term target is set from 2026 until 2030 with the EE&C Law fully enacted in 2025. The energy forecast study has determined the electricity consumption shall be reduced by at least 10.20% below the business as usual scenario at year 2030. This translates into cumulative power plant capacity savings of about 4,144GW.

The projected accumulated total savings over the period from 2016 to 2030 shall be a minimum of 138,775GWh or equivalent to RM46.92 billion savings on the electricity consumption costs by consumers from all targeted sectors. In the same time, there are more costs will be saved from the reduction of generating power plant capacity requirement that will avoid the development, operation and maintenance of new power plants and costs that need to borne by the government for the subsidies for fuels in power generation.

For the protection of our future environment, the DSM programmes is also projected to result in the total amount of CO_2 avoided for the corresponding period at 96,209ktonne.

The plan should achieve this target because by introducing EE initiatives, it will ensure consumers whether public or private to increase the use of energy efficiently. The total public investment required is RM1,050 million. A summary of the long-term saving target EE&C implementation target is shown in the Table 8.13.

Table 8.13 Long-term EE measures with EE&C law enforcement

No	Item	Projected Target
1	**Electricity Savings**	7,362GWh
2	**Capacity Savings**	1,501MW
3	**Demand Savings**	1,201WW
4	**CO_2 Avoidance**	58,644ktonne
5	**Public Funding**	RM505 million

The efficient management and use of energy is one (1) of the key initiatives identified by the government to reduce carbon dioxide emission contributing to our emission intensity reduction as pledged by the Malaysia Government to the world community. The annual electricity savings, capacity savings, CO_2 avoidance and public funding is listed in the Table 8.14.

The Table 8.14 below details the annual estimated savings from the DSM programme over the entire period up to 2030.

Table 8.14 Annual 15 years' energy target from 2016 to 2030

Year	Electricity Savings (GWh)	Demand Saving (MW)	Capacity Savings (MW)	CO_2 Avoidance (ktonne)	Public Funding (RM million)
2016	87	14	18	67	26
2017	392	50	62	300	42
2018	1,032	104	130	781	63
2019	2,194	189	237	1,644	64
2020	3,701	246	307	2,746	66
2021	5,439	283	354	3,995	56
2022	7,201	287	359	5,237	58
2023	9,061	303	379	6,524	59
2024	10,962	310	388	7,815	55
2025	12,967	327	409	9,153	57
2026	14,232	206	258	9,947	77
2027	15,564	217	272	10,770	78

Year	Electricity Savings (GWh)	Demand Saving (MW)	Capacity Savings (MW)	CO_2 Avoidance (ktonne)	Public Funding (RM million)
2028	16,999	234	293	11,646	106
2029	18,616	264	330	12,628	108
2030	20,329	279	349	13,653	137
Total	138,775	3,315	4,144	96,908	**1,050**

The impacts from the proposed programmes and initiatives from 2016 to 2030 is illustrated graphically in Figure 8.2 and Figure 8.3 below. Both figures indicate the projected impacts on the electricity savings and electricity consumption comparison between the BAU and proposed DSM initiatives influenced savings.

Figure 8.2 indicates the projected annual cumulative electricity savings to be achieved with the implementation of the identified and proposed EE initiatives in this study for the period of 2016 to 2030.

Figure 8.2 Projected Annual Cumulative Electricity Savings from EE Initiatives Implementation from 2016 to 2030

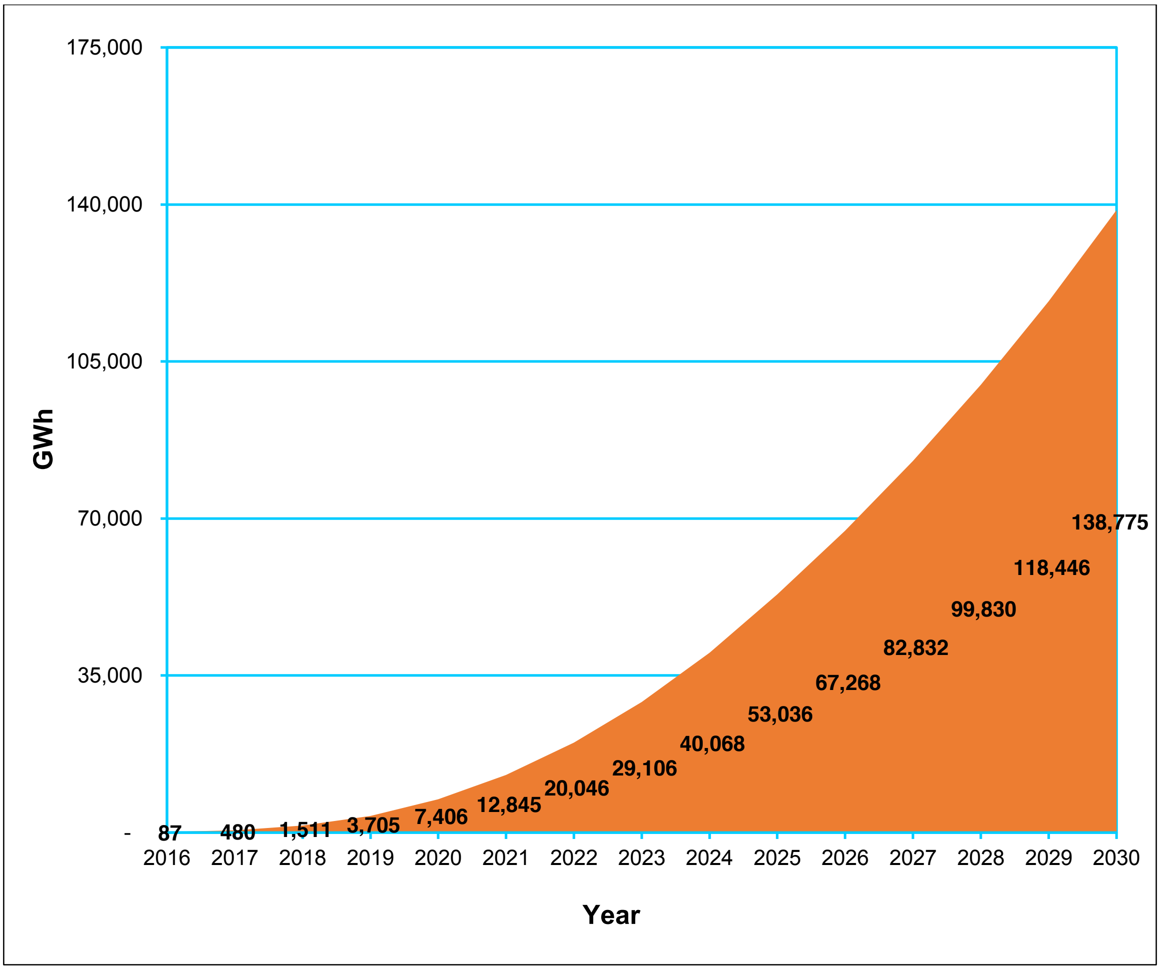
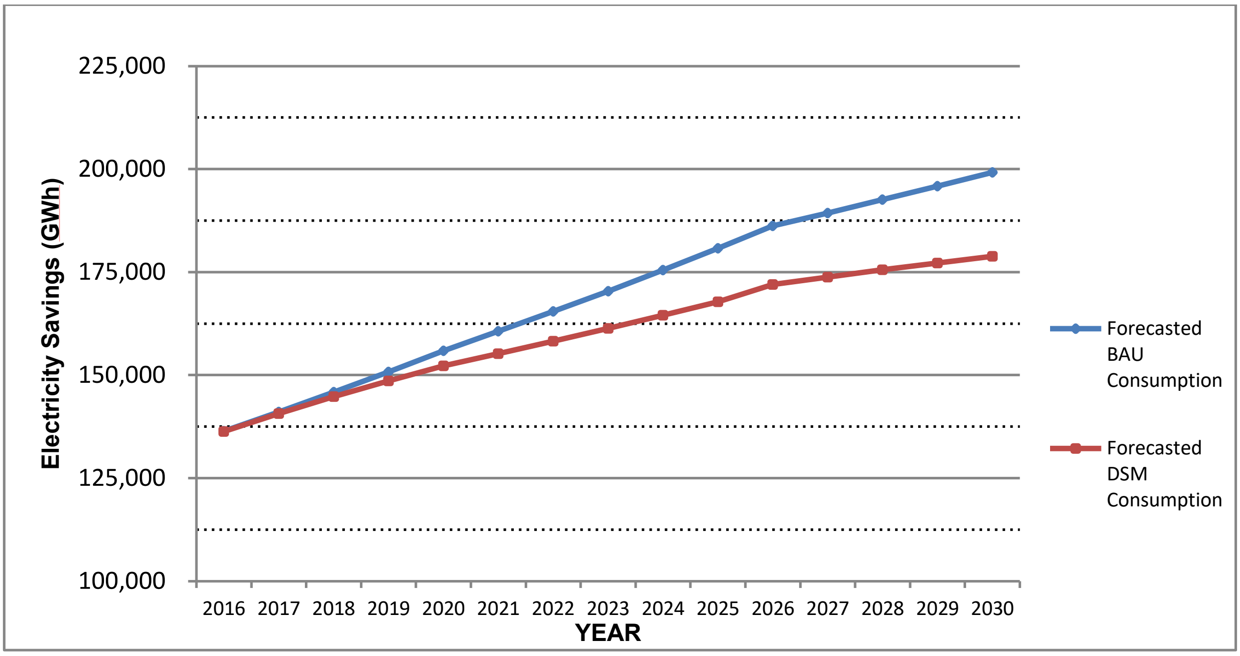


Figure 8.3 indicates the projected annual electricity consumption between the BAU and the with the implementation of initiatives and measures in the DSM programmes as identified and proposed in this study.

Figure 8.3 Projected electricity consumption for BAU vs. DSM programmes implementation for period 2016 to 2030



The required further steps needed for a holistic implementation of the recommended programmes and initiatives for electrical energy from this study is outlined as follows:

i) To examine key enabling factors for DSM implementation in the overall national EE policy together with thermal energy and transport energy use sectors that will be developed and introduced. It is important to assess the needs for, and importance of common and specific key institutional frameworks to implement the national EE policies for the following areas:
   - Legislative enactment or empowered of dedicated EE&C laws with relevant regulations and standards;
   - The need and justifications of sustainable funding mechanism to support the DSM programmes;
   - Justifications and the strategies for the establishment of a dedicated and accountable DSM implementing entity equipped with sustainable funding and human capacity for effective implementation of DSM initiatives;

- Implementation methodologies/procedures and guidelines for the EE strategies and initiatives; and
- Assessment and recommendations for a comprehensive on-going awareness and communications programmes.
- Monitoring of implementation, verification and reporting of progress and results against the intended targets for each DSM initiative within the specified period.

ii) Evaluation and reviews by the accountable key stakeholders the EE initiatives and strategies recommended in this study for the implementation purposes.
   - Endorse the validity and the relevance of the findings;
   - Investigate and consider additional prospectively viable EE options suitable for Malaysia according the current market trends; and
   - Seek and agree viable amendments and/ or alternatives to improvise recommended strategies/initiatives.

iii) To conduct the techno-economic modelling assessment for simulating the proposed DSM initiatives.
   - The energy and macroeconomic modelling by the energy economist and/or energy planner shall cover the economic viability, cost-effectiveness of the proposed public sector investments, and practicability of their implementation according to the proposed timelines; as well as the magnitude of the anticipated benefits in the projected demand reduction forecast and the impacts generating capacity savings.

iv) Assess successful international experience and recommend suitable awareness and communication programmes and R&D DSM fields that Malaysia can profitably pursue.
   - Despite numerous past efforts on the above, the outcomes for these initiatives appear to have been rather limited. Awareness raising and effective communication can be attractive and cost-effective strategies to accelerate the widespread adoption of DSM measures.

   - Similarly, specific and targeted R&D on EE measures for the local environment that are subsequently commercialised can generate substantial business opportunities for Malaysian companies in the regional market.

v) Engagement for stakeholders' feedback
   - To assess the appropriateness and validity of the stakeholder engagement input garnered through the consultations throughout the study process and in the way,

forward. On-going engagements with the relevant and identified stakeholders are crucial to ensure all parties concurrence the intended goals, progress and changes in the way forward in the implementation stages.

8.2.2 Thermal Energy

For the proposed detailed DSM study, the recommendations are summarised as follows:

- Recommended objective:
  The scope of the thermal energy sector in the DSM preliminary study shall cover the fuel energy and RE usage by the industrial and commercial sectors including but not limited to drying, heating and cooling purposes covering both cogeneration and trigeneration, and their respective EE indicators, where applicable.

- Proposed boundary to be confined to the demand of thermal energy from the following sources of energy:
  a) Non-renewable: Fuel oil, natural gas, diesel, kerosene, petrol, coal and coke, LPG, etc.; and
  b) Renewable: Biogas, biomass, solar thermal energy, etc.
  c) Secondary thermal energy generated from other sources such as electricity through cogeneration and trigeneration.

- The focus area identified was the industrial sector, which has been demonstrated that its thermal energy consumption is a significant proportion. However, it is recognised that the combined share of thermal energy consumption of the commercial and residential sectors at 19% of the corresponding Final Energy Consumption is significant and should be included in the detailed DSM study.

- In view of the discrepancies in MSIC and IEA classification of the industrial sub-sectors, the adoption and harmonisation of industrial sub-sector classification is recommended to be reviewed and proposed in the DSM detailed study so that a holistic approach will be recommended.

- Having established three (3) groupings in terms of large, medium and small groups of thermal energy consumption, it is recommended that the detailed DSM study will address the priority and methodology in establishing EE indicators for the industries.
  The methodology shall include but not limited to the following:

- Statutory requirements of data reporting and monitoring under EE&C Law;
- Implementation by a one-stop entity with infrastructure and technical support; and
- Sustainable funding;

- The terms of reference for the proposed DSM detailed study will include the following:
  - Task 1: Review existing institutional setup, regulatory framework, etc.
  - Task 2: Propose counter-measures for the identified shortfalls and barriers (as detailed in Section 7.2.3 under Task 2
  - Task 3: Develop comprehensive strategies and measures (as recommended in Section 7.2.3);
  - Task 4: Conduct cost-benefits analysis;
  - Task 5: Identify and recommend collection and management of thermal energy data; and
  - Task 6: Develop a comprehensive DSM policy for Malaysia to realise the benefits of DSM strategies and measures.

8.2.3 Transport Energy Use

- To have a centralised and empowered entity for energy consumption data collection and compilation mechanism for transportation sector to ensure accuracy, consistency and reliability of inventories need to be established;
- To perform further study on data collection through direct observation, survey or questionnaires to improve the accuracy of estimates kilometres travelled, which is related to fuel economy and CO_2 emission;
- To perform further study on other factors which may influence these variations includes gender, age, geography, age of vehicle and style of driving;
- Any transportation sub-sectors identified as “missing” in this study will be explored for future inclusion for data collection;
- To put additional efforts to enhance the collection of identified missing historical transportation data and its related information;
- To have better cooperation with data providers from various transport entities for energy data collection;
- To align with National Automotive Policy (2014) which promotes Malaysia to become the energy efficient vehicle hub in the region.
- To further increase the EEVs (EVs, HEVs, PHEVs and BEVs) used in Malaysia to exceed the goal of CO_2 emission reduction for transportation sector;

- To increase more charging stations with increase of renewable and sustainable sources of energy;
- To diversify fuel supply and to favour energy sources whose production and consumption both result in lower emission of GHGs;
- To encourage the widespread adoption by fleet operators of more energy-efficient operations and maintenance practices;
- To provide tax incentives for energy efficient vehicles (i.e. biofuels, NGV, EVs, hydrogen fuel cell electric vehicles etc.);
- To establish fuel economy regulations for all types of vehicles;
- To have more R&D efforts to improve transportation EE and reduce GHG emission;
- To establish and introduce a national fuel economy labelling system for vehicles;

9.0 CONCLUSIONS

This preliminary study is the first stage in the preparation of the DSM master plan for Malaysia for better energy resource management and providing high GDP per capita, energy security and sustainable development for the nation.

For electrical energy, this Study is expected to provide more comprehensive information on the implementation of EE programmes in a holistic manner, which should include key initiatives, targets, support measures and estimated budget required. These preliminary inputs, centralised around electrical energy, will form the basis of an eventual detailed DSM study, which will also incorporate both thermal and transport energy uses.

9.1 Electrical Energy

The conclusions that have been derived from this exercise are, among others, that:

- Various EE initiatives have been undertaken to promote the adoption of EE measures and strategies with international assistance programmes since 1998.

- Those initiatives had been conducted on project-based approaches by various parties involved in the projects, without any integrated plan for the continuation of the activities after the project periods ended.

- Other key findings are the absence of institutional framework and existing barriers, especially with respect to the following:

  - Lack of comprehensive EE&C Law;
  - Lack of support from financial institutions for EE initiatives implementation;
  - Fragmented overall national plan for EE initiatives;
  - The absence of a dedicated EE&C implementing entity; and
  - Limited availability of thermal energy consumption data.

These findings warrant the development of key EE programmes and initiatives to overcome the barriers which have hindered success in the adoption of EE measures and practices in the past.

The proposed programmes to promote the adoption of EE measures and initiatives are grouped under each programme listed as follows:

- Introduction and promotion of high efficiency performance standards (HEPS) for electrical appliances used in commercial and residential sector for refrigerators, air conditioners and lightings

- Expanding the mandatory legal requirements of MEPS for more electrical appliances such as:
  - Industrial Appliances; Electric motors, cooling towers and industrial fans;
  - Domestic Appliances; Washing Machines, Rice cookers, Water heaters, Electric Ovens, etc.

- Implementing sustainable EE programmes, identified through energy audits, for industrial and commercial sectors for;
  - Large commercial buildings;
  - Medium commercial buildings;
  - Large and medium industrial facilities; and
  - Government/public facilities

- Promoting in-house cogeneration facilities for industrial and commercial sectors;

- Introduce and enforce compliance with energy efficient building codes; and

- Assigning the implementation of the DSM programmes to a dedicated EE&C entity, with the provision of, and responsibility for:
  - Sustainable EE funding sources and mechanisms;
  - Capacity building development programmes;
  - Competency development and certification programmes;
  - Research and development in EE technologies and applications; and
  - On-going awareness and communications programmes.

For the record, the above elements are like those implemented by other countries like Denmark, Japan and Thailand, who have all successfully adopted EE measures and initiatives for efficient management of their energy needs.

The proposed initiatives in the EE plan for electrical energy, if successfully implemented, are expected to lead to a reduction of 138,775GWh in consumption from 2016 to 2030, which translates to a reduction of 4,144GW in generating capacity requirements. This is equivalent to a reduction of 96.209 million tonnes of CO_2 emission within the same period.

Figure 9.1 Projected electricity consumption for BAU vs. DSM programmes implementation for period 2016 to 2030

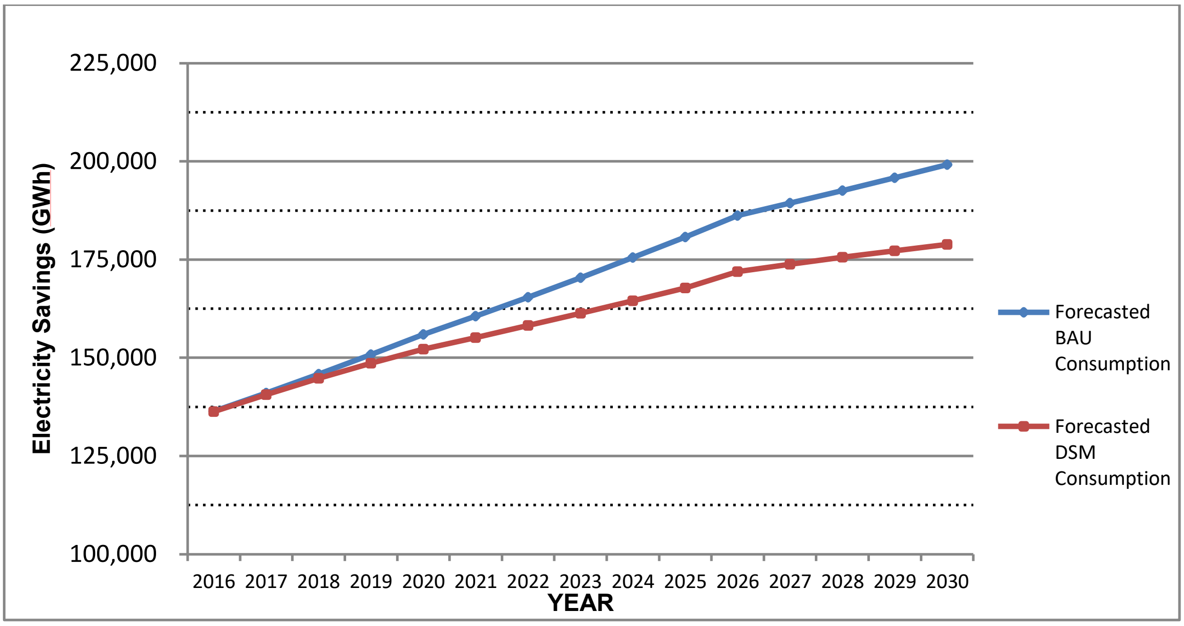


Figure 9.1 illustrates the comparison of the projected BAU scenario against the EE scenario that can potentially resulted from the implementation of proposed initiatives.

One (1) of the other key success factors for the proposed EE initiatives in this study is the availability of sufficient and sustainable funding sources. The total estimated budget required to successfully implement the EE initiatives proposed to achieve the energy consumption reduction targets as stated above will be approximately RM10.325 billion of which RM9.275 billion is expected to be invested by the private sector and the remaining RM1.050 billion would come from the funding sources to be provided by the government.

9.2 Thermal Energy

The project objectives for the preliminary DSM study have been achieved. The baseline studies conducted have identified the shares of thermal energy consumption by the industrial, commercial and residential sectors.

For the industrial sectors, the thermal energy consumption of 11 sub-sectors was reviewed and analysed together with the commercial and residential sectors. It has been shown that thermal energy use is a significant part of the whole spectrum of the consumption in the energy sector where the most significant consumption lies in the industrial sector which takes up the majority share of 86.4% of the combined total thermal energy consumption by the industrial, commercial and residential sectors in the country.

However, the average thermal energy consumption by the industrial sector is some 65.8% of the corresponding average final energy consumption by this sector as reported in the NEB 2014. The average share of thermal energy consumption in the commercial and residential sector is about 19% of the corresponding final energy consumption, and the balance share of energy use should come from electricity.

When combining the three (3) sectors which are industrial, commercial and residential, the share of thermal energy use is much lower at about 49.3%. Therefore, the focus area for the DSM in thermal energy use should be the industrial sector. However, it is recognised that the combined share of thermal energy consumption of the commercial and residential sectors at 19% of the corresponding Final Energy Consumption is significant and should be included in the detailed DSM study.

9.3 Transport Energy Use

In Malaysia, petrol is popular among cars, motorcycles and light duty trucks while for heavy-duty trucks, buses and locomotive trains, they mainly use diesel as its fuel. An airplane is fed with aviation grade kerosene and residual fuel oil is used in ships. Malaysia is still one (1) step behind utilising electric vehicles widely but electricity based vehicle is confined to the usage of electrical train like LRT, MRT and monorail. Bio-fuels like biodiesel are still new in the transportation sector in this country.

Land transportation accounts the main energy consumption in Malaysia. Based on findings of the analysis for year 2014, road transport uses 90.02 % of energy consumed from total transport sector. In 2014, car accounts the largest energy consumption of 67.73%, followed by motorcycle by 8.80%, goods vehicle of 8.79%, bus of 7.44%, taxi of 2.62% and the lowest is the EV of 0.0004%. EV has gained its popularity from their EE for having low energy consumption of 0.1004ktoe which is significantly lower than the energy consumed by a non-electric car. The main reason why road transportation consumes more energy is that they account for the large majority of the people and goods moved in transportation. Train transportation accounts 0.16% of energy consumption that claim to be twice efficient for freight movement and four (4) times more for passengers.

As for water transport, it only dominates around 5.38% from total energy consumed. Water transportation is acknowledged as the most energy efficient in the transportation sector. However, this study only covers water transportation within the boundary of Malaysia

Energy consumed by domestic air transportation is 4.44% which is lower than water transport. It plays an integral part in the globalisation of transportation networks. In this study, the findings from the analysis are based on assumption from MOT for domestic air transport.

The road transportation has been held to account for the highest CO_2 emission with about 89.70% of all transportation related CO_2 emission in 2014 in Malaysia. Car transport emits the highest amount of CO_2 emission from all road transport by 67.15% while 9.18% comes from goods vehicle, 8.67% is attributed to motorcycle, 7.80% for bus, 4.81% comes from other vehicle and 2.40% comes from taxi in 2014. However, EV is the most environmental friendly as it contributed 0.001% of CO_2 emission. To improve in transportation sustainability can be made from a modal shift away from private cars and motorcycles to use of buses and train services. Improvements in the buses fleet and taxis can be made by moving towards EVs.

Air transportation accounts for approximately 4.40% of all transportation related CO_2 emission for domestic flights. Water transportation attributed 5.55% of all transportation related CO_2 emission that limits only for commercial, traditional fishing boat and ferry that operates within Malaysia boundary.

The holistic EE implementation under the DSM will contribute to the reduction of energy consumption for all targeted energy using sectors. The implementation proposed initiatives under the electrical energy sector and potentials initiatives to be proposed from the comprehensive DSM studies for thermal energy and transport energy use at the national will also help Malaysia to contribute to achieve the Sustainable Energy for All (SE4ALL) under the Sustainable Development Goal 7(SDG7).

The goals for the programme under United Nations is empower leaders to broker partnerships and unlock finance to achieve and secure universal access to affordable, reliable, sustainable and modern energy for all by 2030 and reducing the carbon intensity of energy in the same time and DSM could play significant roles in the programme.

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Appendix A: Transport Energy Use-Sample calculation and parameter

A.1 Road Transport: Calculation method for non-electric vehicles

The fuel properties and CO_2 emission factors are determined by comparing the properties provided by Petronas Malaysia as per Malaysian standard (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf) and Units & Conversion Fact Sheet of MIT Energy Club (http://web.mit.edu/mit_energy).

Calculation of fuel consumption

Fuel consumption by car (in L) = Number of vehicles × total distance travelled by a single vehicle/year ÷ fuel economy or mileage in km/L

Number of vehicle has been collected year wise (and in case of car and motorcycle state wise, too) from MOT and JPJ database. The data base is given in section 6.

The distance travelled yearly by a single vehicle is based on survey among the users as no specific data is available from any agency. The average distance travelled by different types of road vehicles is listed as below:

Table A.1: Average distance travelled yearly by different types of vehicles

Vehicle	Average distance travelled/year
Motor cycle	10 000 km
Car	20 000 km
Bus	100 000 km
Taxi	86 000 km
Goods vehicle*	10 000 km
Others	10 000 km

*In goods vehicle category, there are *container prime movers* that operate only in the ports for container handling. According to FMFF - Federation of Malaysian Freight Forwarders, 55% of all import and export volumes in the country is controlled by Port Klang and the rest 45% are handled by Penang Port, PTP in Johor and Kuantan Port. The container prime movers travel only within a limited radius of respective port's hinterland. In case of Port Klang it is estimated that each prime mover travels 2 × 75 = 150 km in up and down trips from the port and for the other ports this distance is taken as 2 × 50 = 100 km. The average number of container handled/year by Port Klang is taken as 3.6 million and that by the each other ports as 3.34 million. The fuel economy or mileage of the prime movers is 2.25 to 2.75 km/L, so as an average this value is taken as 2.5 km/L.

The fuel economy, i.e., mileage in km/L for different types of vehicles has been ascertained by comparing different vehicle manufacturer's specification with the NAP 2014 standard for EEV.

Calculation of energy consumption

The following formulae have been used to calculate the energy consumption by the vehicles using different fuels. The energy conversion unit has been adopted from the Units & Conversion Fact Sheet of MIT Energy Club (http://web.mit.edu/mit_energy).

For Petrol: Energy consumption (in ktoe) = Fuel consumption (in L) × 7.67 × 10^{-7}

For diesel: Energy consumption (in ktoe) = Fuel consumption (in L) × 8.55 × 10^{-7}

For CNG: Energy consumption (in ktoe) = Fuel consumption (in L) × 2.22 × 10^{-7}

In case of the vehicle types that use two (2) types of fuels, the percentage of vehicles using a particular fuel has been estimated using the MOT and JPJ data base. These data are given in section 6.

Calculation of CO_2 emission

Based on Petronas:

The CO_2 emission factors as Malaysian standard on net calorific basis are as follows:

For Petrol (RON95 and RON97), 70 985 kg CO_{2e} / TJ (on net calorific basis)

For Diesel, 75 391 kg CO_{2e} / TJ (on net calorific basis)

For CNG, 56 100 kg CO_{2e} / TJ (on net calorific basis)

Based on the MIT Unit & Conversion Fact Sheet, these values are converted on volume basis as follows:

For Petrol (RON95 and RON97), 2.2786 kg CO_{2e} / L (on volume consumed basis)

For Diesel, 2.6989 kg CO_{2e} / L (on volume consumed basis)

For CNG, 0.5217 kg CO_{2e} / L (on net calorific basis)

Based on IPCC:

For Petrol, 69 300 kg CO_{2e} / TJ (on net calorific basis)

For Diesel, 74 100 kg CO_{2e} / TJ (on net calorific basis)

For CNG, 56 100 kg CO_{2e} / TJ (on net calorific basis)

A.2 Road Transport: Calculation method for electric vehicles

Records for EV have been found from 2011 in MOT data base and only electric car and electric motor cycle are found to be in use in Malaysia. Energy consumption and CO_2 for both types of EV has been calculated as follows:

Energy consumption

Energy consumption by = Number of EV × distance travelled by an EV/year (km) × energy consumption per km (kWh/km)

For electric cars, energy consumption/km has been taken from the United States Environmental Protection Agency (EPA) *and* U.S. Department of Energy *(2015-12-18). The fuel economy of all the brands of electric car has been averaged and the average energy consumption by an electric car is found 20.5 kWh/100 km.*

For electric motor cycles, energy consumptions are found as low as 2 kWh/100 km to a medium of 5 kWh/100 km, to as high as 8 kWh/100 km. In the present case, to be on the conservative side, the highest value (8 KWh/100 km) has been taken for energy consumption calculation.

CO_2 emission

CO_2 emission is considered based on fuel mix electricity generation as 7.626 ktonne CO_2/ktoe where 1 ktoe = 11630000 kWh

A.3 Rail Transport: Calculation method for electric trains

Energy consumption (in ktoe) data for electric train has been collected from Malaysia Energy Statistics Handbook 2015 and National Energy Balance report of 2014.

CO_2 emission is considered based on fuel mix electricity generation as 7.626 ktonne CO_2/ktoe where 1 ktoe = 11630000 kWh

A.4 Rail Transport: Calculation method for non-electric trains

All KTM intercity train are considered as non-electric trains that run on diesel. According to Managing Director of KTMB Datuk Mohd. Salleh Abdullah the total fuel consumption by locomotive train in 2005 was 8.4 million litres. [BizFocus: Keretapi Tanah Melayu on track to recovery by Sharen Kaur, May 23, 2006, Business Times Ref. http://www.skyscrapercity.com/showthread.php?t=97484&page=6]. Total number of non-electric train units comprising of class 22, 23, 24, 25, 26 and 29 has been taken from SPAD and MOT data base and in 2005 the total number of non-electric train units is found as 88. Therefore, the fuel consumption/train for 2005 was estimated as 0.0954 million litres. This value has been used to calculate the fuel consumption for next year on the basis of the number of active trains in that year.

A.5 Air Transport

Energy consumption (in ktoe) data for electric train has been collected from NEB report of 2015. The carbon emission by aviation fuels is considered as 19.5 ton C/TJ (Rypdal) and from MIT Units & Conversions Fact Sheet 1 toe = 41.9 GJ and 3.667 CO_2 emission/ton of C emission.

A.6 Water Transport

The fuel and energy consumption and CO_2 emission by inland water transport (fishing boat and ferry) has been taken into account in this study. The number of fishing boat (total and active) and ferry along with their fuel consumption in litres has been collected year wise from the corresponding authority.

In case of fishing boats, it has been estimated that each boat plies for 6 hours/day, 20 days/month and 10 months/year. Therefore, each boat plies for a total of 1200 hours/year. There are three (3) categories according to GRT (gross river tonnage) and these boats consume 70, 20 and 5 L/hr. In case of ferry, number trips/day, distance travelled/day and fuel consumption is available from the data base (section 6). The calculation method is same for both cases.

Appendix B: Thermal Energy-Template of data collection

Table B1 Annual energy consumption format by sectors

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	------------------------------ (Fuel type)						---------------------- (Calorific value of fuel stated)				Prepared by:			Date:		
											Organisation			Revision:		
Year	Food, beverages & tobacco products (------)	Textiles, wearing apparel & leather products (------)	Wood & wood products and furniture (------)	Paper & paper products (------)	Coke & refined petroleum products (------)	Chemicals & chemical products (------)	Pharmaceutical products (------)	Rubber & plastic products (------)	Non-metallic mineral products (incl. ceramic, concrete, glass) (------)	Basic metals (incl. iron & steel, precious & other non-ferrous metals, casting of	Fabricated metal products (------)	Electrical equipment and electronic, computer & optical products (------)	Machinery & equipment (------)	Motor vehicles, trailers, semi-trailers & other transport equipment (------)	Cement (------)	Commercial / Buildings (------)
2005																
2006																
2007																
2008																
2009																
2010																
2011																
2012																
2013																
2014																
2015																

Note:

1 Please provide annual energy consumption data for the various sub-sectors as listed in the above. Each spreadsheet is dedicated to one fuel type.
The annual energy consumption data for other fuel types shall be provided in a duplicated spreadsheet.

2 Please specify fuel type, energy unit and calorific value of the fuel stated in each spreadsheet.

3 For Commercial / Buildings sector, please state category of buildings, e.g. Shopping Mall, Hotel, Office Complex, Airport, Hospital, University or Township / District Cooling Plant

Table B2 Annual energy consumption format by fuel types

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Fuel Types for the stated organisation / company

Sub-Sector:	________ (To state Sub-Sector)						Prepared by:				Date:	
							Organisation:				Revision:	
Year	Petroleum Products (Specify type, unit & calorific value) Diesel ________ ________ ________	Petroleum Products (Specify type, unit & calorific value) LPG ________ ________ ________	Petroleum Products (Specify type, unit & calorific value) ________ ________ ________	Petroleum Products (Specify type, unit & calorific value) ________ ________ ________	Petroleum Products (Specify type, unit & calorific value) ________ ________ ________	Petroleum Products (Specify type, unit & calorific value) ________ ________ ________	Natural Gas (Specify unit & calorific value) ________ ________	Coal (Specify type, unit & calorific value) ________ ________ ________	Biomass (Specify type of biomass, unit & calorific value) (tonnes) ________ ________ ________	Biogas (Specify type of biogas, unit & calorific value) ________ ________ ________	Others (Specify fuel type, unit & calorific value) ________ ________ ________	Production (Annual production data) or Gross Floor Area (for Commercial / Buildings) ________ (To specify unit)
2005												
2006												
2007												
2008												
2009												
2010												
2011												
2012												
2013												
2014												
2015												

Note:

1 Please provide annual energy consumption data for the various sub-sectors where applicable as listed below. Each spreadsheet is dedicated to one Sub-Sector.
The annual energy consumption data for another Sub-sector shall be provided in a duplicated spreadsheet.

2 Please specify fuel type, energy unit and calorific value of the fuel used, and also annual production data for respective Sub-Sectors.

3 List of Sub-Sectors:
1) Food, beverages & tobacco products
2) Textiles, wearing apparel & leather products
3) Wood & wood products and furniture
4) Paper & paper products
5) Coke & refined petroleum products
6) Chemicals & chemical products
7) Pharmaceutical products
8) Rubber & plastic products
9) Non-metallic mineral products (incl. ceramic, concrete, glass)
10) Basic metals (incl. iron & steel, precious & other non-ferrous metals, casting of metals)
11) Fabricated metal products
12) Electrical equipment and electronic, computer & optical products
13) Machinery & equipment
14) Motor vehicles, trailers, semi-trailers & other transport equipment
15) Cement
16) Commercial / Building

Template of data collection for transport energy use

Table B3 Energy usage according to transportation modes light vehicles (cars & vans)

LAND - ROAD								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Tonne. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B4 Energy usage according to transportation modes medium vehicles (buses & light lorry)

LAND - ROAD								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Tonne. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B5 Energy usage according to transportation modes heavy vehicles (containers & trucks)

LAND - ROAD								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Tonne. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B6 Energy usage according to transportation modes LRT & ERL

LAND - RAIL								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Ton. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B7 Energy usage according to transportation modes KTM (domestic freight & passenger)

LAND - RAIL								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Tonne. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B8 Energy usage according to transportation modes domestic air passenger & freight

AIR								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Ton. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B9 Energy usage according to transportation modes domestic freight & passenger plane

AIR								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Ton. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Table B10 Energy usage according to transportation modes small boat / fisherman boat– cruiser / liner/ferry

WATER								
YEAR	Total Number of Vehicles Registered	Transport Demand		Energy Intensity Data				Costs Data
		Passenger. km	Ton. km	Fuel Type	Specific Carbon Content (kg_C/kg_{fuel})	Fuel Consumption (l/100km)	CO2 Emission (kg_{CO2}/ kg_{fuel})	Fuel Costs for Alternative Fuel Pathways (if applicable)
2005								
2006								
2007								
2008								
2009								
2010								
2011								
2012								
2013								
2014								

Appendix C: Glossary

ATF: Fuel for use in aviation gas turbines mainly refined from kerosene. Distillation range within 150°C and 250°C

Diesel (or Gas Oil): Distillation falls within 200°C to 340°C. Diesel fuels for high-speed diesel engines (i.e. automotive) are more critical of fuel quality than diesel for stationary and marine diesel engines. Marine oil usually consists of a blend of diesel oil and some residual (asphaltic) material.

Kerosene: Is a straight-run fraction from crude oil, with boiling range from150°C to 250°C. Its main uses are for domestic lighting and cooking.

Petrol: Petroleum distillate used as fuel in spark- ignition internal combustion engines. Distillation range is within 30°C and 250°C

Natural Gas: Is a mixture of gaseous hydrocarbons (mainly methane), which occur in either gas fields or in association with crude oil in oil fields

Liquefied natural gas (LNG): Is natural gas (predominantly methane, CH4, with some mixture of ethane C2H6f) that has been converted to liquid form for ease of storage or transport

Crude Oil: Is natural product that is extracted from mineral deposits and consists essentially of many different non-aromatic hydrocarbons (paraffinic, cyclonic, etc.)

Fuel economy or mileage: Of an automobile is the fuel efficiency relationship between the distance travelled and the amount of fuel consumed by the vehicle

Greenhouse gases (GHG): Trap heat from the sun and warm the planet's surface, the majority are related to energy consumption, and most of those are CO_2

EV: Use one (1) or more electric motors or traction motors for propulsion

EEV: as “vehicles that meet a defined specification in terms of carbon emission level (g/km) and fuel consumption (l/100 km)

Hybrid vehicle (HV): Uses two (2) or more distinct types of power, such as internal combustion engine + electric motor, e.g. in diesel-electric trains using diesel engines and electricity from overhead lines

Hybrid electric vehicles (HEV): May be partly fossil fuel (or biofuel) powered and partly electric or powered. Most combine an internal combustion engine with an electric engine, though other variations too exist

Appendix D: Acknowledgements

The members for the three (3) Working Groups have been identified and were grouped as shown in the following tables. These working groups held meetings and workshops with wide range of stakeholders who willingly cooperated and contributed. The invaluable contributions of all the stakeholders are very much appreciated and gratefully acknowledged.

Table D1 List of stakeholders for electrical energy

No	Organisation
1	Energy and Environment Branch, Department of Works
2	Department of Statistics Malaysia
3	Malaysian Green Technology Corporation
4	Academy of Sciences Malaysia
5	Centre for Environment, Technology and Development Malaysia
6	Malaysia Palm Oil Board
7	Energy Commission
8	Petroliam Nasional Bhd
9	Department of Occupational Safety and Gas
10	Construction Industry Development Board
11	Sustainable Energy Development Authority
12	Department of City and Rural Planning
13	Federation of Malaysian Manufacturers
14	Malaysia Association of Energy Service Companies
15	The Electrical and Electronics Association of Malaysia
16	Malaysian Gas Association

17	The Institution of Engineers Malaysia
18	Pembangunan Sumber Manusia Bhd
19	Electrical Engineering Branch, PWD
20	Tenaga Nasional Bhd
21	Sabah Electricity Sdn. Bhd.
22	Sarawak Energy Bhd (SEB)
23	Standards and Industrial Research Institute of Malaysia Bhd
24	National Water Services Commission
25	Real Estate and Housing Developers Association
26	Malaysia Green Building Confederation
27	*Persatuan Pengurusan Kompleks Malaysia*
28	Malaysia Association of Hotel

Table D2 List of stakeholders for thermal energy

No.	Ministry/Agency/Organisation
1	Department of Statistics Malaysia (DOSM)
2	Malaysia Palm Oil Board(MPOB)
3	Energy Commission
4	PETRONAS
5	Town and Country Planning Department of Peninsula Malaysia
6	Federation of Malaysian Manufacturers (FMM)
7	Malaysia Association of Energy Service Companies (MAESCO)
8	The Institution of Engineers, Malaysia (IEM)
9	Public Works Department (PWD) – Mechanical Engineering
10	Malaysia Investment Development Authority (MIDA)
11	ASHRAE Malaysia Chapter (MASHRAE)
12	Gas Malaysia Bhd
13	SME Corp
14	Malaysian Oil and Gas Services Council (MOGSC)
15	Malaysian Rubber Glove Manufacturers Association (MARGMA)
16	The Cement and Concrete Association of Malaysia
17	Malaysian Gas Association (MGA)
18	Sustainable Energy Development Authority (SEDA)
19	Malaysian Green Technology Corporation (MGTC)
20	Academy of Sciences Malaysia(ASM)
21	The Electrical and Electronics Association of Malaysia
22	Department of Occupational Safety and Health(DOSH)
23	Shell Malaysia Limited
24	SIRIM

Table D3 List of stakeholders for transport energy use

No	Ministry/Agency/Organisation
1	Energy and Environment Branch, Public Works Department (PWD)
2	Department of Statistics Malaysia (DOSM);
3	Malaysian Green Technology Corporation (MGTC)
4	Academy of Sciences Malaysia(ASM)
5	Centre for Environment, Technology and Development Malaysia (CETDEM)
6	Malaysia Palm Oil Board (MPOB);
7	Energy Commission (EC)
8	Petroliam Nasional Bhd (PETRONAS)
9	The Institution of Engineers Malaysia(IEM)
10	Electrical Engineering Branch, PWD
11	Chemical Industries Council of Malaysia (CICM)
12	Road Branch, Public Works Department (PWD),
13	Public Land Transport Commission (SPAD)
14	Federation of Malaysian Freight Forwarders (FMFF)
15	Prasarana Malaysia Bhd
16	Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp)
17	Road Transport Department(JPJ)
18	Keretapi Tanah Melayu Bhd (KTMB)
19	Department of Civil Aviation (DCA)
20	Malaysian Aviation Commission (MAVCOM)
21	Malaysia Ship Owners' Association (MASA)
22	Maritime Institute of Malaysia (MIMA)
23	Malaysia Offshore Support Vessel Owners' Association (OSV Malaysia)
24	Charted Institute of Logistics and Transport Malaysia (CILTM)
25	Malaysia Automotive Institute (MAI)
26	Malaysia Institute of Transport (MITRANS)
27	Malaysia Highway Authority(LLM)
28	Centre for Transportation Research (CTR)
29	PLUS Malaysia Bhd (PMB)

30	Automobile Association of Malaysia (AAM)
31	Shell Malaysia
32	PETRON Malaysia
33	Chevron Malaysia Limited
34	BH Petrol
35	Marine Department Malaysia
36	Malaysia Airports Holdings Bhd (MAHB)
37	Department of Fisheries Malaysia

Appendix E: Tabulation of thermal energy data

Table E1 Thermal energy data on natural gas from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	Natural Gas -------------------------------- (Fuel type)	------------------------ (Calorific value of fuel stated)	Prepared by:		Date:		
			Organisation:		Revision:		

Year	Food, beverages & tobacco products ktoe (------)	Textiles & leather products ktoe (------)	Wood & wood products and furniture ktoe (------)	Paper & paper products ktoe (------)	Coke & refined petroleum products (------)	Chemicals & chemical products ktoe (------)	Pharmaceutical products (------)	Rubber & plastic products (------)	Non-metallic mineral products (incl. ceramic, concrete, glass)	Basic metals ktoe (------)	Fabricated metal products (------)	Electrical & Electronic equipment (------)	Machinery & equipment ktoe (------)	Motor vehicles, trailers, semi-trailers & other transport equipment	Cement (------)	Commercial / Buildings (------)	Not elsewhere Specified ktoe (------)
2005	Data is not available																
2006																	
2007																	
2008																	
2009																	
2010	1451	156	47	227		446			134	1754			2	35		Data is not available	59
2011	1413	159	59	157		450			133	1815			2	47			65
2012	1474	146	59	199		531			119	1905			3	53			67
2013	1493	150	17	134		593			121	1855			3	58			64
2014	1620	163	19	145		644			131	2013			3	63			69

Table E2 Thermal energy data on petrol from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	Petrol ------------------------------- (Fuel type)	---------------------- (Calorific value of fuel stated)	Prepared by:		Date:	
			Organisation:		Revision:	

Year	Food, beverages & tobacco products ktoe (_____)	Textiles & leather products ktoe (_____)	Wood & wood products and furniture ktoe (_____)	Paper & paper products ktoe (_____)	Coke & refined petroleum products (_____)	Chemicals & chemical products ktoe (_____)	Pharmaceutical products (_____)	Rubber & plastic products (_____)	Non-metallic mineral products (incl. ceramic, concrete, glass) (___ktoe__)	Basic metals ktoe (_____)	Fabricated metal products (_____)	Electrical & Electronic equipment (_____)	Machinery & equipment ktoe (_____)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (_____)	Cement (_____)	Commercial / Buildings (_____)	Not elsewhere Specified ktoe (_____)
2005	Data is not available																
2006																	
2007																	
2008																	
2009																	
2010	16	4	3	7		24			0	0			26	0		Data is not available	3
2011	30	4	3	15		42			0	0			48	0			3
2012	30	11	9	23		61			0	0			74	0			7
2013	68	13	8	23		73			0	0			78	0			7
2014	68	13	8	23		73			0	0			78	0			7

Table E3 Thermal energy data on diesel from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	Diesel -------------------------------- (Fuel type)						---------------------- (Calorific value of fuel stated)				Prepared by:			Date:			
											Organisation:			Revision:			
Year	Food, beverages & tobacco products ktoe (......)	Textiles & leather products ktoe (......)	Wood & wood products and furniture ktoe (......)	Paper & paper products ktoe (......)	Coke & refined petroleum products (......)	Chemicals & chemical products ktoe (......)	Pharmaceutical products (......)	Rubber & plastic products (......)	Non-metallic mineral products (incl. ceramic, concrete, glass) (....ktoe..)	Basic metals ktoe (......)	Fabricated metal products (......)	Electrical & Electronic equipment (......)	Machinery & equipment ktoe (......)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (......)	Cement (......)	Commercial / Buildings (......)	Not elsewhere Specified ktoe (......)
2005	Data is not available																
2006																	
2007																	
2008																	
2009																	
2010	46	290	86	217		186			92	510			49	571		Data is not available	12
2011	23	131	57	87		127			64	331			27	426			7
2012	46	149	65	171		198			99	507			46	695			15
2013	50	56	67	123		213			80	546			49	717			20
2014	23	25	30	55		95			36	244			22	320			9

Table E4 Thermal energy data on fuel oil from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Fuel Types

Fuel type: (Provide new sheet for each fuel type)	Fuel Oil ------------------------------------ (Fuel type)						------------------------ (Calorific value of fuel stated)				Prepared by:			Date:			
											Organisation:			Revision:			
Year	Food, beverages & tobacco products ktoe (......)	Textiles & leather products ktoe (......)	Wood & wood products and furniture ktoe (......)	Paper & paper products ktoe (......)	Coke & refined petroleum products (......)	Chemicals & chemical products ktoe (......)	Pharmaceutical products (......)	Rubber & plastic products (......)	Non-metallic mineral products (incl. ceramic, concrete, glass) (...ktoe..)	Basic metals ktoe (......)	Fabricated metal products (......)	Electrical & Electronic equipment (......)	Machinery & equipment ktoe (......)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (......)	Cement (......)	Commercial / Buildings (......)	Not elsewhere Specified ktoe (......)
2005	Data is not available																
2006	Data is not available																
2007	Data is not available																
2008	Data is not available																
2009	Data is not available																
2010	11	10	114	0		87			91	75			0	0		Data is not available	31
2011	12	8	89	0		75			71	41			0	0		Data is not available	24
2012	29	17	202	0		209			161	65			0	0		Data is not available	54
2013	13	8	36	0		84			65	28			0	0		Data is not available	23
2014	13	7	34	0		80			62	27			0	0		Data is not available	22

Table E5 Thermal energy data on LPG from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	LPG -------------------------------- (Fuel type)						------------------------ (Calorific value of fuel stated)				Prepared by:			Date:				
											Organisation:			Revision:				
Year	Food, beverages & tobacco products ktoe (______)	Textiles & leather products ktoe (______)	Wood & wood products and furniture ktoe (______)	Paper & paper products ktoe (______)	Coke & refined petroleum products (______)	Chemicals & chemical products ktoe (______)	Pharmaceutical products (______)	Rubber & plastic products (______)	Non-metallic mineral products (incl. ceramic, concrete, glass) (___ktoe..)	Basic metals ktoe (______)	Fabricated metal products (______)	Electrical equipment (______)	Machinery & equipment ktoe (______)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (______)	Cement (______)	Commercial / Buildings (______)	Residential	Not elsewhere Specified ktoe (______)
2005	Data is not available															488	732	Data is not available
2006																529	795	
2007																565	771	
2008																403	960	
2009																632	736	
2010	1	2	0	0		7			0	156			0	1		611	699	65
2011	1	1	0	0		7			0	136			0	2		592	781	77
2012	1	1	0	0		5			0	99			0	1		631	703	32
2013	2	1	0	0		7			0	131			0	1		693	735	37
2014	1	1	0	0		5			0	87			0	1		721	640	25

Table E6 Thermal energy data on kerosene from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection
Annual Fuel Energy Consumption by Sectors for each stated fuel type

Fuel type: (Provide new sheet for each fuel type)	Kerosene ----------- (Fuel type)						----------- (Calorific value of fuel stated)				Prepared by:			Date:			
											Organisation:			Revision:			
Year	Food, beverages & tobacco products ktoe (_____)	Textiles & leather products ktoe (_____)	Wood & wood products and furniture ktoe (_____)	Paper & paper products ktoe (_____)	Coke & refined petroleum products (_____)	Chemicals & chemical products ktoe (_____)	Pharmaceutical products (_____)	Rubber & plastic products (_____)	Non-metallic mineral products (incl. ceramic, concrete, glass) (___ktoe..)	Basic metals ktoe (_____)	Fabricated metal products (_____)	Electrical & Electronic equipment (_____)	Machinery & equipment ktoe (_____)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (_____)	Cement (_____)	Commercial / Buildings (_____)	Not elsewhere Specified ktoe (_____)
2005	Data is not available																
2006																	
2007																	
2008																	
2009																	
2010	0	0	0	0		0			0	0			0	6		Data is not available	0
2011	0	0	0	0		0			0	0			0	9			0
2012	0	0	0	0		0			0	0			0	26			0
2013	0	0	0	0		0			0	0			0	29			0
2014	0	0	0	0		0			0	0			0	16			0

Table E7 Thermal energy data on coal and coke from Energy Commission

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection
Annual Fuel Energy Consumption by Sectors for each fuel type

Fuel type: (Provide new sheet for each fuel type)	Coal and Coke ----------- (Fuel type)						----------- (Calorific value of fuel stated)				Prepared by:			Date:			
											Organisation:			Revision:			
Year	Food, beverages & tobacco products ktoe (_____)	Textiles & leather products ktoe (_____)	Wood & wood products and furniture ktoe (_____)	Paper & paper products ktoe (_____)	Coke & refined petroleum products (_____)	Chemicals & chemical products ktoe (_____)	Pharmaceutical products (_____)	Rubber & plastic products (_____)	Non-metallic mineral products (incl. ceramic, concrete, glass) (___ktoe..)	Basic metals ktoe (_____)	Fabricated metal products (_____)	Electrical & Electronic equipment (_____)	Machinery & equipment ktoe (_____)	Motor vehicles, trailers, semi-trailers & other transport equipment ktoe (_____)	Cement (_____)	Commercial / Buildings (_____)	Not elsewhere Specified ktoe (_____)
2005	Data is not available																
2006																	
2007																	
2008																	
2009																	
2010	0	0	0	0		0			1826	0			0	0		Data is not available	0
2011	0	0	0	0		0			1759	0			0	0			0
2012	0	0	0	0		0			1744	0			0	0			0
2013	0	0	0	0		0			1539	0			0	0			0
2014	0	0	0	0		0			1709	0			0	0			0

Table E8 Thermal energy data on natural gas from Gas Malaysia Bhd

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy (Natural Gas) Consumption by Sectors

Fuel type: (Provide new sheet for each fuel type)	Natural Gas -------------------------------- (Fuel type)								Prepared by:			Date:	
									Organisation:			Revision:	
Year	Food, beverages & tobacco products (mmBTU)	Textiles products (mmBTU)	Wood & wood products and furniture (mmBTU)	Paper & paper products (mmBTU)	Chemicals & chemical products (mmBTU)	Rubber & plastic products (mmBTU)	Non-metallic mineral products (incl. ceramic, concrete, glass) (mmBTU)	Basic metals (mmBTU)	Fabricated metal products (mmBTU)	Electrical & Electronic equipment (mmBTU)	Machinery & equipment (mmBTU)	Motor vehicles, trailers, semi-trailers & other transport equipment	Commercial / Buildings (mmBTU)
2015	42,438,744	4,630,893	156,559	5,248,139	11,858,331	52,953,625	19,300,986	10,765,579	4,742,804	1,873,005	251,223		1,021,607
2006	25,958,899	4,295,823	292,409	3,635,739	8,645,812	18,801,885	20,219,528	7,547,087	3,000,272	2,309,979	450,660		799,000
2006	27%	5%	0%	4%	9%	20%	21%	8%	3%	2%	0%		
2007	28,205,696	4,337,161	281,030	4,867,842	9,202,135	22,487,655	19,023,383	10,305,248	3,416,686	2,142,723	435,809		880,707
2008	29,794,358	4,531,957	314,342	4,842,542	9,241,441	24,578,628	19,601,780	10,793,866	3,562,775	2,164,264	273,834		1,001,104
2009	29,070,546	4,375,177	251,240	4,677,733	8,786,263	25,378,983	18,073,544	9,803,361	3,113,530	1,845,244	204,805		934,766
2010	31,631,345	4,307,853	262,722	4,847,587	9,507,405	28,567,341	19,853,233	10,863,821	3,567,352	2,164,326	259,997		1,006,564
2011	33,315,737	4,242,049	274,206	5,793,796	9,823,832	30,318,664	21,184,812	11,695,310	3,678,646	2,083,166	258,548		1,021,176
2012	34,421,384	4,475,040	252,421	5,584,863	9,467,377	33,861,517	20,116,345	11,318,185	3,749,109	2,000,274	243,448		990,892
2013	37,763,632	4,646,232	209,715	5,716,309	10,410,346	38,755,542	20,943,446	11,119,585	4,480,214	1,984,425	259,167		961,403
2014	40,677,018	4,792,330	175,178	5,171,349	11,218,645	44,333,565	21,437,389	10,826,180	4,472,838	2,021,310	249,723		992,935
2015	42,438,744	4,630,893	156,559	5,248,139	11,858,331	52,953,625	19,300,986	10,765,579	4,742,804	1,873,005	251,223		1,021,607

Table E9 Thermal energy data from Cement Company #1

Demand Side Management (DSM) Preliminary Study - Thermal Energy Sector - Data Collection

Annual Fuel Energy Consumption by Fuel Types

Sub-Sector:	------------------ (To state Sub-Sector)	Prepared by:		Date:		Organisation:	Cement company #1	Revision:		Revision:		Revision:		
Year	Petroleum Products (Specify type, unit & calorific value) Diesel	Average CV Diesel (Litre)	Natural Gas (Specify unit & calorific value)	Coal (Specify type, unit & calorific value)	Average CV Coal (Kcal/kg)	Biomass (Specify type of biomass, unit & calorific value) (tonnes) EFB	Average CV EFB (Kcal/kg)	Others (Specify fuel type, unit & calorific value) carbon black	Average CV Carbon black (Kcal/kg)	Others (Specify fuel type, unit & calorific value) PKS	Average CV PKS (Kcal/kg)	Others (Specify fuel type, unit & calorific value) Tyre	Average CV Tyre (Kcal/kg)	Production (Annual production data) or Gross Floor Area (for Commercial / Buildings) (To specify unit)
2005	837,799			169,959										
2006	634,626			158,028								139		
2007	1,470,559			148,601								4		
2008	1,070,507			215,231										
2009	963,394			214,889										
2010	1,020,008			197,210						19				
2011	1,213,549			205,241		61		68		20				
2012	828,465			200,619										
2013	1,822,144			248,135.50						586		34		
2014	2,336,000			415,357	6052	252.69		384.50		10,438.62		139		
2015	2,322,468	10,000		458,339	5268	249.84	4350	8,347	6563	6,060.02	2654	159.58		

Table E10 Thermal energy data from Cement Company #2

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Fuel Types

Sub-Sector:	Cement (To state Sub-Sector)			Prepared by:				Date:	15-Aug-16
				Organisation:	Cement Company #2			Revision:	
Year	Petroleum Products (Specify type, unit & calorific value) Diesel	Petroleum Products (Specify type, unit & calorific value) LPG	Petroleum Products (Specify type, unit & calorific value) Fuel Oil (Litres) (10,000 cal/kg)	Natural Gas (Specify unit & calorific value)	Coal (Specify type, unit & calorific value) (tonnes) (5,786 cal/kg)	Biomass (Specify type of biomass, unit & calorific value) (tonnes)	Biogas (Specify type of biogas, unit & calorific value)	Others (Specify fuel type, unit & calorific value) Paddy husk (tonnes) (3,400 cal/kg)	Production (Annual production data) or Gross Floor Area (for Commercial / Buildings) Cement (tonnes) (To specify unit)
2005			6,464,618		139,827			17,530	1,430,779
2006			4,751,273		105,000			30,504	1,550,300
2007			2,955,544		191,620			33,659	1,521,076
2008			2,484,885		219,691			48,938	1,566,293
2009			3.568.509		180.307			44.850	1.349.619
2010			3,643,545		221,239			40,195	1,475,048
2011			2,492,191		238,648			34,167	1,668,849
2012			3,642,209		241,901			20,769	1,749,693
2013			3,130,747		249,850			20,707	1,832,198
2014			2,528,280		268,806			21,414	1,795,548
			2,576,730		276,101			21,271	1,823,305

Table E11 Thermal energy data from Cement Company #3

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Fuel Types

Sub-Sector:	CEMENT ------- (To state Sub-Sector)		Prepared by:				Date:	30/8/2016
			Organisation:	Cement Company #3			Revision:	1
Year	Petroleum Products (Specify type, unit & calorific value) Diesel ------- Tonne ------- 10400 kcal/kg -------	Petroleum Products (Specify type, unit & calorific value) Medium Fuel Oil (MFO) ------- Tonne ------- 9800 kcal/kg -------	Natural Gas (Specify unit & calorific value) ------- -------	Coal (Specify type, unit & calorific value) Petroleum Coke ------- Tonne ------- 8350 kcal/kg -------	Biomass (Specify type of biomass, unit & calorific value) Saw Dust ------- Tonne ------- 4500 kcal/kg -------	Biogas (Specify type of biogas, unit & calorific value) ------- ------- -------	Others (Specify fuel type, unit & calorific value) ------- ------- -------	Production (Annual production data) or Gross Floor Area (for Commercial / Buildings) Tonne ------- (To specify unit)
2005	256.98	230.71		20,722.41				137,803.40
2006	217.11	66.33		25,094.82				180,771.62
2007	105.09	219.47		26,118.03				189,392.52
2008	241.94	217.37		26,976.50	101.17			190,378.82
2009	176.46	159.88		24,552.01	537.32			177,493.64
2010	193.09	135.41		25,108.57				177,178.83
2011	205.10	198.03		23,869.76	2829.46			172,436.51
2012	206.00	92.31		23,582.43	4994.04			173,200.27
2013	200.06	15.85		23,965.70	1967.43			171,056.23
2014	269.13	728.81		70,982.91				182,477.00

Table E12 Thermal energy data from Cement Company #4

Demand Side Management (DSM) Preliminary Study – Thermal Energy Sector – Data Collection

Annual Fuel Energy Consumption by Fuel Types

Sub-Sector: Cement	Cement ---------------------------------- (To state Sub-Sector)		Prepared by:			Date:	23/8/2016
			Organisation:	Cement Company #4		Revision:	
Year	Petroleum Products (Specify type, unit & calorific value) Diesel .... litre	Petroleum Products (Specify type, unit & calorific value) Fuel Oil .... litre .... 9906 kcal/kg	Natural Gas (Specify unit & calorific value)	Coal (Specify type, unit & calorific value) Coal .... tons .... 6251 kcal/kg	Biogas (Specify type of biogas, unit & calorific value)	Others (Specify fuel type, unit & calorific value) soap sludge .... tons 7.89kcal/g	Production (Annual production data) or Gross Floor Area (for Commercial / Buildings) .... (To specify unit)
2005	Data not available	6803		287932		1628	
2006	Data not available	4531		257591		638	
2007	Data not available	2218		267730		805	
2008	122109	1968		330123		1781	
2009	148143	1260		276255		2043	
2010	158403	590		328479		3226	
2011	191317	1018		307051		1972	
2012	204491	934		302890		1610	
2013	223860	912		293635		1277	
2014	284157	1181		331909		1057	

Appendix F: Analysis of natural gas consumption data

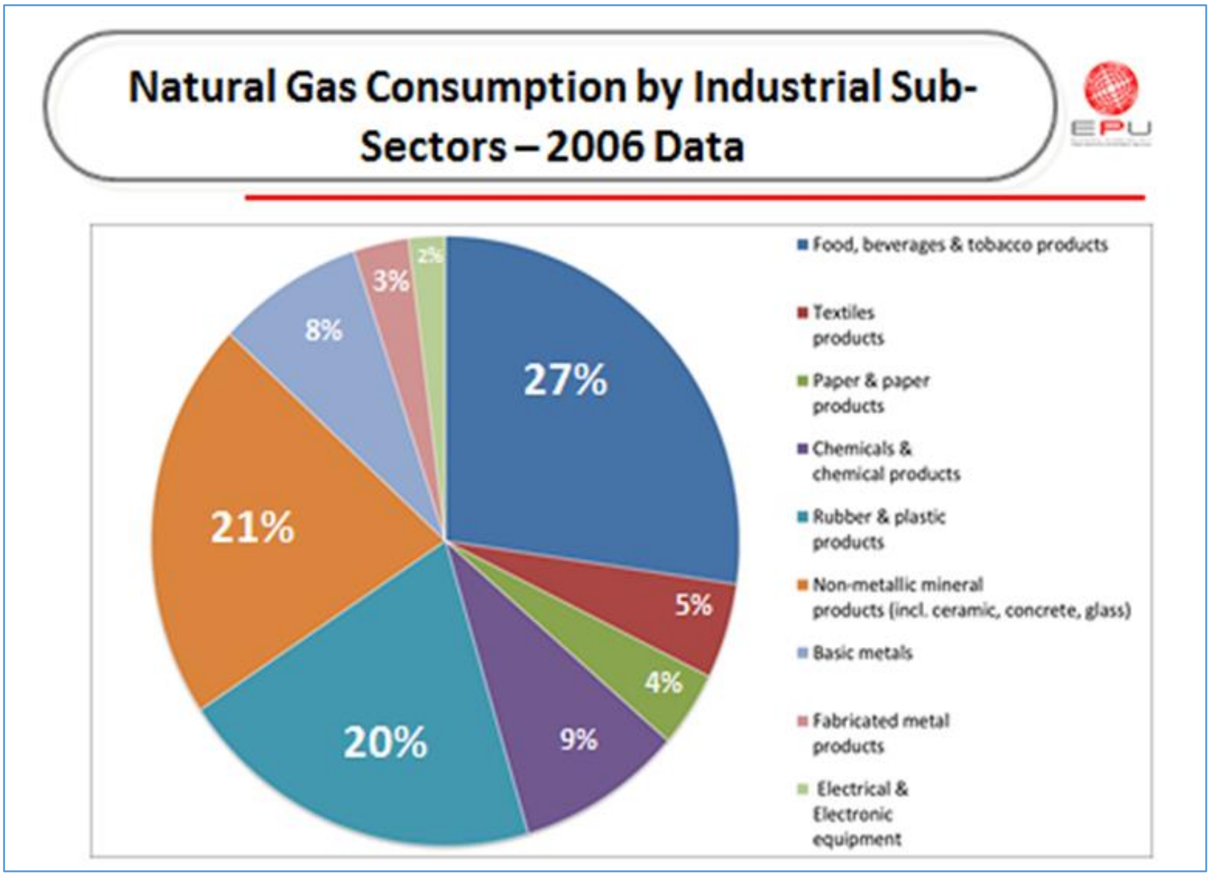


Figure F1 Natural gas consumption analysis showing shares of energy use by industrial sub-sectors, 2006

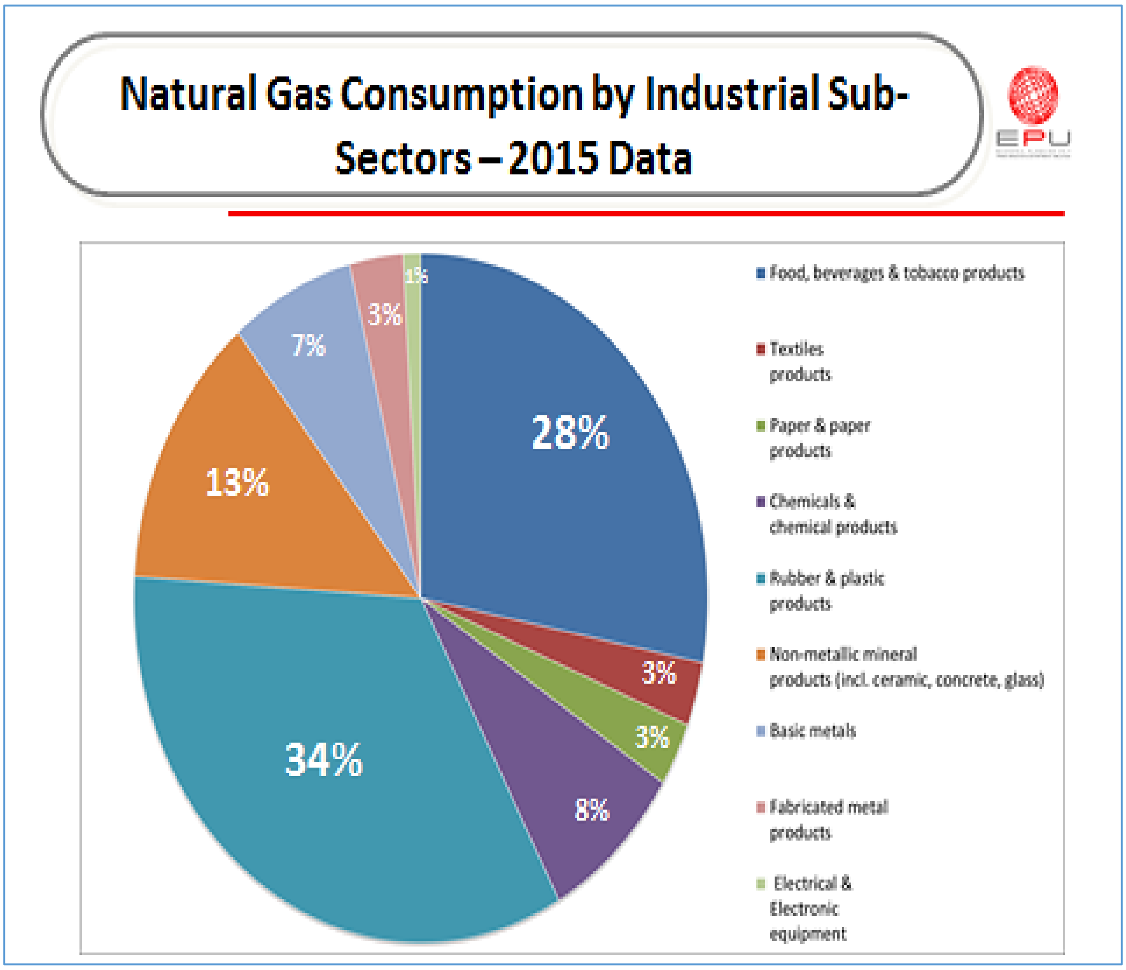


Figure F2 Natural gas consumption analysis showing shares of energy use by industrial sub-sectors, 2015

Based on the natural gas consumption data provided by Gas Malaysia, the three (3) largest consumers in 2006 are as follows:

- Food, beverages and tobacco products (27%)
- Non-metallic mineral products (21%)
- Rubber and plastic products (20%)

Based on the natural gas consumption data provided by Gas Malaysia, the three (3) largest consumers in 2015 are as follows:

- Rubber and plastic products (34%)
- Food, beverages and tobacco products (28%)
- Non-metallic mineral products (13%)

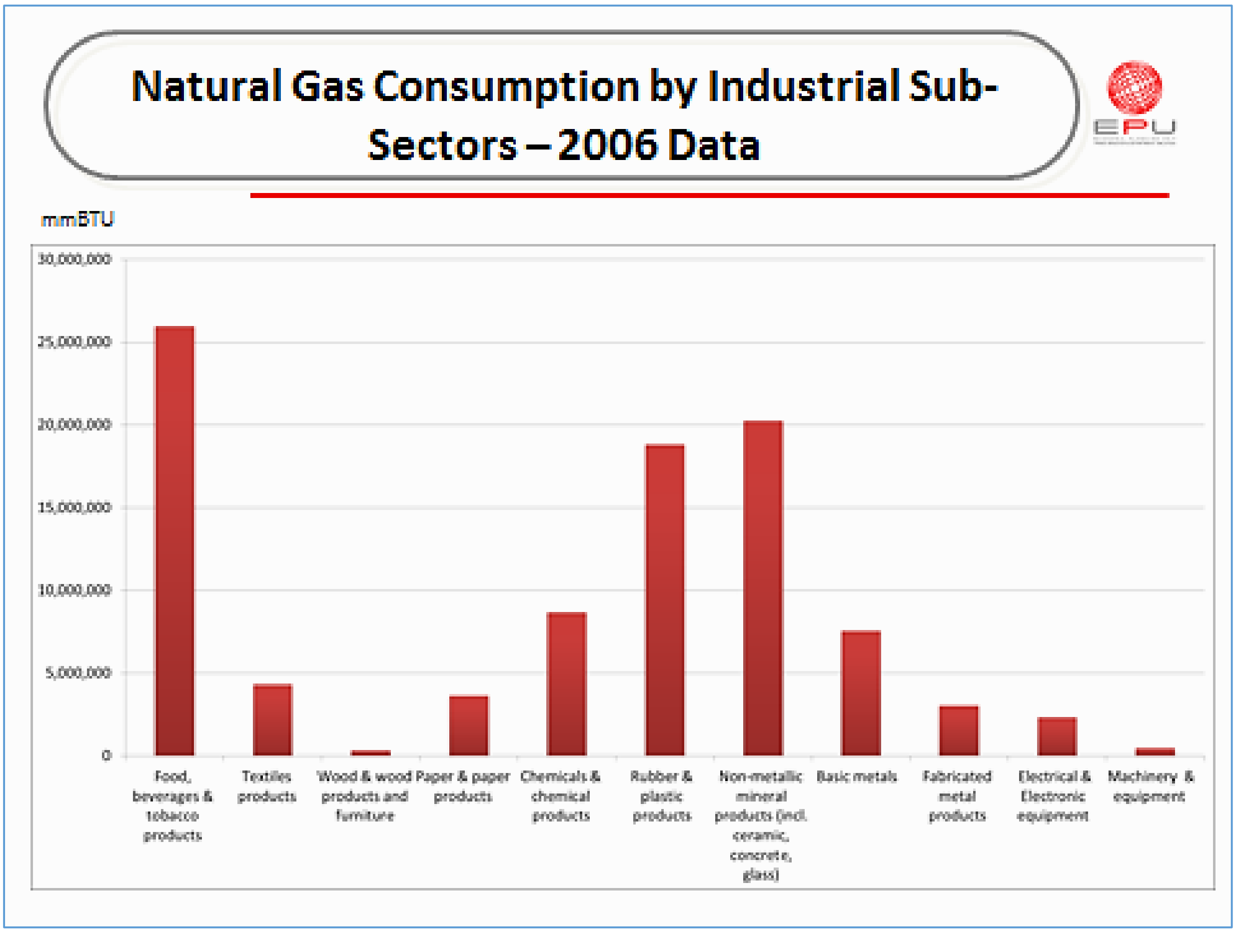


Figure F3 Natural gas consumption analysis showing the amount of energy use by industrial sub-sectors in 2006

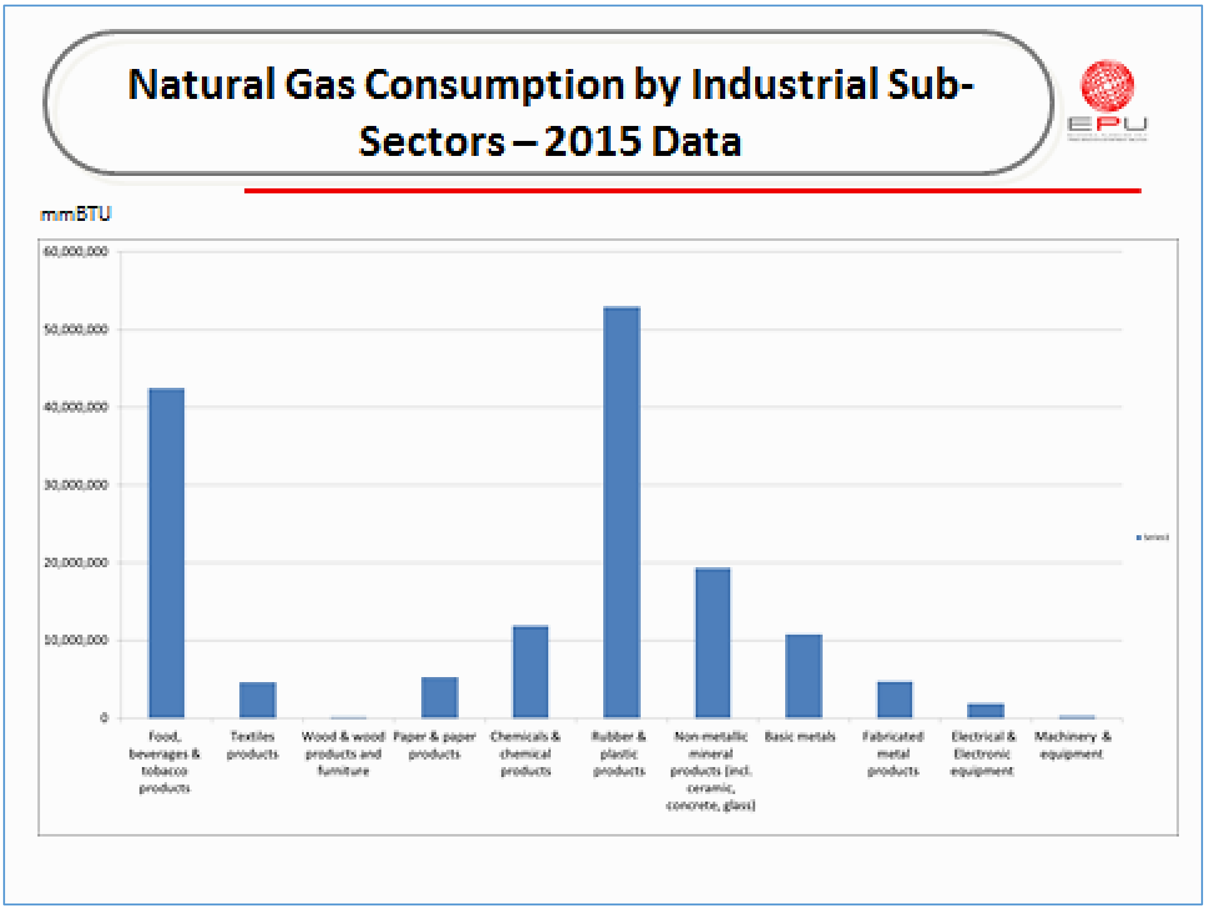


Figure F4 Natural gas consumption analysis showing the amount of energy use by industrial sub-sectors in 2015

Appendix G: Energy flow and definition of fuels

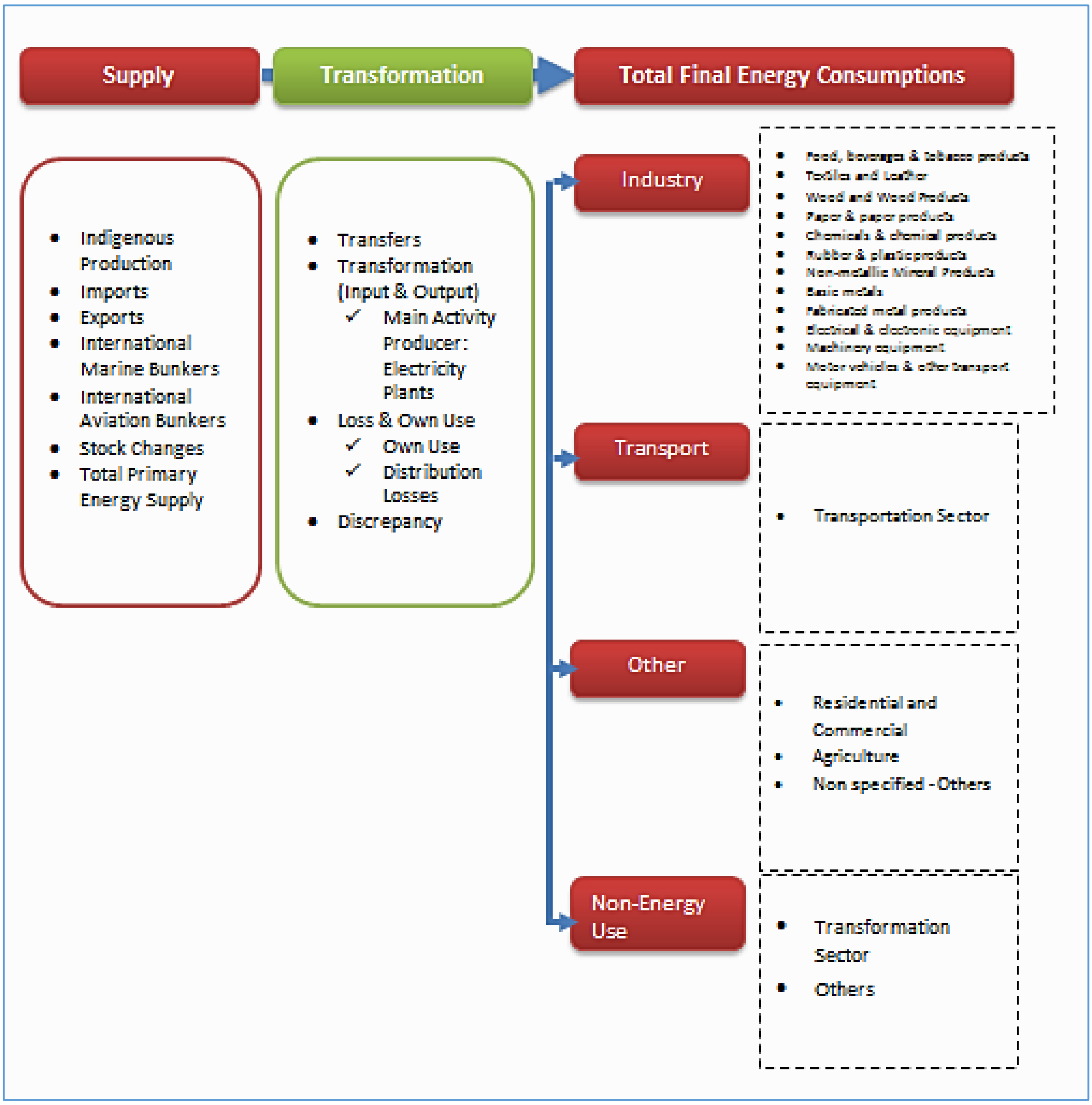
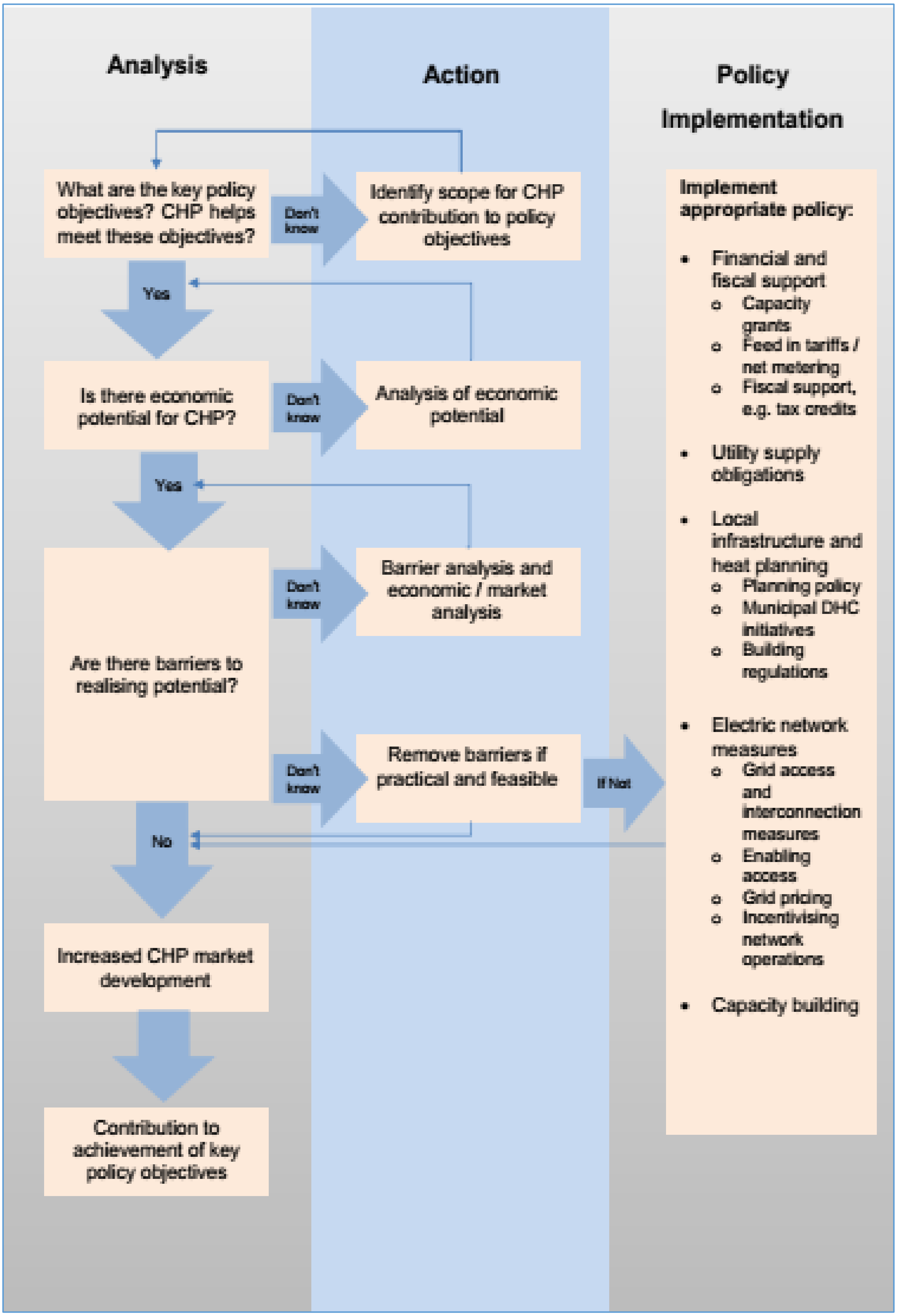


Figure G1 Energy flow in energy balance

Appendix H: CHP policy decision pathway



Appendix I: Projected DSM Programmes Summary Impacts-Electrical Energy

Summary Item	Unit	For Period Y2016 to Y2030 based on 5 DSM Enhanced Measures Activities															Total	Lifetime
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030		
Annual Savings	GWh	87	392	1,032	2,194	3,701	5,439	7,201	9,061	10,962	12,967	14,232	15,564	16,999	18,616	20,329	138,775	184,110
Residential	GWh	78	193	347	563	838	1,162	1,530	2,011	2,540	3,119	3,715	4,323	4,943	5,576	6,221	37,160	21,796
Commercial	GWh	-	43	156	384	683	1,027	1,365	1,701	2,035	2,383	2,493	2,610	2,741	2,899	3,070	23,589	52,854
Industrial	GWh	9	156	529	1,247	2,180	3,250	4,306	5,348	6,387	7,465	8,024	8,631	9,314	10,141	11,038	78,026	109,460
Cumulative Savings	GWh	87	480	1,511	3,705	7,406	12,845	20,046	29,106	40,068	53,036	67,268	82,832	99,830	118,446	138,775	138,775	184,110
Demand Savings	MW	14	64	168	358	604	887	1,174	1,478	1,788	2,115	2,321	2,538	2,772	3,036	3,315	3,315	
Capacity Savings	MW	18	80	210	447	754	1,109	1,468	1,847	2,235	2,643	2,901	3,173	3,465	3,795	4,144	4,144	
Benefits	RM (Million)	28	138	376	804	1,358	1,985	2,602	3,233	3,857	4,497	4,829	5,182	5,564	5,999	6,468	46,920	62,905
Public Funding	RM (Million)	26	42	63	64	66	56	58	59	55	57	77	78	106	108	137	**1,050**	**1,050**
Private Funding	RM (Million)	186	281	393	415	543	571	589	677	703	735	734	760	834	902	952	**9,275**	**9,275**
EEC Administration	RM (Million)	25	25	25	25	35	35	35	35	35	50	50	50	50	50	50	**575**	**575**
Total Payments	RM (Million)	237	348	481	504	643	662	681	771	793	842	861	888	990	1,059	1,139	10,900	10,900
BCR	Ratio	0.1	0.4	0.8	1.6	2.1	3.0	3.8	4.2	4.9	5.3	5.6	5.8	5.6	5.7	5.7	4.3	5.8
Cash Flow	RM (Million)	- 209	- 210	- 105	300	715	1,323	1,921	2,463	3,064	3,656	3,968	4,294	4,574	4,939	5,329	36,021	52,005
Total fuel savings	TJ	966	4,295	11,186	23,547	39,328	57,224	75,020	93,454	111,948	131,114	142,477	154,269	166,823	180,885	195,572	1,388,105	1,841,571
Gas Savings	TJ	444	1,975	5,145	10,831	18,091	26,323	34,509	42,989	51,496	60,312	65,539	70,964	76,739	83,207	89,963	638,528	847,123
Coal Savings	TJ	396	1,761	4,586	9,654	16,124	23,462	30,758	38,316	45,898	53,757	58,415	63,250	68,398	74,163	80,184	569,123	755,044
GHG savings	ktCO2eq	67	298	775	1,632	2,726	3,966	5,200	6,477	7,759	9,087	9,875	10,692	11,562	12,537	13,555	96,209	127,638
Forecast BAU	GWh	136,410	141,048	145,843	150,802	155,929	160,607	165,425	170,388	175,500	180,765	186,188	189,353	192,572	195,846	199,175	2,545,851	
DSM Programmes	GWh	136,322	140,655	144,812	148,608	152,228	155,169	158,224	161,328	164,538	167,798	171,956	173,789	175,573	177,230	178,846	2,407,075	
Savings	Pct	0.1%	0.3%	0.7%	1.5%	2.4%	3.4%	4.4%	5.3%	6.2%	7.2%	7.6%	8.2%	8.8%	9.5%	**10.2%**	**5.5%**	

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Jabatan Perangkaan Malaysia (DOSM)
Sustainable Energy Development Authority (SEDA)
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Malaysian Green Technology Corporation (MGTC)
Federation of Malaysian Manufacturers (FMM)

Akademi Sains Malaysia (ASM)
Tenaga Nasional Berhad (TNB)
Sabah Electricity Sdn. Bhd. (SESB)
Sarawak Energy Berhad (SEB)
Malaysia Association of Energy Service Companies (MAESCO)
The Electrical and Electronics Association of Malaysia (TEEAM)
SIRIM BERHAD
Centre for Environment, Technology and Development, Malaysia
Lembaga Minyak Sawit Malaysia (MPOB)
Malaysian Gas Association (MGA)
Suruhanjaya Perkhidmatan Air Negara (SPAN)
Persatuan Pemaju Hartanah Dan Perumahan Malaysia (REHDA)
Malaysia Green Building Confederation (MGBC)
Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB)
Persatuan Pengurusan Kompleks Malaysia
Persatuan Hotel Malaysia
Association of Private Hospitals of Malaysia
Lembaga Pembangunan Pelaburan Malaysia (MIDA)
American Society of Heating, Refrigerating and Air-conditioning Engineers – Malaysia Chapter (MASHRAE)
The Institution of Engineers Malaysia (IEM)
Gas Malaysia Berhad (GMB)
SME Corporation Malaysia (SME Corp)
The Cement & Concrete Association of Malaysia (C&CA)
Malaysian Petrochemicals Association (MPA)
Malaysia Oil & Gas Services Council (MOGSC)
Chemical Industries Council of Malaysia (CICM)
Malaysia Pulp and Paper Manufacturers Association
The Malaysian Iron and Steel Industry Federation (MISIF)
Malaysian Rubber Glove Manufacturers Association (MARGMA)
The Electrical and Electronics Association of Malaysia (TEEAM)
Pharmaceutical Association of Malaysia (PhAMA)
Malaysian Oil & Gas Engineering Council (MOGEC)
Federation of Malaysian Freight Forwarders (FMFF)
Prasarana Malaysia Berhad
Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp)
Jabatan Pengankutan Jalan (JPJ)
Keretapi Tanah Melayu Berhad (KTMB)
Jabatan Penerbangan Awam Malaysia (DCA)
Malaysian Aviation Commission (MAVCOM)
Malaysia Shipowners' Association (MASA)
Maritime Institute of Malaysia (MIMA)

Malaysia Offshore Support Vessel Owners' Association (OSV Malaysia)
Charted Institute of Logistics and Transport Malaysia (CILTM)
PETRONAS NGV
Malaysia Automotive Institute (MAI)
Akademi Sains Malaysia (ASM)
Malaysia Institute of Transport (MITRANS)
Universiti Teknologi MARA (UiTM)
Lembaga Lebuhraya Malaysia (LLM)
Centre for Transportation Research (CTR)
PLUS Malaysia Berhad
Automobile Association of Malaysia
Shell Malaysia
Petron Malaysia
ExxonMobil Exploration and Production Malaysia Inc.
Chevron Malaysia Limited
BHPetrol, Boustead Petroleum Marketing Sdn. Bhd.