



**ASIA-PACIFIC
ECONOMIC
COOPERATION**

**Follow-Up
Peer Review on
Energy Efficiency
In Malaysia**

**Final Report for
APEC Energy Working Group (EWG)**

**November
2018**

APEC Peer Review on Energy Efficiency in Malaysia: EWG 08 2017A

PRODUCED BY:

Asia Pacific Energy Research Centre (APERC)
Institute of Energy Economics, Japan
Inui Building, Kachidoki 11F, 1-13-1 Kachidoki
Chuo-ku, Tokyo 104-0054 Japan
Tel: (813) 5144-8551
Fax: (813) 5144-8555
E-mail: master@aperc.iecee.or.jp (administration)
Website: <http://aperc.iecee.or.jp/>

FOR:

Asia-Pacific Economic Cooperation Secretariat
35 Heng MuiKeng Terrace, Singapore 119616
Tel: (65) 68 919 600
Fax: (65) 68 919 690
E-mail: info@apcc.org
Website: <http://www.apcc.org>

©2018 APEC Secretariat
APEC#218-RE-01.16

CONTENTS

Preface	vii
Executive summary	viii
Overarching Issues	viii
Transport Sector	ix
Industrial Sector	x
Recommendations	xi
1. Overarching	xi
2. Transport Sector	xiii
3. Thermal (Industry) Sector	xv
Part I: Background	1
Introduction	1
Energy demand and supply	2
Primary Energy Supply	2
Final Energy Consumption	5
Energy policy overview	6
National Energy Policy	6
National Depletion Policy	7
Fuel Diversification Policy	7
National Green Technology Policy	7
National Renewable Energy Policy and Action Plan	10
Malaysia Plan – A Five-Year Development Plan	10
Climate Change Policy	11
Energy Efficiency Policy	11
Governance structure	12
Existing Regulatory Framework	13
Energy Efficiency in Malaysia	15
The National Energy Efficiency Master Plan (NEEAP)	15
Energy Intensity Analysis	17
Demand Side Management (DSM) Preliminary Study	17
Other initiatives and targets in Energy Efficiency	17

Energy Efficient Vehicles	17
Part II: PREE review team report	19
1. Overarching.....	19
1.1 Benefits of Energy Efficiency	19
1.2 Institutional Framework.....	21
1.3 Setting Targets.....	22
1.4 Energy Pricing	23
1.5 Funding.....	23
1.6 International Cooperation.....	24
2. Transport Sector	26
2.1 Institutional Framework.....	26
2.2 Regulatory Framework.....	27
2.3 Data Collection and Monitoring	29
2.4 Travel Demand Management	31
2.5 Deployment of Energy Efficient Vehicles	33
2.6 Vehicle Fuel Economy Labelling and Standards.....	35
2.7 Modal Shifting and Public Transport	36
2.8 Transport Integration	38
3. Industrial Sector.....	40
3.1 Institutional Framework.....	40
3.2 Regulatory Framework.....	42
3.3 Data Collection and Monitoring	44
3.4 Energy Management Systems	46
3.5 Future Deployment of Energy Efficient Technologies.....	49
3.6 Low Carbon Technology Investment and Financing	52
Appendix A: Peer review team members.....	55
Appendix B: Follow-Up PREE Agenda	55
Appendix C: Local Participants.....	57
Appendix D: References.....	59

TABLES AND FIGURES

TABLE

Table 1: GTMP Strategic Thrust	9
Table 2: Regulations in effect in Malaysia	13
Table 3: Energy efficiency vehicle definition and classification.....	18
Table 4: List of responsible agencies implementing energy efficiency awareness program	20

FIGURE

Figure 1: Total primary energy supply, 2000-2015	2
Figure 2: Natural gas import and export in Malaysia, 1990-2015.....	3
Figure 3: Primary Energy Growth Index and Total Primary Energy Supply, 2010-2015	4
Figure 4: Final Energy Consumption by Sector, 2000-2015	5
Figure 5: Final Energy Consumption by Fuel, 2000-2015.....	6
Figure 6: Emission testing for heavy load vehicles.....	29
Figure 7: ASIF policy framework with data collection and monitoring.....	31
Figure 8: The US vehicle efficiency labelling.....	36
Figure 9: Comparison of road space used when travellers use public bus and private cars.....	37
Figure 10: Missing bus service between Sibul Airport and city centre	39

ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
ASEAN	Association of Southeast Asian Nations
DSM	Demand Side Management
EC	Energy Commission
EEV	Energy Efficient Vehicle
EPU	Economic Planning Unit, Ministry of Economic Affairs, Malaysia
ESCO	Energy Service Company
FiT	Feed-in Tariff
GHG	Greenhouse Gasses
GMB	Gas Malaysia Berhad
GTFS	Green Technology Funding Scheme
GTMP	Green Technology Master Plan
IEA	International Energy Agency
IEEMMS	Industrial Energy Efficiency for Malaysian Manufacturing Sector
ISO	International Organization for Standardization
KATS	Ministry of Water, Land and Natural Resources (formerly known as Ministry of Natural Resources & Environment)
MESTECC	Ministry of Energy, Science, Technology, Environment and Climate Change, Malaysia
MDTCC	Ministry of Domestic Trade and Consumer Affairs (KPDNHEP) (formerly known as Ministry Domestic Trade, Co-operative and Consumerism)
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MAI	Malaysia Automotive Institute
MEPS	Minimum Energy Performance Standards
MITI	Ministry of International Trade and Industry, Malaysia
MOT	Ministry of Transport, Malaysia
MPI	Ministry of Primary Industries (formerly known as Ministry of Plantation, Industry and Commodity)
NEEAP	National Energy Efficiency Action Plan
NGTP	National Green Technology Policy
NREPAP	National Renewable Energy Policy and Action Plan
PREE	Peer Review on Energy Efficiency
RE	Renewable Energy
SEDA	Sustainable Energy Development Authority
TDM	Travel demand management
TNB	Tenaga Nasional Berhad

TOD	Transit-oriented development
UN	United Nation
UNFCCC	United Nations Framework Convention on Climate Change

Energy Units

bbbl	barrel
GWh	Giga Watt-hour
Ktoe	Kilotonnes of oil equivalent
kWh	kiloWatt hour
MMscf/d	Million standard cubic feet/day
MW	Mega Watt

PREFACE

According to the guidelines for the APEC Peer Review on Energy Efficiency (PREE), the objectives of the PREE as endorsed by APEC Leaders at their 2007 meeting are to:

- Share information on energy efficiency performance as well as on policies and measures for improving energy efficiency.
- Provide opportunities for learning from the experiences of other economies and for broadening the network among energy efficiency policy experts.
- Explore how energy efficiency goals on an overall and /or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy.
- Monitor progress by attaining energy efficiency goals on an overall and/or sectoral basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review.
- Provide recommendations for voluntary implementation on how the implementation of action plans could be improved to achieving energy efficiency goals.

Three activities are undertaken as part of the PREE:

- **Peer Review** of volunteer member economies.
- The **Compendium of Energy Efficiency Policies** of APEC member economies based on either the APEC voluntary PREE or energy efficiency aspects of the IEA Energy Policy Review.
- The **Energy Efficiency Policy Workshop** for capacity building of member economies.

Malaysia conducted its first Peer Review on Energy Efficiency (PREE) by a team of nine experts who visited Malaysia from 29 November to 3 December 2010. After a lapse of nearly eight years, Malaysia conducted the Follow-Up on PREE from 26 to 30 March 2018, focusing on energy efficiency in the transport sector and industry sector. A total of six experts visited Putrajaya and the review team listed 56 recommendations that were divided into three groups – overarching issues, transport sector and industry sector. During the visit, the Follow-Up PREE Review Team held comprehensive discussions on energy efficiency with representatives and experts from government ministries and agencies. A three-day workshop was held on 26-28 March 2018 where 13 presentations from 9 agencies presented their latest status on energy efficiency, covering policies, statistics and implementation program.

The Review Team wishes to thank all the presenters and those who participated in the discussions, including officials from Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) (formerly known as Ministry of Green Technology and Water (MEGTW)) – especially to Ms. Falisyah Noor Azam, Ms. Siti Sarah Sharuddin, Ms. Rosliana Mohamed and Ms. Siti Khalijah Jahya and; Mr. Zulkiflee Umar and Kumareshan a/l Mardappan from Energy Commission (EC) who has been showing unequivocal support in making this event and report a success.

EXECUTIVE SUMMARY

Energy efficiency is recognised as one of the critical pillars in the energy policy framework. This pillar is evident in Malaysia's National Energy Policy that was drafted in 1979, where under the utilisation objective, the government recognised the importance of *efficient utilisation of energy and discourage wasteful and non-productive patterns of energy consumption*.

In making energy efficiency into a national agenda, Malaysia has formulated many policies and initiatives such as National Green Technology Policy and National Green Technology Master Plan. Malaysia has also just completed the Preliminary Study on Demand Side Management, to formulate policy and action plan covering the entire spectrum of the energy sector including electrical, thermal and usage in the transport sector, includes to identify the gap, opportunities and challenges that need to be addressed to achieve a high energy efficient economy.

OVERARCHING ISSUES

The Expert Review Team recommends for Malaysia to address the limited energy resources over longer-term horizons as domestic reserves decline or higher volumes are exported, by considering energy efficiency as an energy resource with low generation costs that should be prioritised when designing long-term energy policy plans. It is also important for Malaysia to expand the awareness-raising activities for the public with targeted messaging for different generations of Malaysians.

The Malaysian Government is recommended to strengthen the institutional energy set up by taking into account that an energy efficiency improvement is an across-the-board approach. In this regard, the responsibility and accountability to improve energy use by various sectors in Malaysia must be shared by all stakeholders especially policy-makers at the ministerial level. The leading energy efficiency policymaker in Malaysia is the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) (formerly known as Ministry of Energy, Green Technology and Water (KeTTHA)). However, the MESTECC jurisdiction on energy matters is limited to electricity. Currently, the National Green Technology and Climate Change Council established under the previous government, chaired by the Prime Minister is the highest level of the policy-makers meeting where deliberations on green technology and climate change issues including energy are made.

Institutional framework is crucial in making energy efficiency program success. Therefore, the Expert Review Team recommended for Malaysia to establish an organisation in charge of overall energy policy that can continue the coordination in planning and to implement energy efficiency policies. Improve policy coordination among Ministries by providing a clear target on energy efficiency and emissions reductions. It would be worthwhile to consider designating one dedicated entity responsible for energy efficiency policy implementation. The government should also set clear ambitious goals for energy efficiency improvements by sector and develop strategies to achieve them. Timelines for implementation should occur on a cost-prioritised basis

The Expert Review Team also recommended for Malaysia to continue to reduce subsidies on energy for better functioning of price mechanisms and encourage an economy-wide discussion on the introduction of energy taxes and carbon pricing. Among initiatives in Malaysia is establishing the Energy Performance Contracts (EPC) fund. These efforts will be more meaningful if Malaysia deepens its collaboration with international and regional energy organisations as well as to conduct a periodic peer review, every three to five years, to monitor and evaluate progress.

TRANSPORT SECTOR

In 2015, oil was still the most consumed fuel, particularly in the transport sector, accounting for 56% of total final energy consumption. The large use of energy by the sector was attributed to high usage of private cars for passenger transport, even in the densely built urban areas. The transport energy demand is growing at an annual average growth rate (AAGR) of 4.3% per year for the 2005-2015 period. This growth rate is higher than buildings energy consumption AAGR of 3.9% and industrial AAGR with -1%.

The Malaysian government is taking efforts to improve public transportation by introducing new rail lines such as Mass Rapid Transit (MRT) 1 and 2 (in Kuala Lumpur). The MRT 1 was completed in July 2017 while MRT 2 is expected to be fully operationalised by 2022. In addition to expanding public transport systems, further opportunities remain to capture additional energy efficiency potentials in the transport sector.

The Expert Review Team recommends for Malaysia to assign a central agency to play a more significant role in coordinating relevant transport policies related to energy efficiency as well as to appoint specific agencies to implement energy policy in the transport sector. This effort needs to be supported by a comprehensive and holistic regulatory framework. Policies that encourage low-carbon mobility such as electric vehicles should be introduced or expanded. Increase the number of electric vehicles by setting a measurable target and by increasing incentives for alternative fuel transportation systems. Besides that, the public need to be educated about how to use personal transport efficiently, for example, by using smart driving techniques. Better enforcement, such as loaded emissions testing for heavy-duty trucks is also another recommendation that was suggested by the Expert Review Team.

Data is fundamental in helping to formulate an effective energy efficiency policy. The Expert Review Team recommends for Malaysia to develop a central data collection and monitoring unit for the transport sector and to appoint and provide 'sufficient resources and power' to a specific body or institutions to regularly gather necessary data. It is essential for this body to collect the data according to Activity-Structure-Intensity-Fuel (ASIF) framework, open the database to the public, and update data on a regular basis.

Other recommendations are divided into a few subjects such as emphasis on travel demand management, deploy more energy efficient vehicles, introduce vehicle fuel economy labelling and standards, encourage the use of public transport and develop a better transport integration.

INDUSTRIAL SECTOR

Malaysia has embarked on other energy efficiency initiatives, such as energy efficiency labelling, and pushed for more regulations for industry, such as Efficient Management of Electrical Energy Regulations 2008, whereby installations that consumed or generated electrical energy for own consumption equal to or more than 3,000,000 kWh for six consecutive months are mandated to comply with the efficiency regulation. However, the efforts have produced a limited success to improve energy efficiency in the economy.

To improve overall energy efficiency in Malaysia, the Expert Review Team recommends Malaysia to develop a comprehensive energy efficiency strategy covering key sectors and sub-sectors and appoint a responsible entity to implement. The government needs to continue broad stakeholder consultation and coordination with relevant ministries and agencies, as well as to communicate strategy and emphasise the multiple benefits of energy efficiency. Identify champions who can most effectively communicate this strategy.

The Expert Review Team also recommended Malaysia to increase support for training of energy managers (e.g. ISO 50001 training) and encourage adoption of ISO 50001 certification (or similar accreditation and international best practices) and to broaden engagement with industry and commercial users to inform companies of the importance and benefits of implementing energy management measures. Consider using energy efficiency indicators to benchmark key industrial and commercial sectors.

The energy efficient pathway will not be complete without technology adoption. Therefore, Malaysia is recommended to consider the development of national technology roadmaps or action plans for the most significant industrial sub-sectors. Once the roadmap is ready, the government may consider introducing mandatory energy policies for industry and expand MEPS to industrial equipment covering thermal energy use based on global best practices.

To support the industry sector, Malaysia needs to implement policy incentives to encourage the adoption of energy efficiency and low carbon measures as well as to set up a dedicated energy efficiency fund and to develop and communicate detailed financial case studies. Introducing market-based mechanisms will also help the industry sector to shift to more efficient technology and practice.

RECOMMENDATIONS

1. OVERARCHING

1.1 BENEFITS OF ENERGY EFFICIENCY

Recommendation 1

Need to think about energy resources over longer-term horizons as domestic reserves decline or higher volumes are exported. Lower energy consumption can provide more significant opportunities for Malaysia to export more energy and extend the lifetime of existing energy reserves.

Recommendation 2

Consider energy efficiency as an energy resource with low generation costs that should be prioritised when designing long-term energy policy plans.

Recommendation 3

Expand awareness-raising activities for the public with targeted messaging for different generations of Malaysians. Learn from other economies to help Malaysia learn the most effective awareness program for its consumers.

1.2 INSTITUTIONAL FRAMEWORK

Recommendation 4

The government organisations in charge of energy policy require continued coordination in planning and implementing energy efficiency policies.

Recommendation 5

These organisations are recommended to prioritise cooperation with relevant stakeholder organisations such as MITI, MOT, and PLANMalaysia to improve energy efficiency in the thermal energy use in industry and transport sectors.

Recommendation 6

It would be worthwhile to consider designating one dedicated entity responsible for energy efficiency policy implementation.

1.3 SETTING TARGETS

Recommendation 7

The government should set clear ambitious goals for energy efficiency improvements by sector and develop strategies to achieve them. Timelines for implementation should occur on a cost-prioritised basis, (i.e. zero cost ones first, more expensive ones next).

Recommendation 8

When assigning targets, the government also needs to designate which organisation is responsible for collecting and evaluating the necessary data for the whole energy sector and then enable data collection through mandatory reporting.

1.4 ENERGY PRICING

Recommendation 9

Continue to review the gas pricing formula and its mechanism to ensure the effectiveness of subsidy removal programme as well as to ensure consumers interest is protected.

Recommendation 10

Encourage an economy-wide discussion on the introduction of energy taxes and carbon pricing, taking into account global developments on CO₂ emission reductions.

1.5 FUNDING

Recommendation 11

Consider the introduction of a dedicated fund to finance energy efficiency implementation. For example, a small charge could be added to fuel and electricity tariffs to fund implementation.

1.6 INTERNATIONAL COOPERATION

Recommendation 12

The government should deepen collaboration with international and regional energy organisations, including the UN, IEA, ISO, APEC, and ASEAN, to update energy efficiency policies, which can then be tailored to local conditions in Malaysia.

Recommendation 13

Conduct a periodic peer review, every five years, to monitor and evaluate progress.

2. TRANSPORT SECTOR

2.1 INSTITUTIONAL FRAMEWORK

Recommendation 14

Improve cohesive policy coordination among Ministries by providing a clear target on energy efficiency and emissions reductions.

Recommendation 15

Assign a central agency to play a more significant role in coordinating relevant transport policies related to energy efficiency (e.g. urban planning, vehicle fuel economy standards, public transport) by appointing specific agencies to implement energy policy in the transport sector.

Recommendation 16

Develop a masterplan for energy use in the transport sector that includes a detail plan to assess the investments necessary to improve the transport system

2.2 REGULATORY FRAMEWORK

Recommendation 17

Deploy regulatory framework that encourage energy efficiency and low-carbon transportation mode

Recommendation 18

Increase the number of electric vehicles by setting a measurable target and by increasing incentives for alternative fuel transportation systems.

Recommendation 19

Provide better electric vehicle infrastructure

Recommendation 20

Improve existing emissions test for commercial vehicles to include loaded emission testing.

2.3 DATA COLLECTION AND MONITORING

Recommendation 21

Develop a central data collection and monitoring unit for the energy sector. provide 'sufficient resources and power' to a specific body or institutions to regularly gather necessary data

Recommendation 22

Establish energy efficiency indicators to monitor the progress.

Recommendation 23

Collect the data according to the ASIF framework, open the database to the public, and update data on a regular basis.

2.4 TRAVEL DEMAND MANAGEMENT**Recommendation 24**

Reduce private vehicle dependency by increase the accessibility and quality of public transport services.

Recommendation 25

Educate the public about how to use personal transport efficiently.

Recommendation 26

Increase the cost of vehicle ownership by raising economy-wide vehicle excise taxes and car registration fees based on carbon emissions emitted and removal of vehicles that are not road worthy.

Recommendation 27

Consider implementing a congestion charge in overcrowded areas that are easily accessible by public transport systems and prioritise non-motorized transport such as walking and cycling in these areas.

Recommendation 28

Include transport demand management strategies to meet energy saving targets in the transport sector.

Recommendation 29

Improve the sustainable energy transport system – by increasing the public transport usage, expand the IITS across major cities, increase the use of alternative fuel and improve the vehicle fuel efficiency.

2.5 DEPLOYMENT OF ENERGY EFFICIENT VEHICLES**Recommendation 30**

Encourage people to use alternative energy for transport through public awareness building.

Recommendation 31

Require more frequent inspection of vehicles beyond a certain age or/and setting end of life for vehicles.

Recommendation 32

Foster deployment of efficient and electric two-wheelers especially in cities.

Recommendation 33

Improved the freight rail utilisation through better predictability.

2.6 VEHICLE FUEL ECONOMY LABELLING AND STANDARDS

Recommendation 34

Urge the automotive industry to label vehicles for energy efficiency.

2.7 MODAL SHIFTING AND PUBLIC TRANSPORT

Recommendation 35

Set a long-term policy direction and develop public transport system as the transport backbone in cities with adequate facilities for public transport and non-motorised users.

Recommendation 36

Continue to implement transit-orientated development and redeploy the income from land development around stations to develop new public transport lines.

Recommendation 37

Increase the deployment of energy efficiency technologies in the public transport system, for example: adoption of energy recuperation technology for the railway transport system.

2.8 TRANSPORT INTEGRATION

Recommendation 38

Prioritize and/or enhance connectivity to town centres from transportation hubs (airports, bus and train stations) and between transportation hubs of neighbouring cities.

Recommendation 39

Expand high-speed and light rail to the rest of Malaysia outside of the Kuala Lumpur area

Recommendation 40

Extend and enhance urban planning and transit-orientated-development to all urban centres around Malaysia.

Recommendation 41

Improve the ridership appeal for public transport, especially bus services.

3. THERMAL (INDUSTRY) SECTOR

3.1 INSTITUTIONAL FRAMEWORK

Recommendation 42

Develop a comprehensive energy efficiency strategy covering key (energy-intensive and strategic) sectors and sub-sectors and appoint a responsible entity to implement. Continue broad stakeholder consultation and coordination with relevant ministries and agencies. Provide 'sufficient resources and power' to a specific body or institutions to regularly gather necessary data

Recommendation 43

Communicate strategy and emphasise the multiple benefits of energy efficiency. Identify champions in crucial sectors who can most effectively communicate this strategy.

3.2 REGULATORY FRAMEWORK

Recommendation 44

Broaden energy efficiency regulations including expanding MEPS for industrial equipment (e.g. energy efficient motors, boilers, industrial processes). Where possible, align to regional or international standards (e.g. ISO60034 for motors). Policies should cover both new and existing installations.

3.3 DATA COLLECTION AND MONITORING

Recommendation 45

Appoint a responsible agency with research and analysis capabilities and empower it to collect the necessary data for all fuel and sector (can be combined with Recommendation 26 under the transport sector).

Recommendation 46

Expand the data collection to sub-sector (e.g. level II ISIC codes) level to develop energy efficiency indicators and benchmarks.

3.4 ENERGY MANAGEMENT SYSTEMS

Recommendation 47

Broaden engagement and training with industry and commercial users to inform companies of the importance and benefits of implementing energy management measures.

Recommendation 48

Increase support for training of energy managers (e.g. ISO 50001 training) and encourage adoption of ISO 50001 certification (or similar accreditation and international best practices).

Recommendation 49

Consider using energy efficiency indicators to benchmark key industrial sub-sectors.

3.5 FUTURE DEPLOYMENT OF ENERGY EFFICIENT TECHNOLOGIES

Recommendation 50

Consider the development of national technology roadmaps or action plans for industrial sub-sector.

Recommendation 51

Compliance to energy efficiency to be mandatory for all sectors.

Recommendation 52

Implement policies aimed at supporting increased recycling and materials efficiency.

Recommendation 53

Develop an action plan to support the broader adoption of cogeneration technologies.

3.6 LOW CARBON TECHNOLOGY INVESTMENT AND FINANCING

Recommendation 54

Implement policy incentives to encourage the adoption of energy efficiency and low carbon measures.

Recommendation 55

Develop and communicate detailed financial case studies.

Recommendation 56

Consider the introduction of market-based mechanisms.

PART I: BACKGROUND

INTRODUCTION

Malaysia is located in South-East Asia and lies entirely in the equatorial zone, with an average daily temperature varying from 21°C to 32°C. It has a total territory of approximately 330 323 square kilometres (km²), covering eleven states and two federal territories in Peninsular Malaysia as well as two states and one federal territory on the island of Borneo. In the 4th quarter of 2017, Malaysia's population stood at 32.3 million, an increase of 1.3% compared to the 4th quarter of 2016 (EPU, 2018).

Malaysia's gross domestic product (GDP) reached USD 752 billion (2010 USD purchasing power parity [PPP]) in 2015, an increase of 5% from USD 717 billion in 2014. The rise in GDP contributed to a 3.3% improvement in GDP per capita from USD 23 706 in 2014 to USD 24 483 in 2015. The largest contributions to GDP were from services (54%), manufacturing (23%), agriculture (9.0%), mining and quarrying (9.1%), and construction (4.4%) (EPU, 2018). In 2015, Malaysia's primary export products were electrical and electronic products (approximately 36% of total exports), chemicals and chemical products (7.1%) petroleum products (7%) and liquefied natural gas (LNG) (6%) (MATRADE, 2017).

Traditionally, Malaysia has been an energy exporter of crude oil and natural gas (by both pipeline and LNG). The economy registered total energy exports of 46 035 ktoe in 2015, an increase of 11% from 2014 (41 414 ktoe). Most of the growth in energy exports was because of a sudden rise of crude oil exports from 2 051 ktoe in 2014 to 7 696 ktoe in 2015, a level that had not been reached since 2007. For the 2014-2015 period, total energy imports decreased by 0.4% from 38 080 ktoe to 37 927 ktoe. Most of the decrease occurred in petroleum products, which saw imports decline from 16 009 ktoe in 2014 to 14 218 ktoe in 2017 (EC, 2017).

When compared with other large economies in the Asia-Pacific Economic Cooperation (APEC) region, Malaysia's energy resources can be considered moderate when compared to other big economies in APEC. Data published by the Energy Commission of Malaysia in 2017 shows that the East Malaysian states hold nearly two-thirds of Malaysia's energy reserves, while the rest are located in Peninsular Malaysia. The economy's oil reserves (including condensate) were 5.9 billion barrels, 37% of which is found in Peninsular Malaysia (the Malay basin). The natural gas reserves of the economy are estimated at approximately 2.8 trillion cubic metres or 100 trillion cubic feet (Tcf) in 2015. More than half of the reserves are found in the Sarawak Basin. Coal reserves, assessed at 1.9 billion tonnes, are located mostly in Sarawak and Sabah (EC, 2017).

Malaysia conducted its first Peer Review on Energy Efficiency (PREE) by a team of nine experts who visited Malaysia from 29 November to 3 December 2010. Based on the visit, presentations, and discussions, the Review Team listed 41 recommendations that broadly covered a range of energy efficiency issues across all sectors of the economy (APEREC, 2011).

ENERGY DEMAND AND SUPPLY

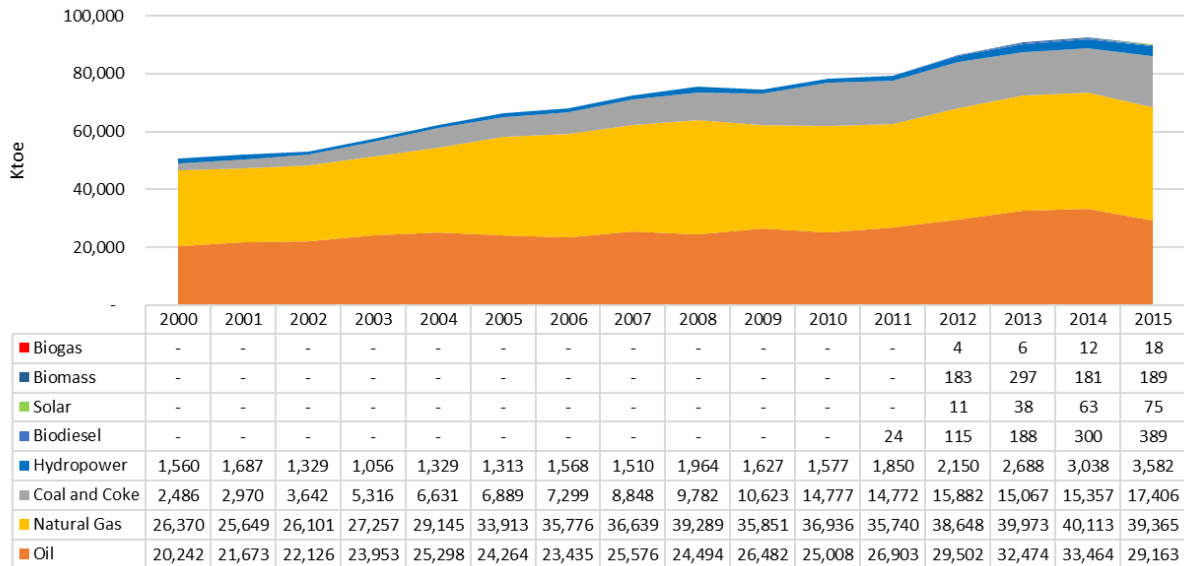
PRIMARY ENERGY SUPPLY

Malaysia's total primary energy supply was 90 189 kilotonnes of oil equivalent (ktoe) in 2015, a decrease of 2.5% from 2014 (92 487 ktoe). Gas contributed the most significant share at approximately 44% (39 365 ktoe), followed by oil with 32% share (29 163 ktoe) and coal with a 19% share (17 406 ktoe). Other resources include hydro, which in 2015 only accounted for 5% (4 253 ktoe) of the total primary energy supply (EC, 2017).

OIL SUPPLY

Malaysia's oil reserves are the fourth-largest in the Asia-Pacific region and are mostly located in offshore fields. Malaysia's continental shelf is divided into three producing basins; the offshore Malay basin in Peninsular Malaysia in the west, and the Sarawak and Sabah basins in the east. Malaysia's average daily oil production was 662 thousand barrels per day in 2015, approximately 85% of which was crude oil, while the rest was condensate. In 2014, Peninsular Malaysia yielded 40% of total oil production, followed by Sabah with 37% and Sarawak with approximately 23% (EC, 2017).

Figure 1: Total primary energy supply, 2000-2015



Source: (EC, 2017)

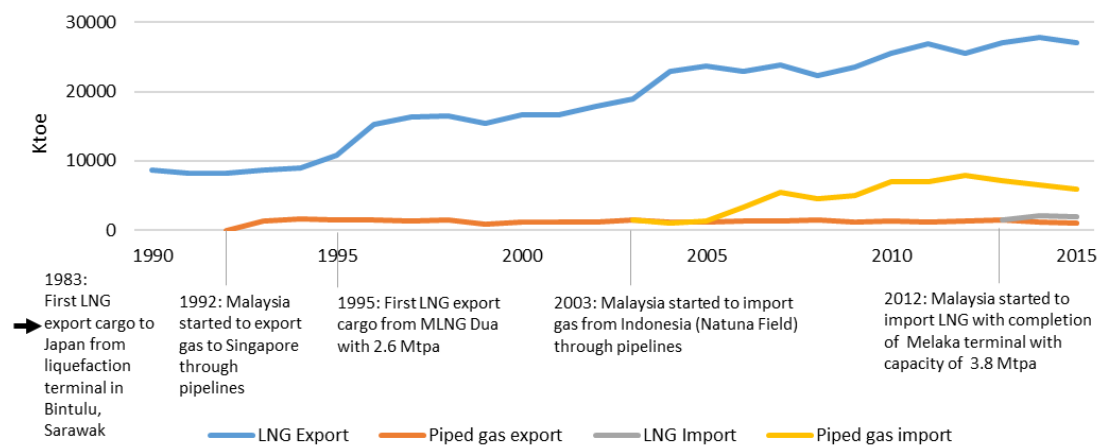
Malaysia has five oil refineries with a combined capacity of 566 thousand barrels per day (kbb/d) (including condensate splitter capacity). PETRONAS has three refinery facilities that provide more than 50% of total daily refinery production. Petrol and diesel accounted for 78% of total domestic sales of petroleum products in 2015.

NATURAL GAS SUPPLY

Most of the gas reserves in Malaysia are offshore in Peninsular Malaysia, and in the eastern areas of Sarawak and Sabah. Most of the gas reserves are non-associated (86%), while the remaining reserves are associated with oil basins (14%). Sarawak hosts slightly more than half of the total reserves, followed by Peninsular Malaysia with 32% and Sabah with 15%. In 2015, the average daily natural gas production was 6 472 million standard cubic feet per day (MMscf/D), a decrease of 1.8% from the 2014 level of 6 593 MMscf/D. Most of the production came from Sarawak (64%), while Peninsular Malaysia produced 30% of total production and 6% was produced in Sabah. Besides local production, Malaysia sourced its gas requirements via pipelines from the Malaysia-Thailand Joint Development Area (MT-JDA), imports from Indonesia and LNG imports starting from 2012.

Although Malaysia is one of the world's largest LNG exporters, a geographical mismatch between where the gas is produced (Sabah and Sarawak) and the regions of highest consumption (Peninsular Malaysia) prompted Malaysia to build a regasification terminal (RGT) to facilitate the importation of LNG. In 2015, Malaysia imported approximately 1 873 ktoe of LNG, a decrease of 7.2% from 2 019 ktoe in 2014.

Figure 2: Natural gas import and export in Malaysia, 1990-2015



Source: (EC, 2017) and APERC analysis.

COAL SUPPLY

Malaysia's coal resources mostly consist of bituminous and sub-bituminous coal. Estimated reserves are approximately 1 938 Mt, all of which is found in Sabah and Sarawak. Nearly two-thirds of these reserves have been categorised as inferred. Even with substantial coal resources, domestic coal production has not been limited because most of the coal deposits are far inland, leading to high extraction costs. Some areas with coal resources have also been protected, such as the Maliau Basin in Sabah, thereby prohibiting coal-mining activities. Only Sarawak currently allows coal-mining

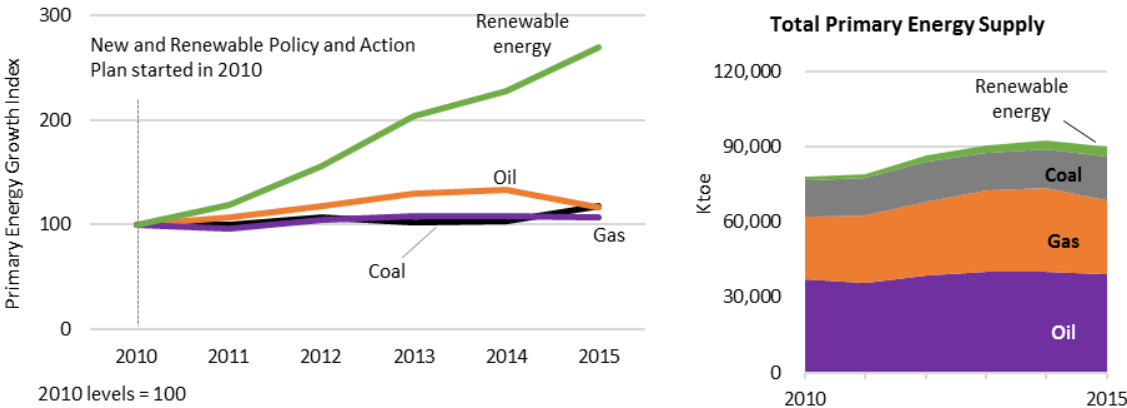
operations, with Mukah (the largest producing coal basin) with 1.8 million metric tonnes of production in 2015, Kapit with 0.7 million metric tonnes and Sri Aman with 25 842 metric tonnes (EC, 2017).

According to IEA Energy Statistics 2017, Malaysia was ranked the eighth-largest coal importer in the world in 2015 with coal consumption reaching 29 Mt. This reflects a rapid expansion of coal generation capacity, especially during 2000–15 when coal consumption in the power sector increased from 1.5 million tonnes of oil equivalent (Mtoe) to nearly 16 Mtoe. Coal generation capacity was expanded to meet increasing electricity consumption and to reduce dependence on natural gas, which previously dominated generation with a share as high as 70% in the 1990s (EC, 2017).

RENEWABLE ENERGY SUPPLY

Malaysia highlighted the importance of renewable energy in the Tenth Malaysia Plan period (2010–15), where the focus was given to implementing GHG mitigation measures. Among the actions undertaken were the introduction of the RE Act in 2011 and the implementation of the Feed-in Tariff (FiT) mechanism. SEDA Malaysia, a statutory body established by the government to promote renewable energy and energy demand management, set a target of 415.5 MW of additional renewable capacity by 2015 (EPU, 2015). As of 1st February 2018, total installed capacity (excluding hydropower with capacity above 30 MW and only covering Peninsular Malaysia and Sabah) achieving commercial operation was 532.3 MW, of which biomass was 87.9 MW, biogas 56.2 MW, small hydro 30.3 MW and solar PV 357.9 MW.

Figure 3: Primary Energy Growth Index and Total Primary Energy Supply, 2010-2015



Source: (EC, 2017) and APERC analysis

In the past six years, the growth rate of renewables has shown tremendous improvement, tripling from 606 Ktoe in 2010 to 1 816 Ktoe in 2015. This massive increase is partially a result of the New and Renewable Energy Policy and Action Plan introduced by the government in 2009, where the FiT for renewable energy was introduced (Figure 3). In 2015, the share of modern renewables to final energy

consumption increased from 2.5% in 2014 to 2.6%. Based on year-on-year growth, current renewables registered a 5.7% increase in final energy use.

ELECTRICITY SUPPLY

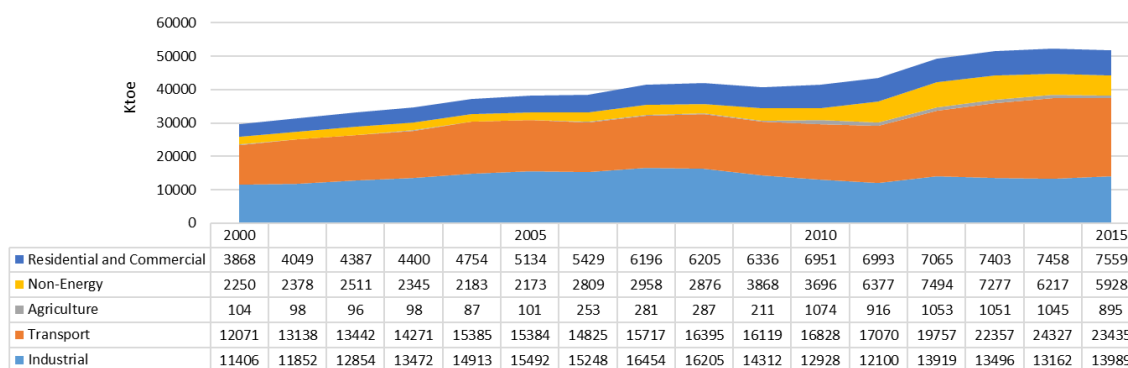
There are three major electricity grids in Malaysia. The main network in Peninsular Malaysia and the Sabah grid are both regulated by the federal government and the Sarawak grid is under the jurisdiction of state government. The main network is connected to Thailand's network to the north (with the capacity for power transfer of 380 MW) and Singapore's main grid to the south (with the capacity for power transfer of 450 MW). The Sarawak grid is connected to the Kalimantan grid in Indonesia. The power transfer reached 70 MW by May 2016 (The STAR, 2016).

Malaysia's total licensed power generation capacity in 2015 was recorded at 30 439 MW, an increase of 1.5% from the 2014 level of 29 974 MW. Such an increase in installed capacity was attributed to the additional 700 MW of capacity from the hydro project in Sarawak and additional 1 000 MW of coal power plant capacity in Peninsular Malaysia. Approximately 60% of the total licensed capacity was owned by the independent power producers (IPPs) and the rest by government-linked utilities, self-generation facilities, and co-generation facilities (EC, 2017).

FINAL ENERGY CONSUMPTION

In 2015, Malaysia's total final energy consumption reached 51 806 ktoe, with 45% demanded by the transport sector, followed by the industrial sector with 27%.

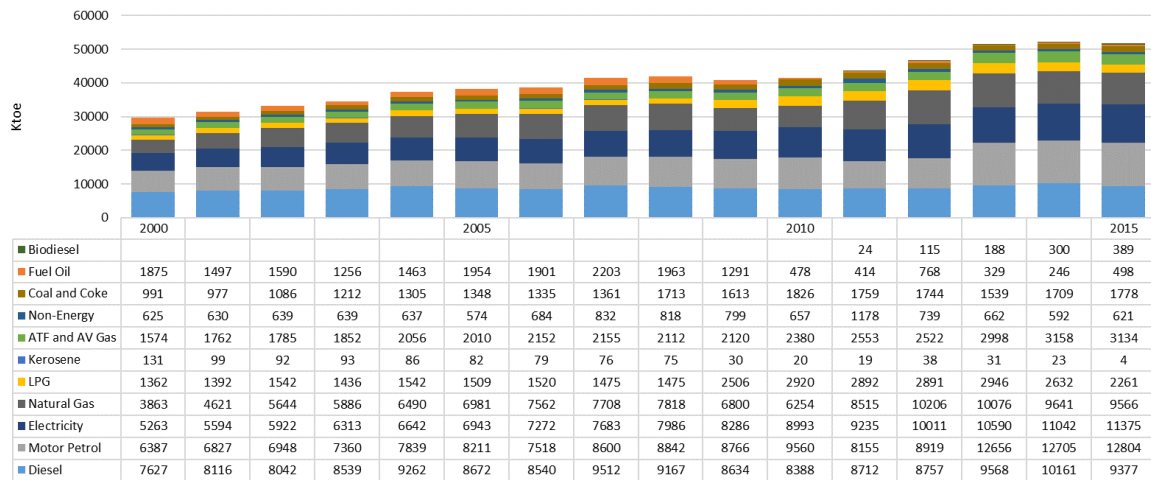
Figure 4: Final Energy Consumption by Sector, 2000-2015



Source: (EC, 2017)

In 2015, oil was still the most consumed fuel, particularly in the transport sector, accounting for 54% of total final energy consumption, followed by electricity with a 22% share, gas with 18% and coal with 6%. Oil consumption decreased by 3% to 28 078 ktoe in 2015 from 28 925 ktoe in 2014.

Figure 5: Final Energy Consumption by Fuel, 2000-2015



Source: (EC, 2017)

ENERGY POLICY OVERVIEW

The Malaysian government has introduced many policies to ensure reliable, sustainable and affordable energy supply for all people. Since 1979, more than half-a-dozen policies have been put in place to achieve the aforementioned energy objectives.

NATIONAL ENERGY POLICY

Malaysia's National Energy Policy, which was first formulated in 1979, serves as the overall framework for the development of the energy sector. It consists of the following three 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 the diversification of energy supply from domestic and international sources.
- **The utilisation objective:** To promote the efficient utilisation of energy and 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.

This policy has been instrumental in the development of Malaysia's energy sector. Subsequent policies have been designed to support these objectives and their implementation.

NATIONAL DEPLETION POLICY

In 1980, the National Depletion Policy was enacted to safeguard and preserve Malaysia's energy resources, particularly its oil and gas resources. Under this policy, total annual production of crude oil should not exceed 3% of 'oil initially in place'. In effect, this limits the production of crude oil to 650 thousand barrels per day (UNPAN, 1999). The policy also extends to the production of natural gas, imposing a limit of 2000 million standard cubic feet per day (MMscf/D) in Peninsular Malaysia.

FUEL DIVERSIFICATION POLICY

Malaysia introduced the Four-Fuel Diversification Policy to expand the fuel mix for power generation. Initially, the focus of the policy was to reduce the economy's dependence on oil as the dominant energy source for power generation. However, the scope of this policy was further expanded in 2001 with the implementation of the Five-Fuel Diversification Policy, which incorporated renewable energy (e.g. biomass, solar and mini-hydro) as the fifth fuel.

In support of the Five-Fuel Diversification Policy, the National Biofuel Policy was launched in 2006 and the National Renewable Energy Policy and Action Plan (NREPAP) was introduced in 2010 as part of the policy framework to advance the development of indigenous renewable energy and expand its contribution to the power generation mix. The NREPAP provides long-term goals and a holistic approach to the sustainable development of renewable energy power capacity, which is expected to increase to 2 080 MW (11 GWh) by 2020 contributing 7.8% to the total power generation mix (EPU, 2015).

NATIONAL GREEN TECHNOLOGY POLICY

The National Green Technology Policy (NGTP) was launched in 2009 as an initial step to encourage the sustainable development of the economy. The NGTP has identified green technology as the main driver to accelerate the national economy and promote sustainable development. Spearheaded by the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), Malaysia has introduced numerous programs and incentives to advocate the use of green technology in key economic sectors. NGTP aims to facilitate the growth of the green technology industry and enhance its contribution to national economy, to increase national capability and capacity for innovation and improve Malaysia's competitiveness in the global market, as well as to conserve the environment and ensure sustainable development for the future generation. The policy is built on the following four pillars:

- Energy: Seek energy independence and promote efficient utilisation;
- Environment: Conserve and minimise the impact on the environment;
- Economy: Enhance national economic development through the use of technology; and
- Society: Improve the quality of life for all.

Under the NGTP, various specific initiatives have been created by the government, including:

Green Technology Financing Scheme

The Green Technology Financing Scheme (GTFS) was established in 2010 to accelerate the expansion of the green technology industry with an allocated government fund of MYR 3.5 billion (USD 813 million) until 2017. The objective of establishing the fund is to provide a special financing scheme for soft loans to companies that produce and utilise green technology. As of 31 December 2017, 356 companies have received the GTFS Certification, with financing amounting to MYR 3.64 billion (USD 845 million).

MyHIJAU Labelling Program

The introduction of the MyHIJAU Labelling Program is intended to ensure the availability of green products and services by international standards and regulations. Currently, three main agencies in Malaysia have been recognised as providing environmentally friendly certification schemes:

- SIRIM Eco-Labeling by SIRIM Berhad for certifying the environmental attributes of green products and services;
- Energy Efficiency Labelling by the Energy Commission for energy-efficiency labelling of domestic electrical appliances; and
- Water-Efficient Products Labelling by the National Water Services Commission.

Green Building Index

The Green Building Index (GBI) has been developed as a rating tool to promote green technology in the buildings sector. It also intends to raise awareness among developers and building owners about the design and construction of green and sustainable buildings. A GBI certificate is granted to developers and building owners who have satisfied the standards in six areas: energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation.

Government Green Procurement

In order to do so, Malaysia introduced the Government Green Procurement (GGP). The GGP integrates environmental considerations into the public sector procurement process to protect the natural environment, conserve resources and lessen the harmful effects of human activities. By 2020, the GGP will be implemented in all government offices and will ensure that 20% of the public sector's purchases of products and services are green-labelled.

Green Technology Master Plan

To pursue green growth further, as stated in the Eleventh Malaysia Plan, KeTTHA launched the Green Technology Master Plan (GTMP) in 2017 to push for green growth as one of six game-changers altering the trajectory of the economy's growth. The GTMP creates a framework, which facilitates the

mainstreaming of green technology into planned developments while encompassing the four pillars set in the NGTP (KeTTHA, 2017). Under this master plan, six target sectors have been identified: energy, manufacturing, transport, building, waste, and water. Derived from NGTP, GTMP listed five major strategic thrusts necessary to cultivate "green culture" in Malaysia (Table 1).

Table 1: GTMP Strategic Thrust

Strategic Thrust	Key Areas	Outcomes
Promotion and awareness	<ul style="list-style-type: none"> Tailored communication strategy Industry and business promotion via International Greentech & Eco Products Exhibition & other platforms. Collaboration with primary & secondary educational institutions 	<ul style="list-style-type: none"> Improved awareness & receptiveness towards green technology Increase in business transaction, entrepreneurship & global value chain integration Improved knowledge on GT among younger generations to drive behavioural change
Market enablers	<ul style="list-style-type: none"> Government Green Procurement (GGP) Green incentives Innovative financing Green cities International collaborations 	<ul style="list-style-type: none"> Strengthened industry readiness in the production of green products & services Improved financial feasibility of green projects & affordability of green products and services Improved infrastructure readiness for green adoption Creation of export opportunities through regional collaborations
Human capital development	<ul style="list-style-type: none"> Capacity building in the public sector Capacity building in the private sector Collaboration with higher education institutions 	<ul style="list-style-type: none"> Improved knowledge of Government officials Increase in recognition of skills and competencies Improved workforce readiness of fresh graduates
Research & development & commercial (R&D&C)	<ul style="list-style-type: none"> R&D&C funding Public-private partnership 	<ul style="list-style-type: none"> Demand-driven, market and result oriented R&D&C projects Stronger collaboration among Government bodies & research institutes in information sharing to enable efficient strategic planning and resource deployment
Institutional framework	<ul style="list-style-type: none"> Governance (policy leadership) Policy planning Policy implementation 	<ul style="list-style-type: none"> Strengthened governance to facilitate cross-sectoral cooperation among Government bodies to improve the ease of doing business

Source: (KeTTHA, 2017)

NATIONAL RENEWABLE ENERGY POLICY AND ACTION PLAN

Since 2001, Malaysia has strengthened efforts towards encouraging renewable energy development, adopting the principle of utilising market forces to deliver intended outcomes for electricity generation. The result of the past eight years provides valuable lessons in identifying issues arising from such an approach, with the key lesson being that a 'business-as-usual' approach is not sustainable, appropriate nor productive.

Renewable energy policy must be recognised as a convergence of energy, industrial and environmental policies. The reasons for the introduction of a new convergent and forward-looking renewable energy policy are:

- Addressing the renewable energy market failure;
- Provision of long-term sustainability by avoiding stop-start strategies, having sufficient outcomes and securing the commitment of all stakeholders;
- Provision of a new growth industry in Malaysia;
- Recognising that the environment is an economic growth contributor, which can be leveraged to spur innovation;
- Effectively diffuse renewable energy technology, thereby improving on human capital and utilisation; and
- Avoidance of the incoherence of existing renewable energy policy and the sending of mixed signals that affect business decisions.

In original NREPAP that was release in 2010, the government targeted for RE capacity to reach 10% of total generation capacity in 2020 and 13% by 2030. Since then, the government has revised the target upwards to 20% of total installed capacity by 2025.

MALAYSIA PLAN – A FIVE-YEAR DEVELOPMENT PLAN

The Malaysia Plan is a mid-term (5 years) development plan that supports the long-term (20 years) plan. The First Malaysia Plan began in 1966 and the Eleventh Malaysia Plan took effect in 2016.

In May 2015, the government launched the Eleventh Malaysia Plan 2016–2020 as the final stage in the journey towards realising Vision 2020, a long-term development plan launched in 1991 that envisions Malaysia as a fully developed economy across all dimensions by 2020. Six strategies are outlined in the Eleventh Malaysia Plan. These include pursuing green growth for sustainability and resilience and strengthening infrastructure to support economic expansion, both of which have implications for energy initiatives (EPU, 2015). In the past, the focus for economic growth was on quantity over quality. The Eleventh Malaysia Plan places greater emphasis on quality growth, taking into consideration the economy's natural resources and the impact of their use on the environment.

The Eleventh Malaysia Plan also stressed the effort needed to address the challenges of climate change by developing a roadmap for resilient economic growth, which covers adaptation and mitigation approaches. In order to reduce the economy's carbon footprint, development work will focus on creating green markets, increasing the share of renewables in the energy mix, enhancing demand-side management (DSM), encouraging low-carbon mobility and managing waste holistically (EPU, 2015).

CLIMATE CHANGE POLICY

Malaysia is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and ratified the treaty on 17 July 1994. Subsequently, the National Climate Committee was established in 1995, which is composed of various government agencies and stakeholders from business and civil society groups. Its purpose is to guide responses to climate change mitigation and adaptation.

At the 2015 United Nations Climate Change Conference in Paris, Malaysia's pledged to reduce the greenhouse gas (GHG) emissions intensity of the economy's GDP by 45% by 2030 relative to the emissions intensity of GDP in 2005. The 45% consists of 35% on an unconditional basis and a further 10% conditional upon receipt of climate finance, technology transfer and capacity building from developed economies. The sectors that are covered by this emission intensity reduction target are energy; industrial processes; waste; agriculture; and land use, land use change and forestry (LULUCF) (NRE, 2015).

ENERGY EFFICIENCY POLICY

At this time, Malaysia's only energy efficiency policy lies in the National Energy Policy under the Utilisation Objective: To promote the efficient utilisation of energy and discourage wasteful and non-productive patterns of energy consumption. Recently, the Government has approved the implementation of the National Energy Efficiency Action Plan (NEEAP), 2016-2025 which focusing more on electricity efficiency.

In order to create a holistic policy on energy efficiency, the DSM Preliminary Study was conducted and completed in July 2017 with the objective to formulate policy and action plan covering the entire spectrum of the energy sector including electrical, thermal and usage in the transport sector.

GOVERNANCE STRUCTURE

The key ministries and government agencies responsible for the Malaysian energy sector are as follows:

- The Economy Planning Unit, Ministry of Economic Affairs sets the general direction and broad strategies for Malaysia's energy policies and development of the oil and gas industry.
- MESTECC oversees programs and projects in strengthening energy resources to ensure electricity supply is of quality, is reliable and is cost-effective. It also drives the development of renewable energy and the promotion of energy efficiency. Part of the ministry's role is also to assist the EPU in the formulation of energy policy.
- The Energy Commission (EC) is a statutory body established in 2001 to serve as a regulator for the electricity and piped gas supply industries in Peninsular Malaysia and Sabah. The commission's primary functions are to provide technical and performance regulations for the power and piped gas supply industries; act as the safety regulator; and protect consumers by ensuring the quality of services, the supply of electricity and piped gas, and the maintenance of reasonable prices.
- The Sustainable Energy Development Authority (SEDA), whose key role is to administer and manage the implementation of the feed-in tariff mechanism.
- The Malaysian Green Technology Corporation (GreenTech Malaysia) is an implementing agency to promote green technology in Malaysia.

Besides the aforementioned main agencies, other authorities involved in energy development in Malaysia include:

- The Ministry of Water, Land and Natural Resources, which oversees the overall Malaysia environmental targets as well as natural resources other oil and gas.
- Ministry of Plantation Industries and Commodities (currently known as Ministry of Prime Industries), which overlooks biofuels development in Malaysia; and
- The Ministry of International Trade and Industry, which promotes investment in Malaysia as well as helping the government set gas prices for industrial users.

Petroleum Nasional Berhad (PETRONAS) is a national oil company (NOC) that was created under the Petroleum Development Act 1974 (PDA74). It is vested with exclusive rights for exploration and production of petroleum whether onshore or offshore in Malaysia. It also has responsibility for the planning, investment, and regulation of the upstream sector. Any foreign or private company desiring to explore and produce petroleum in Malaysia has to enter into a Production Sharing Contracts (PSC) with PETRONAS.

Malaysia's power industry is dominated by three vertically integrated utilities, namely Tenaga Nasional Berhad (TNB) serving Peninsular Malaysia, Sabah Electricity Sendirian Berhad (SESB) in Sabah state and Sarawak Energy Berhad (SEB) in Sarawak state. These utilities undertake electricity generation,

transmission, and distribution in their respective areas. Various independent power producers (IPPs), dedicated power producers and co-generators complement the three utilities.

EXISTING REGULATORY FRAMEWORK

Malaysia established a series of laws and regulation to regulate energy market and to encourage the development of clean energy. A range of regulations influences energy use and energy efficiency, as outlined in Table 2.

Table 2: Regulations in effect in Malaysia

Acts /Regulation	Description
Petroleum Development Act (1974)	An Act to provide for exploration and exploitation of petroleum whether onshore or offshore by a Corporation (PETRONAS) in which will be vested the entire ownership in and the exclusive rights, powers, liberties and privileges in respect of the said petroleum, and to control the carrying on of downstream activities and development relating to petroleum and its products. http://www.agc.gov.my/agcportal/uploads/files/Publications/LOM/EN/Act%20144%20-%20Petroleum%20Development%20Act%201974.pdf
Electricity Supply Act 1990 [Act 447]	There are 62 Sections in current Electricity Supply Act 1990 [Act 447] which mainly touches in 13 main parts including energy efficiency. http://www.st.gov.my/images/article/polisi/2016/01-Act_447_-_Electricity_Supply_Act_1990.pdf
Energy Commission Act 2001 (Amendment 2009) [Act 610]	Energy Commission or Suruhanjaya Tenaga was established in the year 2001 under the Energy Commission Act 2001 to replace the Electricity and Gas Supply Department. Base to the Energy Commission Act 2001, the provisions comprises: <ul style="list-style-type: none"> ➤ The establishment of the Commission which includes the common seal, membership, tenure, remuneration, revocation of appointment and statutory declaration ➤ Functions and powers of Commission which includes the direction by Minister ➤ Officers of the Commission which includes appointments of the CEO & Officers ➤ Finance part which includes the way of the fund to be used and disbursed including accounts ➤ The general part which includes the prosecution and protection as authorities
Renewable Energy Act 2011	An Act to provide for the establishment and implementation of a special tariff system to catalyse the generation of renewable energy and to provide for related matters.
Sustainable Energy Development Authority (SEDA) Act 2011	An Act to provide for the establishment of the Sustainable Energy Development Authority of Malaysia and to provide for its functions and powers and related matters.

Licensee Supply Regulation 1990	This Regulation was made to manage the licensee. It is also a way to determine the standards and daily operations procedure that the licensee needs to embark.
Electricity Supply Regulation 1994	This regulation was made in exercise of the powers conferred by section 53 of the Electricity Supply Act 1990 [Act 447]. There are 123 regulations which aim to regulate the electricity industry that comprises installation, operation, registration, competent person and maintenance.
Electricity Supply (Compounding Of Offences) Regulations 2001	<p>The regulations was made for offences that can be compounded and details of the processes</p> <ul style="list-style-type: none"> • All offences specified in subsection 43(1) of the Act may be compounded. • An offer to compound shall be made in Form 1 of the Schedule. • A person who accepts an offer to compound shall furnish payment for the compound by using Form 2 of the Schedule.
Efficient Management Of Electrical Energy Regulations 2008	<p>The regulations were made to ensure any big electricity user as below:</p> <ul style="list-style-type: none"> • Any installation which receives electrical energy from a licensee or supply authority with a total electricity consumption equal to or exceeding 3,000,000 kWh as measured at one metering point or more over any period of six consecutive months; or • Any installation used, worked or operated by a private installation licensee with a total net electrical energy generation equal to or exceeding 3,000,000 kWh over any period of six consecutive months; • For existing installations, electrical energy calculated over six months from the effective date. • For new installations, electrical energy is calculated over six months from the date the electrical energy supply is connected to the installation by the licensee or supply authority. <p>To inform Suruhanjaya Tenaga on the details of the usage. Upon receiving the details, The Commission may at any time by written notice, direct</p> <ul style="list-style-type: none"> ▪ to appoint or designate a registered electrical energy manager ; ▪ to submit a written confirmation of such appointment or designation (name, particulars, date of expiry of registration); ▪ to submit information; ▪ to submit reports.
Electricity (Amendment) Regulations 2013 P.U.(A)151	<p>The regulations were made to ensure energy efficiency standards and labelling to be enforced in Malaysia, as below:</p> <ul style="list-style-type: none"> • <i>EE standards for appliances and for industry standards:</i> For the purpose of efficient use of electricity, any person who manufactures, imports, sells or offers for sale or lease any equipment, shall ensure that such equipment meets the energy performance testing standards, the minimum energy performance standards and the efficiency ratings. • <i>EE labeling:</i> Any equipment that meets all the requirements of efficient use of electricity under this regulation shall be affixed with an efficiency rating label.

	A set of the technical specification which defines the parameters of electricity generating plant and grid system network that both have to meet to ensure proper functioning of the electrical grid.
Malaysia Grid Code	The Grid Code highlights in details the roles and responsibilities of parties involved in managing or using the system. The Energy Commission Malaysia as the regulatory body of the energy industry; will chair the Grid Code Committee, which is a committee represented by members from the industry. It has been enforced since 1 st January 2011 https://www.tnb.com.my/assets/files/the_malaysian_grid_code.pdf
Transmission System Reliability Standards	TSRS are the standards that define distinct processes that are paramount in ensuring reliability in planning and development of electric power system, and in ensuring its secure and robust operation. This document is the primary reference standards within the MGC.
Malaysia Distribution Code	<p><u>Objectives of the Code</u></p> <ul style="list-style-type: none"> ▪ Specify the normal technical parameters and requirements for design and operation. ▪ Specify the technical requirements for connection to the Distribution System. ▪ Specify the data exchange requirements between Users and Distributors. ▪ Comply with relevant provisions of the Grid Code. <p><u>The scope of the Code</u></p> <ul style="list-style-type: none"> ▪ Applies to distribution license holder and Users. ▪ Contain rules and technical procedures ▪ Designed to <ul style="list-style-type: none"> i. Permit the development, operation and maintenance. ii. Facilitate competition. iii. Ensure nondiscrimination. <p>https://www.tnb.com.my/assets/files/the_malaysian_grid_code.pdf</p>

Source: MESTECC, 2017

ENERGY EFFICIENCY IN MALAYSIA

THE NATIONAL ENERGY EFFICIENCY ACTION PLAN (NEEAP)

The National Energy Efficiency Action Plan (NEEAP) prescribes a path towards improving energy efficiency by pursuing the implementation of measures that are considered low-hanging fruit. The 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. Previous barriers include:

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

The NEEAP presents instruments for the successful implementation of energy efficiency in Malaysia for the period of 10 years, covering 10 specific energy efficiency programmes covering 3 sectors.

THE PLAN OBJECTIVES AND ACTIVITIES

The NEEAP presents a strategy for a well-coordinated and cost-effective implementation of energy efficiency in all segments of the society, which will lead to reduced energy consumption and increase economic savings for consumers and the economy.

In meeting the policy direction, the National Energy Efficiency Action Plan will be supported by 4 main thrusts that will drive the nation towards a sustainable energy path:

Thrust 1: Implementation of Energy Efficiency Action Plan;

Thrust 2: Strengthen Institutional Framework, capacity development and training for Implementation of Energy Efficiency initiatives

Thrust 3: Establishment of Sustainable Funding Mechanisms to Implement Energy Efficiency Initiatives;

Thrust 4: Promotion of Private Sector Investment in Energy Efficiency Initiatives

The above 4 thrusts will help eliminate the existing barriers and ensure that energy consumers in the targeted sectors will be encouraged to adopt and adapt energy efficiency as a way of life and reap the benefits that energy efficiency could provide. The plan can be grouped into 5 key initiatives related to the design of the programmes. i.e:-

Initiative 1: Promotion of 5-Star Rated Appliances;

Initiative 2: Minimum Energy Performance Standards (MEPS);

Initiative 3: Energy Audits and Energy Management in Buildings and Industries;

Initiative 4: Promotion of co-generation; and

Initiative 5: Energy Efficient Building Design.

TARGETS AND IMPACT OF THE PLAN

The target of NEEAP is to save electricity and reduce electricity demand growth. The effective and efficient implementation of the NEEAP supported with sufficient resources will be able to save 52,233 GWh of electricity over the plan period against a business-as-usual (BAU) scenario. The corresponding electricity demand growth reduction at the end of the plan is 8%. The electricity savings will eventually lead to a reduction in peak demand and the need to build new power plants in future.

In other words, NEEAP's achievement will improve the electricity load profile by better management of peaking load in the power system. A straight-forward calculation of peak demand reduction from

the plan implementation will result in a total capacity saving of 2,526 MW. The fuel savings derived from the plan will also lead to less environmental impact and reduction in greenhouse gas emissions. The total reduction of greenhouse gas emission over the plan is projected to be 38 million tonnes CO₂ equivalent. A total reduction of 88 million tonnes of CO₂ equivalent will be achieved over the lifetime of the energy-efficient technologies adopted and adapted from the plan implementation.

ENERGY INTENSITY ANALYSIS

Malaysia's primary energy intensity decreased from 110 toe/million USD in 2014 to 106 toe/million USD in 2015, representing a 2.9% reduction. The reduction in 2015 marked the fifth consecutive year of primary energy intensity reduction for Malaysia. Final energy consumption intensity also decreased at 4.3% from 68 toe/million USD in 2014 to 65 toe/million USD in 2015. By excluding the non-energy sector, the final energy consumption intensity reduction would stand at 3.9% (EGEDA, 2018). However, based on Malaysia's National Energy Balance 2015, final energy consumption in 2015 reached 51 806 ktoe, a decrease of 0.8% from 2014 (52 210 ktoe) (EC, 2017).

DEMAND SIDE MANAGEMENT (DSM) PRELIMINARY STUDY

A lack of holistic and long-term policy for demand-side management (DSM) has been identified as one of the main barriers in implementing energy efficiency initiatives in Malaysia, even though it is considered an essential element in Malaysia's energy plan and policy. Energy efficiency initiatives are set to receive renewed attention under the Eleventh Malaysia Plan through a reinvigoration of DSM. It is intended that this will be achieved by formulating a comprehensive DSM master plan. The EPU initiated a study on DSM covering the whole energy sector, which was completed in July 2017.

OTHER INITIATIVES AND TARGETS IN ENERGY EFFICIENCY

ENERGY EFFICIENT VEHICLES

The Malaysian government announced the third National Automotive Policy (NAP) in 2014. The NAP 2014 aims to turn Malaysia into an energy efficient vehicle (EEV) hub in ASEAN. The plan encompasses strategies and measures to strengthen the entire value chain of the automotive industry and will also lead to environment conservation, high-income job creation, transfer of technology and new economic opportunities for local companies. The Malaysia Automotive Institute (MAI), which was established in 2010, has been tasked to work with the government in shaping the industrial competitiveness in the automotive sector. Table 3 lists the EEV definition and classification set by MAI. Based on the current Malaysian car market, EEV accounted for around 33% of the total vehicle sales in 2015, growing to reach 40% in 2016 and 85% in 2020.

Table 3: Energy efficiency vehicle definition and classification

Vehicle segment	Vehicle Type	Weight (kg)	Fuel Efficiency (L/100km)
A	Microcar	< 800	4.5
	City car	801 – 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 car	1 401 – 1 550	7.0
	Executive car	1 401 – 1 550	7.0
E	Executive car	1 550 – 1 800	9.5
F	Luxury car	1 801 – 2 050	11.0
G	Large 4 x 4	2 051 – 2 350	11.5
Others	Others	2 351 – 2 500	12.0

Source: (MAI, 2015)

PART II: PREE REVIEW TEAM REPORT

Malaysia is currently in the process of drafting the Energy Efficiency and Conservation Act and has already undertaken initial steps such as conducting a Preliminary Study on Demand Side Management (DSM). As part of the consultation process and to receive feedback from international experts on the DSM study that was completed in July 2017, the Follow-Up PREE was conducted from 26 – 31 March 2018 in Putrajaya, Malaysia.

A total of six experts from five different economies and 54 local experts as well as relevant agencies attended the 3-day workshop. A full list of experts/attendees can be found in Appendices A and C.

During the Follow-Up PREE process, a total of 45 challenges were identified and 56 recommendations as presented in this report. The challenges and recommendations are grouped into three categories:

- Overarching;
- Land transportation; and
- Thermal energy use in industry.

1. OVERARCHING

1.1 BENEFITS OF ENERGY EFFICIENCY

Energy efficiency is a priority target that requires constant promotion by all parties and improved understanding across multiple stakeholders. A comprehensive analysis of the benefits of energy efficiency, as well as investment needed for energy efficiency, needs to be established to improve the deployment of energy efficiency in Malaysia.

Achievements

- There is already a general awareness of the benefits of energy efficiency in Malaysia, especially in relevant government ministries.
- Malaysia has designed programs to improve awareness in government and the public sector, such as labelling programs for appliances and rating tools for buildings.

Challenges

- There is an insufficient understanding across multiple stakeholders, including industry and the general public, about the value of energy efficiency and its importance to energy security and affordability.

Expert Recommendations

Recommendation 1

Need to think about energy resources over longer-term horizons as domestic reserves decline or higher volumes are exported. Lower energy consumption can provide more significant opportunities for Malaysia to export more energy and extend the lifetime of existing energy reserves.

Recommendation 2

Consider energy efficiency as an energy resource with low generation costs that should be prioritised when designing long-term energy policy plans.

Recommendation 3

Expand awareness-raising activities for the public with targeted messaging for different generations of Malaysians. Learn from other economies to help Malaysia learn the most effective awareness program for its consumers.

There are many agencies around the world that are doing energy efficiency awareness program, where the best practice can be learned from these agencies. Among those agencies are:

Table 4: List of responsible agencies implementing energy efficiency awareness program

Economy	Agencies responsible for awareness programs
Canada	Natural Resources Canada https://www.nrcan.gc.ca/energy/efficiency
Hong Kong, China	Energy Efficiency Labelling Scheme, the Energy Saving Charter, 4Ts Charter (4Ts means to target, timeline, transparency and together) http://ee.emsd.gov.hk
Japan	Energy Conservation Grand Prize: https://www.eccj.or.jp/bigaward/item.html
Korea	National Energy Efficiency Awards http://www.energy.or.kr/renew_eng/pr/pr/campaign.aspx http://www.energy.or.kr/renew_eng/pr/pr/exhibition.aspx
New Zealand	Energy Efficiency and Conservation Authority: www.eeca.govt.nz Energy Efficiency information: www.energywise.govt.nz
USA	ENERGY STAR programme: https://www.energystar.gov/ Better Buildings Alliance: https://betterbuildingsinitiative.energy.gov/ Better Plants programme: https://energy.gov/eere/amo/better-plants Superior Energy Performance programme: https://energy.gov/eere/amo/superior-energy-performance Vehicle fuel economy labelling programme: https://www.epa.gov/fueleconomy/basic-information-fuel-economy-labeling

Source: (APERC, 2017)

1.2 INSTITUTIONAL FRAMEWORK

In 2017, there were five main agencies responsible for implementing energy policies. These agencies were given specific responsibility in formulating policies and implementing energy initiatives as listed in Part I - Governance Structure.

Achievements

- The current institutional framework is well-established with an extensive regulatory framework for supply and planning.
- The Electricity Supply Act [Act 447] empowers the Energy, Green Technology and Water Minister and Energy Commission to promote the efficient use of electricity, for electricity supply and gas supply at reticulation ends.

Challenges

- The responsibility for energy policy formation and implementation is distributed to several governmental organisations in Malaysia.
- Energy efficiency (EE) policies for industry and transport sectors inevitably span across other policy portfolios: industry policy, transport policy, automotive policy and land-planning policy.
- Current energy efficiency legislation only exists for electricity use.

Expert Recommendations

Recommendation 4

The government organisations in charge of energy policy require continued coordination in planning and implementing energy efficiency policies.

Recommendation 5

These organisations are recommended to prioritise cooperation with relevant stakeholder organisations such as MITI, MOT, and PLANMalaysia to improve energy efficiency in the thermal energy use in industry and transport sectors.

Recommendation 6

It would be worthwhile to consider designating one dedicated entity responsible for energy efficiency policy implementation.

1.3 SETTING TARGETS

Malaysia has set a few energy efficiency targets as explained in Part I (*The National Energy Efficiency Action Plan (NEEAP) - Targets and Impact of the Plan*) as well as CO₂ reductions outlined in the Biennial Update Report to the UNFCCC published in 2015.

Achievements

- In the past, Malaysia has a few targets based on short-term programs such as Sustainability Achieved via Energy Efficiency (SAVE) program, which was launched in 2011 and ended in 2013. This program targets to save energy consumption at about 246-gigawatt hours (GWh) for two years.
- Under the Intended Nationally Determined Contribution (INDC), Malaysia pledged to reduce by 45% the GHG emissions intensity of the economy's GDP by 2030 relative to the emissions intensity of GDP in 2005. The 45% figure consists of 35% on an unconditional basis and a further 10% conditional upon receipt of climate finance, technology transfer and capacity building from developed economies and the target does not limit only to energy (UNFCCC, 2015).

Challenges

- Insufficient long-term energy efficiency strategy that outlines specific sector responsibilities that can be used as guidance.

Expert Recommendations

Recommendation 7

The government should set clear ambitious goals for energy efficiency improvements by sector and develop strategies to achieve them. Timelines for implementation should occur on a cost-prioritised basis, (i.e. zero cost ones first, more expensive ones next).

Recommendation 8

When assigning targets, the government also needs to designate which organisation is responsible for collecting and evaluating the necessary data in that sector and then enable data collection through mandatory reporting. In Malaysia case, since the Energy Commission is responsible for collecting electricity data, expanding its function to collect all energy data will be an excellent way to achieve this objective.

1.4 ENERGY PRICING

According to IEA Energy Subsidy 2016 Database, Malaysia provided USD 4.2 billion (USD 2016) in subsidies related to crude oil, equivalent to 4% of GDP in 2014. However, with the rationalisation of energy subsidies beginning at the end of 2014, this oil subsidy shrank by 88% to USD 511 million in 2016 (IEA, 2018).

Achievements

- In 2014, when global oil prices dropped below USD 60/bbl, Malaysia took the opportunity provided to remove most of the oil energy subsidies previously provided.

Challenges

- Despite the partial rationalisation of prices, the government still provides some form of subsidy and does not tax oil consumption.
- Energy prices for the energy sector are at market prices except for regulated gas price for power and non-power sectors. However, since its rationalisation of regulated gas price beginning 2010, it is now reaching towards the reference market gas price, that is on LNG-based pricing. Nevertheless, electricity tariff is regulated as well as gas prices for non-power sector, that may reduce the value of energy efficiency to consumers.

Expert Recommendations

Recommendation 9

Continue to review the gas pricing formula and its mechanism to ensure the effectiveness of subsidy removal programme as well as to ensure consumers interest is protected..

Recommendation 10

Encourage an economy-wide discussion on the introduction of energy taxes and carbon pricing, taking into account global developments on CO₂ emission reductions.

1.5 FUNDING

Funding energy efficiency initiatives is a challenge for many economies, including Malaysia. Energy efficiency funding includes grants for promoting energy efficiency, as well as funding to establish an agency for implementation and enforcement of regulations.

Achievements

- Under the 11th Malaysia Plan, the Special Industrial Tariff will be gradually reduced at 2% per annum and abolished in 2020

- The Energy Audit Program under the 11th Malaysia Plan. The energy audit conditional grant received 100 applications in 2016 and 55 in 2017 from industrial and commercial sectors with 149 audits completed and 6 underway. An additional 62 audits are targeted for the industrial and commercial sectors in 2018;
- Green Technology Financing Scheme was introduced in 2010 with an allocation of RM3.5 billion until 2017. Under this scheme, the applicants were offered a rebate of 2% per annum on interest or profit rates charged by financial institutions while also providing a Government guarantee of 60% for the green cost of the financed cost. The scheme is earmarked as one of the financial initiatives to catalyze the green technology project in Malaysia. Based on the 319 projects supported during 2010 to 2017, with a total funding of RM3.5 billion from the PFIs, the scheme has assisted the growth of RM7.1 billion of green investment in the economy, estimated to contribute to approximately 3.1% of the economy's GDP (based on Keynesian Multiplier);
- Green Tax Incentives. Under Budget 2014, the Government announced the provision of investment tax allowance for the purchase of green technology assets and income tax exemption for green technology service providers. The main objective of providing the incentives is to encourage investment in green technology industries and the adoption of green technology by private sectors. The incentives are divided into two main categories:
 - Green Investment Tax Allowance (GITA) of 100% of qualifying capital expenditure incurred on green technology projects and assets until the year of assessment 2020
 - Green Income Tax Exemption (GITE) of 10% of statutory income on green technology services until the year of assessment 2020
- Energy Performance Contract Fund. The Government has injected funds amounting to RM5.8 million to reprofile the facility financing rate of 8.0% per annum to 7.0% per annum, to enhance the attractiveness of this financing package.

Challenges

- Securing sufficient funding to enforce the implementation of energy efficiency policies.

Expert Recommendations

Recommendation 11

Consider the introduction of a dedicated fund to finance energy efficiency implementation. For example, a small charge could be added to fuel and electricity tariffs to fund implementation.

1.6 INTERNATIONAL COOPERATION

International cooperation has been a major source of learning for effectively implementing energy efficiency in many economies.

Achievements

- Malaysia has joined many regional groups involved in promoting energy efficiencies, such as ASEAN Energy Efficiency and Conservation – Sub-sector Network and the APEC Expert Group of Energy Efficiency and Conservation.
- Also, Malaysia underwent a peer review process under APEC's Energy Working Group in 2010.

Challenges

- There are many international partners supporting energy efficiency policy design based on the accumulation of examples and best practices, which may differ from each other.
- Best practices are continually improving and it requires significant resources to keep informed of these changes.

Expert Recommendations

Recommendation 12

The government should deepen collaboration with international and regional energy organisations, including the UN, IEA, ISO, APEC, and ASEAN, to update energy efficiency policies, which can then be tailored to local conditions in Malaysia.

Recommendation 13

Conduct a periodic peer review, every three to five years, to monitor and evaluate progress.

2. TRANSPORT SECTOR

2.1 INSTITUTIONAL FRAMEWORK

Despite insufficient or clear targets for reducing energy consumption in the transport sector, there are many agencies involved indirectly with green transportation. For example, the revised National Automotive Policy proposed by MITI highlighted that one of the policy thrusts for the automotive industry is to advance the green transport ecosystem. Similarly, both PLANMalaysia and the Town and Country Planning Department emphasise transit-oriented-development (TOD), while the Ministry of Transport (formerly under the Land Public Transport Commission that was disbanded in May 2018) oversees general planning for public transport systems. Although these organisations have indirect responsibility for planning specific transport initiatives, no institution is directly responsible for all energy use in the transport sector.

Challenges

- Policies for energy use in the transport sector are handled by many institutions.
- The high-level strategy for addressing energy use in transport is unclear.
- Sufficient coordination is necessary to harmonise transport energy policies across and within municipalities.

Expert Recommendations

Recommendation 14

Improve cohesive policy coordination among Ministries by providing a clear target on energy efficiency and emissions reductions.

Recommendation 15

Assign a central agency to play a more significant role in coordinating relevant transport policies related to energy efficiency (e.g. urban planning, vehicle fuel economy standards and public transport) by appointing specific agencies to implement energy policy in the transport sector.

As an example in Indonesia, the economy formed the National Energy Council (Dewan Energi Nasional - DEN) through the legislative process. This institution covers a wide range of energy areas, involving seven ministries that are responsible for energy supply, transport, distribution, and usage. These ministries are:

- Ministry of Finance;
- Ministry of Transportation;
- Ministry of Industry;
- Ministry of Development Planning;

- Ministry of Agriculture;
- Ministry of Technology Research and Advance Education; and
- Ministry of Environment and Forestry

The mission of the Indonesian National Energy Council is to:

- Design and formulating energy policy as a guide for the government executives
- Set up the National Energy Planning
- Design the procedure for energy crisis mitigation
- Supervising the implementation of energy policy.

Recommendation 16

Develop a masterplan for energy use in the transport sector that includes a detail plan to assess the investments necessary to improve the transport system

The strategy should include policy and guidance about the overall objectives that are to be achieved, the period over which the plan will be implemented, the parties involve in effectively implementing the policies, resource availability, procedures to be followed, and an evaluation of future consequences if business-as-usual continues unabated.

A detailed investigation of the investment required for highway transport and public transport systems should be conducted. Planning should include data acquisition, a plan to update the analysis regularly, definitions of relevant concepts for transport, and specific processes necessary for multiple transport sectors with the study of the price elasticity of transportation commodities. For example, if the price of fuel is increased by 10%, how much does the consumption reduce?

For each transport segment, there should be a specific and detailed plan to guide the government institution responsible how best to achieve the energy efficiency and the estimated effectiveness of each efficiency investment for the transport system, including a forecast of future demand. Projections of future system demand should be analysed across multiple scenarios and with strategies for implementation to reach targets. Detailed planning should include a step-by-step guide to achieving intended results to minimise future duplication or redesign during deployment.

2.2 REGULATORY FRAMEWORK

Despite having robust regulation in transportation safety and planning, specific regulatory frameworks for energy efficiency in the transport sector in Malaysia could be designed.

Challenges

- The policy of Energy source for transport is still unclear
- Carbon incentives policy for transportation is not available
- Inadequate infrastructure for electric vehicle

- Personal transports are not used efficiently by travelers e.g correct tyre pressure, passive driving.

Expert Recommendations

Recommendation 17

Deploy regulatory framework that encourage energy efficiency and low-carbon transportation mode

In European economies, which are mostly oil importers, the transportation system was improved through traffic control measures in cities to avoid congestion, as well as through strict enforcement of vehicle speed on highways. These measures had to effect of tremendously reducing the total fuel consumption and improving air quality in dense areas. By implementing efficiency policies such as a fuel economy standards and by introducing alternative fuel cars with lower fuel consumption, Malaysia can lower emissions.

Recommendation 18

Increase the number of electric vehicles by setting a measurable target and by increasing incentives for alternative fuel transportation systems.

Recommendation 19

Provide better electric vehicle infrastructure.

Electric vehicles (EV) can be more efficient than conventional combustion engine vehicles, however the relative efficiency improvement depends strongly on the usage of the vehicle.

The largest customer concerns related to EVs tend to centre on the vehicle cost and range. The range of a conventional vehicle is associated with the fuel tank size, which is an insignificant fraction of the cost of the vehicle, whereas the range of an EV is directly proportional to the battery capacity, which is one of the more expensive components.

Proper labelling of the vehicles long-term cost of ownership may help sway consumers towards more efficient vehicles, and EVs in particular, however the altruistic attraction to a more “environmentally friendly” vehicle is not likely to have much impact on the majority of the consumers in South East Asia.

See IEA’s latest GEVO 2018 for more details on policy options to support EVs:

https://webstore.iea.org/download/direct/1045?fileName=Global_EV_Outlook_2018.pdf

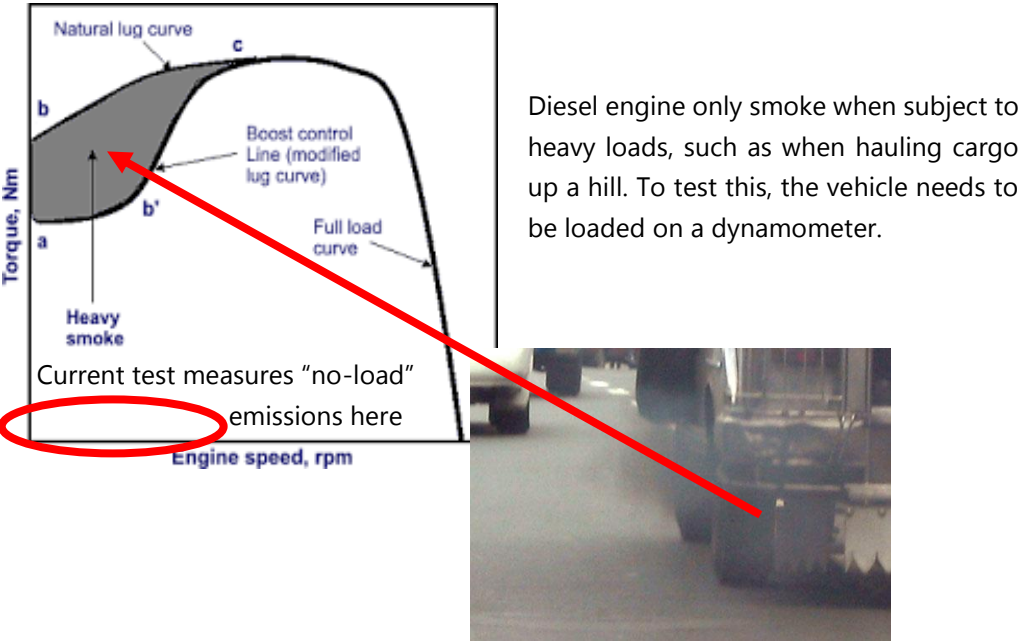
Recommendation 20

Improve existing emissions test for commercial vehicles to include loaded emission testing.

Currently heavy-duty diesel vehicles (commercial trucks) are inspected and measured for emissions every six months. The emissions measurement, however is done with no load on the engine, resulting in most vehicles passing the emissions test, despite consuming fuel inefficiently when carrying a typical load.

The solution to this is to require loaded emissions testing. The vehicles should drive the rollers of a dynamometer with a heavy load, typical of what the vehicle sees in actual service, when testing for emissions.

Figure 6: Emission testing for heavy load vehicles



Source: Expert Analysis

2.3 DATA COLLECTION AND MONITORING

Data collection is one of the most challenging components, particularly for the transport sector where the related data is obtained from various agencies. Also, to evaluate the improvement of energy efficiency in the transport sector, the data from both on the supply and demand side of transport systems are needed. Despite that, energy efficiency has not been the main objective for the related ministries, for example, the Ministry of Transport. The acquisition of related data from various organisations is always difficult and complicated but necessary.

Achievements

- The Malaysian government has recognised the importance of data and initiated a data collection unit.

Challenges

- Data related to the transport sector comes from different agencies and is collected inconsistently.
- Lack of travel demand data and no monitoring system to evaluate energy efficiency improvements or CO₂ emissions reductions in the transport sector.

Expert Recommendations

Recommendation 21

Develop a central data collection and monitoring unit for the energy sector. Provide 'sufficient resources and power' to a specific body or institutions to regularly gather necessary data.

Recommendation 22

Establish energy efficiency indicators to monitor the progress.

Recommendation 23

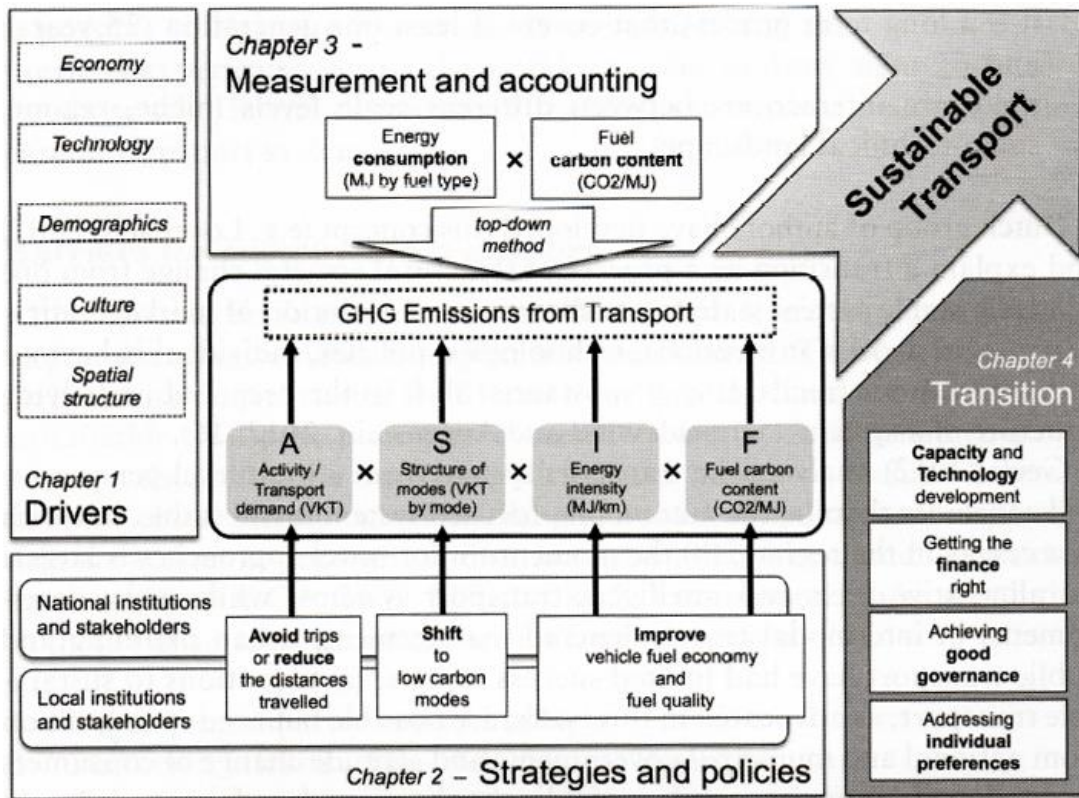
Collect the data according to the ASIF framework and open the database to the public on a regular basis.

To have an efficient data collection and monitoring system, all related data should be collected accordingly to policy framework towards energy efficiency and low-carbon transport systems in Malaysia. A well-known analytical approach called ASIF (activity, structure, intensity, fuels) is suggested as follows:

- **Avoiding or shortening journeys (A)** by, for example, densifying urban landscapes, sourcing localised products, utilising ICTs. Smart land-use planning in a compact city could save energy for long-term periods.
- **Mode shift (S)** to lower-carbon transport systems – encouraged by increasing investment in public transport, walking and cycling infrastructure, and so on.
- **Lowering energy intensity (I)** by enhancing vehicle and engine performance, using lightweight materials, increasing freight load factors and passenger occupancy rates, deploying new technologies, and promoting eco-driving for on-road vehicles
- **Fuel choice (F)** by shifting to efficient and low-carbon content fuels, such as biofuels and electricity.

Figure 7 shows an example of the linkage between policy framework with data collection and monitoring system. ASIF helps to understand what is happening to transport and why GHG emissions are as they are. The framework is concerned with the question of how to reduce GHG emissions and intends to help develop comprehensive GHG emission reduction policies and strategies (Bongardt, 2013).

Figure 7: ASIF policy framework with data collection and monitoring



Source: Bongardt et al, 2013

2.4 TRAVEL DEMAND MANAGEMENT

Travel demand management (TDM) is recognised as a robust measure to reduce demand for driving by changing traveller's behaviour. The most effective measures are paired measures, by increasing the cost of driving (both regarding price and time) and reducing the cost of transit (both regarding price and time). Typically, this is achieved by making it more expensive to drive and improving public transit travel times. Alternatives to driving, that is, an effective public transport system that offers a similar travel time or faster to driving must be in place to accomplish a behaviour change where drivers shift their mode of travel to transit. The Malaysian government has recognised this and focused on building efficient public transport systems and plan to introduce TDM policies more specific areas in the longer term.

Achievements

- Malaysia government has initiated the Demand Side Management (DSM) Program covering energy efficiency in the transport sector.

Challenges

- Travellers are highly dependent on private vehicles which is the main barrier to implementing TDM measures.
- Expand urban planning and transit-orientated-development to the outside of the Kuala Lumpur Metro Area
- Despite expressway tolls, and heavy traffic, car owners still insist on driving their cars alone in rush hour traffic.

Expert Recommendations

Recommendation 24

Reduce private vehicle dependency by increase the accessibility and quality of public transport services.

Recommendation 25

Educate the public about how to use personal transport efficiently.

If public transport options exist, drivers should be encouraged to become riders (or carpool). One way to directly affect the perceived convenience of driving is to increase the cost. Toll fees can be raised in connected areas at peak traffic hours, and new "congestion tolls" can be implemented in areas of highest traffic. Additionally larger, heavier vehicles used for commuting purposes should be charged at a higher rate than smaller, more efficient vehicles.

Specifically high speed and light rail should be expanded to the other major urban centres in Malaysia, which links between major cities will also help reduce the need for air and bus travel, subsequently improve overall transportation efficiency.

Recommendation 26

Increase the cost of vehicle ownership by raising economy-wide vehicle excise tax and car registration fees based on carbon emissions emitted and removal of vehicles that are not road worthy.

Recommendation 27

Consider implementing a congestion charge in overcrowded areas that are easily accessible by public transport systems and prioritise non-motorized transport such as walking and cycling in these areas.

Recommendation 28

Include transport demand management strategies to meet energy saving targets in the transport sector.

Recommendation 29

Improve the sustainable energy transport system – by increasing the public transport usage, expand the IITS across major cities, increase the use of alternative fuel and improve the vehicle fuel efficiency.

Several transportation programs are viable for Malaysia to be improved and expanded:

- *The increased use of public transport. Large urban centres (Klang Valley, Penang and Johor Bahru) can maximise energy saving potential by improving public transportation to 50% by 2020, thus minimising urban congestion, air pollution and safety problems and significantly lowering fuel consumption attributed to rapidly growing car population.*
- *To develop Intelligent Transport Information Systems (ITIS). Improving traffic flows with proper road network capacity along with better traffic management (signal operation, ramp metering.) can reduce problems related to urban congestion. Such actions may include the use of INSIAX or SMART.*
- *The increased use of alternative fuel technologies. As outlined by the National Biofuel Policy, biofuels help with diversifying fuel consumption by introducing alternative renewable options. By utilising blends of bio-diesel together with natural gas, these new fuel technologies allow greater savings in fuel consumption.*
- *Strategic improvement in vehicle efficiency. Aimed at improving fuel efficiency for the entire vehicle fleet, these measures are geared towards establishing higher standards and promoting technologies to offset rising petrol prices. In addition to fuel cost savings, a move to lighten road load will lessen the strain on the supply of transport fuels.*

Source: (Al-Mofleh, Taib, & A.Salah, 2010)

2.5 DEPLOYMENT OF ENERGY EFFICIENT VEHICLES

Malaysia, through MAI, has established the EEV definition and classification. However, there is no mandatory requirement for vehicles to adopt this definition, which subsequently makes the deployment of EEV harder.

Achievements

- Currently, EEV (as defined by MAI) accounted for around 52% (299,850 units) of the total vehicle sales in 2017 and it is expected to reach 80% in 2022.

Challenges

- Internal combustion engines remain the dominant choice for land transport.
- Modern vehicles have On-Board Diagnostics (OBD) systems, which track the vehicles fuel consumption and emissions and can warn (via the "Check Engine Light") if the engine is operating improperly. Generally these systems will function properly for the first ten years or

so, obviating the necessity for re-inspection of the vehicle. After a very long time, however, normal vehicle wear can result in inefficient operation, making a few older vehicles gross emitters of pollution.

- Two-wheelers are much more efficient than cars, however they are also much more vulnerable to accidents. Efforts should be made to enhance the safety and utilisation of this efficient class of vehicles especially for first/last mile.
- Despite having an extensive rail freight network, the freight share of rail is disappointingly low. Utilisation rates are low because load/unload scheduling is unpredictable and port de-bottlenecking is necessary.

Expert Recommendations

Recommendation 30

Encourage people to use alternative energy for transport through public awareness building.

Recommendation 31

Require more frequent inspection of vehicles beyond a certain age or/and setting end of life for vehicles.

Older vehicles should be inspected for emissions/fuel consumption conformity (according to the specifications applied at the time of manufacture, with perhaps some degradation allowance) after ten years. For example, personal fleet vehicles could be inspected at 15 and 20 years of age. Waiting to conduct inspections and then only conducting them at this interval balances the costs and benefits of placing an undue burden on vehicle owners, while ensuring targeted testing of older vehicles. After 25 years, it is no longer worth testing vehicles as so few remain on the road.

Vehicles found to fail the appropriate emissions or fuel consumption limits should require repairs to bring them back into conformity. If a vehicle cannot, or the owner does not wish to bring the vehicle back into conformity, then the owner could be given a rebate used towards buying a newer, more efficient vehicle, with the condition that the older vehicle is impounded.

Recommendation 32

Foster deployment of efficient and electric two-wheelers especially in cities.

Road tax and other fees could be reduced on two-wheelers, funded by a commensurate increase in the fees of four-wheelers. Transportation hubs should be designed to enable people to take advantage of two-wheelers as part of a public transport trip by including things like free prioritised, covered parking and helmet storage. Malaysia is the world leader in two-wheeler only infrastructure and this should be encouraged in urban planning and transport hub planning, specifically for first- or last- mile transportation.

Recommendation 33

Enhance freight rail utilisation through regulation and improvement in service.

Logistics companies have tight schedules to keep, so any rail link should be fast and convenient. If getting into/out of the port area is problematic, or the trains are not reliably on schedule, then hauliers will revert to the road.

2.6 VEHICLE FUEL ECONOMY LABELLING AND STANDARDS

Although Malaysia has introduced energy labelling for electrical and electronic products, there is a lack of regulation to promote and enforce mandatory labelling and standards for vehicle fuel economy.

Achievements

- The Malaysian government has identified that consumer awareness through vehicle fuel economy labelling and standards is important for promoting energy efficiency in the transport sector.

Challenges

- Current standards are voluntary and insufficient.
- Existing heavy-duty diesel (HDD) emissions tests are performed at no-load conditions, rather than under typical usage, rendering them useless.
- Consumers often have trouble assessing the long-term financial benefits of more efficient technologies. This assessment may result in the purchasing of lower-cost, less-efficient vehicles that cost more in the long term.

Expert Recommendations

Recommendation 34

Urge the automotive industries to start providing standardised efficiency labelling.

Vehicle efficiency labelling should be implemented with an annual, or lifetime energy cost estimate, similar to the US fuel economy sticker in Figure 8. Vehicles could be ranked relative to other vehicles in a given category based on usage (i.e. pickup trucks, which are typically used as passenger vehicles, should be compared to other passenger cars) to help consumers make decisions based on longer-term costs, rather than only the initial purchase price.

Figure 8: The US vehicle efficiency labelling



Besides the US vehicle efficiency labelling above, there is much other labelling that can be used for vehicle fuel economy labels and standards such work of GFEI / IEA (for more details <https://www.iea.org/topics/transport/gfei/>) Also the Fuel Economy Policies Implementation Tool could also be used, which can be assessed at this website <https://www.iea.org/media/topics/transport/FEPITUserGuide.PDF>

2.7 MODAL SHIFTING AND PUBLIC TRANSPORT

An efficient and cost-effective public transport system could replace private car use as shown in Figure 10. Since most economies have developed by focusing on road-based networks and promoting passenger cars, the government need to reform the development of transport networks by prioritising public transport development. Restricting private vehicles use should also be considered, especially in areas that are easily accessible by the public transport network.

Achievements

- A target for increasing the utilisation of public transport in Klang Valley Area as a share has been established.
- Related agencies recognise transit-oriented development (TOD) as a tool to develop mass transit systems and attract more travellers.

Challenges

- Public transport is not developed well enough to be used as the primary mode of urban transportation.
- First and last mile travelling is not well designed to encourage travellers to use public transport.

Figure 9: Comparison of road space used when travellers use public bus and private cars.



Source: Photo from the internet

Expert Recommendations

Recommendation 35

Set a long-term policy direction and develop public transport system as the transport backbone in cities with adequate facilities for public transport and non-motorised users.

Recommendation 36

Continue to implement transit-orientated development and redeploy the income from land development around stations to develop new public transport lines.

Recommendation 37

Increase the deployment of energy efficiency technologies in the public transport system, for example, adoption of energy recuperation technology for the railway transport system.

2.8 TRANSPORT INTEGRATION

Malaysia is adopting an integrated public transportation system in big cities, particularly in Kuala Lumpur. For example, the Terminal Bersepadu Selatan (South Integrated Terminal) at Bandar Tasik Selatan integrates a few rail lines as well as the bus terminal. Integrated public transportation system design needs to be expanded to second-tier cities such as Ipoh and Bandar Melaka.

Achievements

- Malaysia is expanding and upgrading its transportation infrastructure, including new and improved airports, rail stations and bus terminals.
- Malaysia, through the Land Public Transport Agency (APAD) (formerly known as Land Public Transport Commission) introduced the Greater Kuala Lumpur/Klang Valley Land Public Transport Master Plan, which emphasised transport integration concepts.

Challenges

- In many cases these transport hubs are not linked, either to other nearby transport hubs, or to the city centres they serve. For example, there is no transport link between the airport at Sibu, Sarawak, and the town of Sibu (20 km away), forcing passengers to take a taxi or private vehicle for pick-up and drop-off. The same is true for Melaka.
- The new bus station at Ipoh (Aman Jaya) does not have a convenient shuttle bus to the train station or town centre.

Expert Recommendations

Recommendation 38

Prioritize and/or enhance connectivity to town centres from transportation hubs (airports, bus and train stations) and between transportation hubs of neighbouring cities.

In many cases, ridership could quickly pay for a shuttle bus. For example, there is 116 flight per week from Sibu. Assuming a bus could take 20 passengers (each way) for RM 10 (the taxi price is RM 45), revenue would be RM 46,400 per week, or almost RM 200,000 per month. Significant improvements in efficiency can be achieved by ensuring all public transportation hubs are interconnected by convenient shuttle buses or similar mass rapid transport options.

Figure 10: Missing bus service between Sibul Airport and city centre



Source: Google Maps application and expert analysis

Recommendation 39

Expand high-speed and light rail to the rest of Malaysia outside of the Kuala Lumpur area.

Recommendation 40

Extend and enhance urban planning and transit-orientated-development to all urban centres around Malaysia.

Recommendation 41

Improve the appeal for public transport, especially bus services.

In areas where public transportation does exist, it is often underutilised, primarily by women, due to a concern over personal safety. One of the most significant safety factors is visibility: people are less comfortable in dark, enclosed spaces. Busses and bus stations with large, open windows and good lighting reduce the fear of safety incidents. Lit transit stops at night also help ensure rider's safety. Safety training for bus drivers could also be provided.

3. INDUSTRIAL SECTOR

3.1 INSTITUTIONAL FRAMEWORK

Malaysia's energy institutional setup recognises that an energy efficiency improvement is an across-the-board approach. In this regard, the responsibility and accountability to improve energy use by various sectors in Malaysia are shared by a range of stakeholders.

Achievements

The National Green Technology and Climate Change Council established under the previous government chaired by the Prime Minister is the highest level of the policy-makers meeting where deliberations on green technology and climate change issues including energy are made. The development of energy policy is led by EPU. MESTECC is responsible for policies related to electricity and gas supply, and the Energy Commission is the body tasked with implementation of regulations. The EPU decides macro energy policies including energy subsidies, energy market structure, and energy infrastructure development.

Related authorities including MESTECC which oversees Malaysia's environmental targets; and the Ministry of International Trade and Industry, with responsibility for gas market reform and promotion of inbound investment.

- Malaysia's National Energy Policy, which was first formulated in 1979 and most recently revised in 2010, consists of three objectives relating to secure and cost-effective supply, efficient utilisation, and minimisation of environmental impacts. At this level, the overarching policy provides a firm basis for meeting Malaysia's Paris commitment¹.
- The Energy Commission has developed systems to facilitate the collection and reporting of energy consumption data, and degree of engagement with industry has facilitated the collation of thermal energy use data across most of the economy. The approach has promoted a good understanding of electricity consumption/intensity and related greenhouse intensity across the economy.
- The range of policies and programs delivered to date have recognised the need for skills development. The UNIDO Industrial Energy Efficiency for Malaysian Manufacturing Sector (IEEMMS) program provided training, raised awareness and supported capability development in energy management systems and optimisation based around ISO50001. 309 Industry groups were engaged, resulting in a reach of over 1,500 organisations.

¹ Malaysia's commitments under the 2015 Paris Agreement include a 45% reduction in GHG emission intensity of GDP by 2030 relative to 2005 levels. Of this, 35% is unconditional and an additional 10% is conditional upon receipt of climate finance, technology transfer & capacity building from developed economies.

Challenges

- The absence of regulation and institutional responsibility for thermal energy use.

The role of various institutions and their relationship to supporting electrical energy efficiency is unambiguous – for example the Electricity Supply Act [Act 447] empowers the Energy, Green Technology and Water Minister to promote the efficient use of electricity. However, this jurisdiction is limited to electricity supply and gas supply at reticulation ends.

The current institutional structures relating to thermal energy use are less clear. In some instances the policy issues are spread across some portfolios, including industry, transport, urban planning and health; they may compete with other matters relating to energy security, affordability and wellbeing. The framework lacks a responsible agent playing a leading role, making it difficult to progress issues or to assign accountability for improvements in thermal energy use.

- The potential opportunity for municipalities to provide a conduit for supporting and driving change has been overlooked

Further, the role of municipalities is unclear. This second tier of government presents a fundamental group of stakeholders in the transition to a less energy-intensive economy that is suited to local conditions and may prove to be an influential supporter in the transition. The current institutional framework does not reflect this opportunity.

- The importance and value of energy efficiency is not apparent to key stakeholders

There have been positive steps towards a thorough understanding of electrical energy demand and intensity across most sectors of the economy, but industrial thermal demand (and thermal energy intensity) data has proven more challenging to obtain. Thus, the energy efficiency gaps are not well understood. The lack of data makes it difficult for the government to develop policies and for the industry to benchmark activities – an information barrier that increases the uncertainty (thus the risk) for businesses considering investment in efficiency.

There are ongoing challenges with capability and capacity of industry to understand energy efficiency imperatives and opportunities. There is a need for further skills development across both trades and consultancies.

At the level of decision-makers, the lack of commitment from senior management and boards of top private-sector organisations is an indication that the opportunities are not well understood. The investment return from energy efficiency reaches to a wide range of co-benefits (including maintenance reductions, material savings, improvements in labour productivity, health and wellbeing), however analyses often simplify the value of energy efficiency to the level of energy cost savings. Businesses are simply unaware of or do not understand the range of opportunities and benefits available to them from energy efficiency.

Expert Recommendations

Recommendation 42

Develop a comprehensive energy efficiency strategy covering key (energy-intensive and strategic) sectors and sub-sectors and appoint a responsible entity to implement. Continue broad stakeholder consultation and coordination with relevant ministries and agencies. Provide 'sufficient resources and power' to a specific body or institutions to regularly gather necessary data

The roles of various stakeholders should be clarified. Strategies and targets and the industrial sector and sub-sector level can provide clarity to industry, reducing the risk (and cost) of investment. The strategy's development should recognise the positive consultation work undertaken thus far, and continue to build on this to ensure buy-in from the wide range of stakeholders with interest in this area.

Recommendation 43

Communicate strategy and emphasise the multiple benefits of energy efficiency. Identify champions who can most effectively communicate this strategy

Within government, the difficulty of coordinating between the various stakeholder institutions is compounded by the lack of a responsible agency play a leading role. This challenge can be alleviated by appointing or assigning responsibility for implementation of energy efficiency strategy to a single entity, providing both accountability and assurance of a *champion*. Malaysia needs to consider hypothecated fund for this purposes. E.g. sourced from fuel/energy/carbon tax or levy on energy/environmental industry (A key element of the strategy is the inclusion of broad internal (government) and external (industry and community) engagement. This fund will ensure that the strategy and its drivers are effectively communicated and understood by players across the authorising environment.

3.2 REGULATORY FRAMEWORK

Malaysia's Paris 2015 commitments include a 45% reduction in GHG emission intensity of GDP by 2030 relative to 2005 levels. The 45% commitment consists of a 35% reduction on an unconditional basis, and an additional 10% which is conditional upon receipt of climate finance, technology transfer & capacity building from developed economies.

Achievements

- Malaysia has identified core strategies necessary to pursue green growth, sustainability and resilience in the industry sector.
- The existing regulatory framework provides reasonable coverage of the efficiency of electrical energy use, particularly for newly installed equipment.

Challenges

- Insufficient comprehensive regulations to support industrial energy efficiency.

Thermal energy consumption makes up about 65% of industrial energy use, but this is not so clearly reflected in the policies, strategies and systems currently in place which focus on electrical energy efficiency.

Thermal energy efficiency targets are established at a high level as part of broader goal-setting and processes seeking to improve energy intensity. However, the regulations developed to date are not comprehensive.

- Lack of empowerment for enforcement of regulations.

The Energy Commission has developed systems to facilitate the collection and reporting of energy consumption data, and degree of engagement with industry has facilitated the collation of thermal energy use data across most of the economy. However, some challenges remain – much of the data needed to guide policy development in this area either does not exist or is not available to regulators and policy writers.

- Lack of clear sectoral commitments.

Despite ongoing rapid growth in energy consumption, economy-wide energy intensity has been relatively stable. However, the intensity will need to improve substantially for Malaysia to meet its Paris commitments.

Malaysia's Paris 2015 pledge provides an overall economy-wide commitment of up to 45% reduction in GHG emission intensity per GDP. It is clear that the commitment covers the sectors of energy, industry, waste, agriculture and land use, land change and forestry, but the proportions of the reduction to be provided by each sector are uncertain.

Expert Recommendations

Recommendation 44

Broaden energy efficiency regulations including expanding MEPS for industrial equipment (e.g. energy efficient motors, boilers, industrial processes). Where possible, align to regional or international standards (e.g. ISO60034 for motors). Policies should cover both new and existing installations.

The MEPS that have been introduced appear to have been effective to date for reducing residential electrical energy consumption; such approaches have been shown to be highly effective in other jurisdictions.

There is a substantial international precedent for successfully expanding such approaches to commercial and industrial equipment. Note that the cost of implementing such an expansion can be reduced by employing regulations that align with regional international standards.

Recognizing that much of the industrial equipment that will be operating in 2030 is already in place, regulations should account for existing installations by seeking to improve their operation.

While development of regulations demands consultation and ownership across a range of stakeholders, successful implementation of regulations requires some lead agency to be empowered and resourced with the capacity for their monitoring and enforcement.

3.3 DATA COLLECTION AND MONITORING

Reliable data and indicators on how energy is used at the economy level are key to developing, informing and monitoring the effectiveness of energy efficiency policies. A comprehensive data gathering effort, using key indicators can provide valuable insights on the overall patterns of energy consumption as well as at the sectoral level, and can enable Malaysia to implement appropriate and informed efficiency improvement policies and measures across sectors and end uses.

Achievements

- The preparation of the PREE Report was instrumental in the implementation of a data collection and analysis process, which has not been done before, for any Malaysian energy-using sector.

In doing so, it helped to pinpoint available data, institutions, and stakeholders important to this process, as well as identified knowledge and responsibility gaps that will need to be addressed if this process were to be institutionalised into an ongoing effort.

As much as possible, the PREE Report's use of indicators to collect data was based on the international methodology adopted by the IEA.² While the PREE Report's data collection activities were not able to collect detailed data across all sectors and fuel types, it was able to identify and manage available data on one of the most important categories - thermal energy consumption indicators by sector and sub-sector, expressed in percentage terms (i.e. share of the sectors or sub-sectors in the overall thermal energy consumption) in the industrial, commercial and residential sectors.

The data gathering efforts did encounter some difficulties in the establishment of energy efficiency indicators, since not all activities and production data across all sectors could be obtained because of non-mandatory disclosure of such data by industry. Therefore, the data gathering efforts' priority was focused on gathering energy consumption data only for the sectors and sub-sectors as available.

² IEA, 2014a.

Activities undertaken for the PREE Report included the following about the collection and analysis of existing thermal energy data, MRV systems, and the identification of the following:

- Gaps for main DSM data requirements;
- Boundary and focus areas of thermal energy use;
- Sources of thermal energy;
- Data collection formats;
- Potential providers of data;

Once the data was collected, the Report intended to review and consolidate all data and to conduct an in-depth analysis of the aggregated data and information.

Before surveys were distributed to all identified potential data providers, data collection formats were identified and prepared according to stakeholders' input. The data collection format, along with potential sources of data were presented and deliberated in three workshops held with stakeholders. For the industrial sector, FMM also organised a dialogue session to educate their members on the purposes of obtaining energy consumption data.

The finalised data collection templates were sent to some government and private organisations, including the following:

- Energy Commission;
- Department of Statistics Malaysia;
- Gas Malaysia Bhd;
- Federation of Malaysian Manufacturers (FMM);
- Petroliam Nasional Berhad;
- Shell Malaysia;
- Malaysian Gas Association;
- Cement and Concrete Industry Association; and
- Malaysian Rubber Glove Manufacturers Association.

According to the Report, the final analysis of data presented at the stakeholders' workshop was based on EC's survey conducted with 520 manufacturing companies in Peninsular Malaysia in 2013. This set of data differed in the classifications of the manufacturing industry sub-sectors (as noted by the Report), which are by the breakdown of the manufacturing sub-sectors based on the IEA and APEC formats of classification.

However, for the Report, the data collected by EC should included data for Sabah and Sarawak and not just Peninsular Malaysia. EC's data included seven types of thermal energy from natural gas, petrol, diesel, fuel oil, LPG, kerosene and coal, covering 11 industrial sub-sectors from 2010 to 2014. This data represented the aggregate final energy consumption in the manufacturing sector (demand-side) only.

It was also noted that the survey was a one-time effort, heavily reliant on voluntary reporting and not an on-going activity. EC's data did not include the consumption of biomass and biogas in the industrial sector.

Challenges

- Lack of knowledge and analytical capacity to determine the techno-economic potential for industrial energy efficiency.

Currently, there is no systematic or regular data gathering process across all sectors, nor is there an appreciation for the need for this data or what it can provide regarding consumption trends, energy intensities and opportunities for increasing efficiency. Also, there is not a designated agency or agencies responsible for the collection, housing, or analysis of energy data in Malaysia. For the PREE Report, EC was the lead agency for data collection, which worked with consultants, to carry out the analyses needed. However, as this was a singular activity, essential lessons learned throughout the process may not have been retained for the future.

Similarly, the tools that were required for the process were created from scratch, as were the categories and indicators used. While the results from this analysis can be considered an energy baseline, it remains incomplete and not yet institutionalised. Future data gathering and analysis efforts may or may not be aware of what has already been done regarding classification, collection, or analysis, depending on whether or not the responsible agencies remain, or new agencies are designated.

Expert Recommendations

Recommendation 45

Appoint a responsible agency with research and analysis capabilities and empower it to collect the necessary data for all fuel and sector.

Recommendation 46

Expand the data collection to sub-sector (e.g. level II ISIC codes) level to develop energy efficiency indicators and benchmarks.

3.4 ENERGY MANAGEMENT SYSTEMS

An energy management system helps organisations and facilities to manage their energy use better. It involves developing and implementing an energy efficient approach, setting targets for energy use and designing action plans to reach them. This effort might include implementing energy monitoring practices, introducing new energy-efficient technologies, reducing energy waste or improving current processes to cut energy costs. The application of this practice at the facility, enterprise, and economy

level can go a long way in managing Malaysia's future energy security and reducing harmful emissions from fossil fuel use.

Two significant prerequisites for assessing and improving the energy efficiency and general operations of production facilities are the regular monitoring of energy data, and analysis of such data. Such practices enable understanding of facility operations and further improvements by assessing KPIs, condition or status monitoring, and direct feedback or evaluation of efficiency measures for their effectiveness. A standardised approach to collecting, analysing energy data, coupled with process improvement measures, and systematic feedback process (known as the "plan-do-check-act" cycle), constitute the main thrust of many energy management systems.

The practice of energy monitoring, analysis and comparing facilities' or enterprises' energy efficiency against established benchmarks, baselines, or economy-wide and international best practices can further reduce an enterprise's operating costs, improve their energy efficiency, and the overall efficiency of the industrial sector. Bringing such a system to bear, however, requires supporting policies and commitment from both the government as well as top management of enterprises.

Achievements

- Establishment of the IEEMMS program.

The IEEMMS program was implanted from 2012 – 2017 with the support of UNIDO, its objectives were to promote energy efficiency improvements in the Malaysian manufacturing sector through:

- Implementation of National Energy Management Standard and
- Application of System Optimization

Its main goal was to enable and establish a policy environment that can support the sustainable adoption of energy efficient technologies and management as an integral part of industries' business practices, resulting in the reduction of greenhouse gas emissions. The program focused on key management and operational personnel of enterprises, as well as the support network of vendors, consultants, suppliers ("allies") and consisted of three main components:

- Policy Input and awareness raising
- Capacity building Energy Management System (EnMS) System Optimization
- Implementation

The program's implementation aimed to increase energy efficiency awareness and buy-in of top management, increase adoption of EMS practices and implementation by technical managers, and increase technical capacity and availability of EMS experts with targeted, specialised training of different focus and content for each of these key groups. The experts' training program was based on ISO 50001 training materials, and included hands-on training on various energy-consuming technologies, with measurement equipment and analysis tools. The preparation for experts took 3 to 5 days, and also added a final examination, which qualifies the expert as an Energy Management

System Expert upon passing. The program also targeted personnel in related and support (“allies”) groups, such as equipment vendors, service providers, ESCOs, consultants, and others with capacity building and awareness-raising training sessions. These training were oriented towards industrial operations and equipment such as pumps, fans, air compressor, as well as thermal energy use.

Overall, the program reported a total of over 300 industry participants over the period, with the majority of representation (over 15%) coming from the chemical and chemical products sector, as well as electrical and electronics, food products and beverages, and basic metals sectors (approximately 10% each). Currently, the program reports that at least 40 industrial facilities have complied with ISO 50001 guidelines, and at least five facilities have received ISO 50001 certification. Energy savings as a result of the program was estimated to be 4,865 GWh of electricity, and 949,701 GJ of thermal energy, and a total of 3.4 million tons of CO₂ emissions avoided.

The program also took steps to ensure its sustainability once the UN funding period expired. It was able to transfer the developed materials to some other organisations, both private and public, to ensure continued use of the training materials in person as well as online.

Challenges

- Low awareness of the benefits of energy management systems, particularly among decision makers.

The main challenges to increased adoption of energy efficiency in general, and energy management practices by enterprises specifically, as identified both by the IEEMMS program and other observers.

Specific to the IEEMMS program, some other challenges were identified, which included the lack of interest by enterprises’ key decision makers. This lack of interest can be directly attributable to a low value placed on energy resources, and a lack of awareness of the importance of energy efficient production practices. As a result, the program experienced an insufficient commitment and buy-in from top management, resulting in low rates of participation by capable consultants and factory representatives, lack of communication from some representatives selected by top management of enterprises, and even consistent participation by the participants in the program.

The program also identified that the internal knowledge of energy practices was weak in many enterprises. This was evidence in a low passing rate by consultants used by enterprises, and the need for the training sessions to focus more on basics, such as baseline calculations, energy performance indicators (EnPI), and regression analyses. This is also a challenge because less qualified, undertrained consultants are less able to convey the value of energy efficiency, reducing both the consultants’ value as well as energy management practices in general.

Drawing from the lessons learned by the program, another challenge can be identified: there needs to be an enabling environment for the adoption of energy management and system optimisation practices in enterprises, especially those with significant energy footprints (the program report

indicated that participation among medium-sized enterprises was low). This enabling environment can only happen through increased awareness of the benefits of adopting energy efficiency measures and practices, and further supported by an increase in capacity and capabilities of professionals and experts who are capable of providing these services.

- Limited capacity to undertake in-depth energy management audits to enable adoption of conservation measures.

Another challenging area is the lack of sectoral energy efficiency indicators and benchmarks, whereby enterprises who have conducted their audits can compare their energy performances to other enterprises of similar size or capacity, and in the same sectors. Such a database can only be implemented and administered by a trusted and impartial third-party, such as a government agency, or an organization that can be trusted to maintain confidential and sensitive industrial information, as well as conduct impartial analyses to increase capacity and to bring Malaysia's industrial sectors to international best practices in energy efficiency and management.

Expert Recommendations

Recommendation 47

Broaden engagement and training with industry and commercial users to inform companies of the importance and benefits of implementing energy management measures.

Recommendation 48

Increase support for training of energy managers (e.g. ISO 50001 training) and encourage adoption of ISO 50001 certification (or similar accreditation and international best practices).

Recommendation 49

Consider using energy efficiency indicators to benchmark key industrial sectors.

3.5 FUTURE DEPLOYMENT OF ENERGY EFFICIENT TECHNOLOGIES

Improving thermal energy efficiency in the industry sector will require a combination of improved energy management practices as well as the deployment of more energy efficient technologies. In particular the adoption of global best available technologies can lead to substantial energy savings and where possible should be made mandatory for new industrial equipment. In addition to supporting the uptake of energy efficient technologies, policies should also cover materials efficiency and use.

Globally the IEA estimates that the adoption of the best available technology could save between 20% and 30% compared to current energy consumption. In developing economies where the industry

is expected to grow, significant efficiency improvements and energy savings can be realised at relatively low costs by policies aimed at influencing investment decisions towards the most efficient equipment as retrofit options are much more costly to implement.

Cogeneration or combined heat and power allows the use of waste heat produced at industrial facilities (or in power plants) to be captured and used to generate electricity. Modern CHP facilities can reach efficiencies of 90% or higher. In Malaysia, CHP facilities are most common in the chemical sector given high demand for both heat and electricity. Other industrial sub-sectors with high heat and electricity consumption that could adopt cogeneration technologies include food and beverage, textiles and pulp and paper. In the cement sector, waste heat recovery technology could be considered.

Malaysia's NEEAP has recognised the energy efficiency potentials from cogeneration and has included the promotion of cogeneration as one of five initiatives. Cogeneration technologies face a complex set of economic and regulatory barriers that restrain its wider adoption. These include difficulty in securing a fair market price for surplus electricity that is exported to the grid, high upfront costs, timely and cost-effective grid access, insufficient knowledge by industry on the benefits of CHP and lack of integrated heat planning which would make projects more cost-effective.

Achievements

- In 2008, Malaysia implemented minimum energy performance standards covering five electrical appliances and equipment including energy efficient industrial motors.

Cumulative electrical savings of nearly 5 000 GWh have been achieved from 2013 to 2017 as a result of adopting standards. MEPS will be expanded for a further six appliances and to date cover only electrical energy use. There is an opportunity to expand this instrument to thermal applications to ensure the most efficient equipment and industrial processes are adopted in Malaysia.

- Malaysia has recognised that a lack of a holistic and long-term policy for demand-side management as one of the main barriers to implementing energy efficiency initiatives in the economy.

This is despite being identified as a key element of Malaysia's energy plan. Under the 11th Malaysia plan energy efficiency is expected to receive renewed attention and EPU initiated a DSM preliminary study covering the entire energy spectrum which was completed in July 2017.

In the cement sector, the deployment of waste heat recovery technology has helped to improve the efficiency of facilities using this technology by capturing waste heat from the kiln to power a turbine for onsite electricity generation thereby reducing the need for electricity purchases. For new cement kilns above a certain size, this technology is now implemented in facilities following best practice.

Challenges

- The DSM study concluded that insufficient data to make assessments for thermal energy efficiency potentials.

Additional efforts are needed to develop comprehensive data sets which would facilitate the energy efficiency potentials offered by adopting more energy efficient equipment. The lack of sufficient data and analysis at the sub-sector level can lead to poor knowledge among industry stakeholders to the benefits of taking more efficient technologies with equipment and technology choices often determined by upfront capital expenditure. Energy efficient equipment often comes at a price premium and without policies or sufficient information to guide technology choices companies are unlikely to adopt the most energy-efficient technologies.

Expert Recommendations

Recommendation 50

Consider the development of national technology roadmaps or action plans for industrial sub-sector.

To help identify energy efficiency and emission reduction potentials, industry and government can work together to develop a technology roadmap or action plan to outline an implementable strategy for the sector to reduce energy consumption and emissions. Sectoral technology roadmaps allow collaboration among key stakeholders to identify the most important technologies and levers for reducing energy and emissions. They can help to accelerate the uptake of efficient equipment by providing the latest technology performance and cost information.

Roadmaps also provide an opportunity for companies to share lessons learned in the adoption of more energy efficient equipment and can be used to quantify technical energy savings potentials which can be used to establish targets for industry. The process for developing sectoral technology roadmaps can facilitate buy-in of a wide range of stakeholders, including companies, governments, consumers and the financial sector, which will need to take action in implementing the measures and milestones identified by the road mapping process.

As the largest industrial sub-sectors, Malaysia could consider developing economy-wide technology roadmaps for the steel, cement and chemicals sectors. As the second largest thermal energy user and given the outlook for rapid demand growth, the cement sector is a particularly good candidate for the development of an economy-wide roadmap. Significant technical information is also available given the recent release of the CSI-IEA global cement roadmap and technology papers as well as the Indian roadmap and supporting technology papers from 2013.

Recommendation 51

Compliance to energy efficiency to be mandatory for all sectors.

The introduction of mandatory policies for energy efficiency in the industry can help support the adoption of more efficient technologies and restrict the use of inefficient and outdated equipment. China (Top 1000 enterprises) and India (PAT Scheme) provide excellent examples of the implementation of mandatory energy policies in the industry. These policies should be designed to encourage the adoption of global best available technologies and practices. Benchmarking at the sub-sector level can help to identify energy efficiency opportunities and share information on effective measures and technologies to reduce energy use.

Recommendation 52

Implement policies aimed at supporting increased recycling and materials efficiency.

In addition to targeting policies towards efficient industrial processes, policies covering recycling and materials efficiency should also be developed. Across all major energy-intensive sectors, secondary production routes can save up to 95% of energy compared to primary routes. For example crude steel produced in an electric arc furnace uses 60-70% less energy than crude steel produced in a blast furnace and aluminium produced from recycled aluminium uses only 5% to 8% the energy required for primary aluminium production (IEA 2009).

Recommendation 53

Develop an action plan to support the wider adoption of cogeneration technologies.

Significant opportunity exists to reduce thermal energy use through the adoption of cogeneration technologies in the industry that would allow waste heat to be captured and used to produce electricity for own site use or exported to the grid. However a range of economic and regulatory barriers exists which today limits its use. The development of a cogeneration action plan could help to address these barriers by identifying suitable policies aimed at overcoming these challenges. Some policies that economies have used to address these barriers include interconnection obligations, local infrastructure and heat planning, and capacity building and outreach.

3.6 LOW CARBON TECHNOLOGY INVESTMENT AND FINANCING

Improving energy efficiency of thermal energy use in the industry through the adoption of energy efficient equipment will require government support for programmes that help identify energy saving opportunities such as energy audits and implementation of energy management systems. Support may also be required to increase local capacity and training of energy auditors. Government engagement with the finance sector on the opportunities and importance of energy efficiency can also help to attract financial resources.

Achievements

- As explained under Section 1.5 Funding Part II of this report
- Under the 11th Malaysia Plan, the Special Industrial Tariff will be gradually reduced at 2% per annum and abolished in 2020

Challenges

- With limited resources, industry often priorities investments that increase revenues and pay less attention to energy savings.
- Malaysian industry has benefited from low energy prices compared to both regional and international levels which can act as a disincentive for energy efficiency investments.

In many cases energy efficiency investments are funded by internally generated cash flow and finance managers are often ill-informed about the benefits of energy efficiency investments and hence less likely to prioritise these investments.

Low energy prices also represent a challenge and make adopting more efficient and generally more expensive technologies less attractive. Payback periods tend to be longer which can make investments unattractive and difficult to finance. Financial institutions are unlikely to have the required expertise to evaluate the risks and opportunities of adopting energy efficient technologies and as a result industry may not have access to sufficient capital.

The information presented during the workshop gave the Review Team limited knowledge to draft detailed and comprehensive recommendations on investment and financing. The recommendations presented here are based on the review teams knowledge of effective policies implemented in other economies to support the investment and financing of industrial energy savings.

Expert Recommendations

Recommendation 54

Implement policy incentives to encourage the adoption of energy efficiency and low carbon measures

To help facilitate investments in energy efficient technologies and industrial processes, support such as fiscal incentives or other funding mechanisms could be implemented to encourage investment in energy efficient and low carbon technologies. Preferential loans and direct subsidies for energy efficiency can help support technology adoption particularly for new industrial processes which are difficult to finance solely by local financial institutions.

Recommendation 55

Develop and communicate detailed financial case studies.

To overcome knowledge barriers within the financial sector, a dedicated energy efficiency entity can help to develop and communicate detailed financial case studies on industrial energy efficiency successes. This can help to provide the needed information for banks to evaluate the risk and returns of efficiency investments. Also dedicated training and capacity building programs could be developed to build technical capacity on the benefits of energy efficiency investments within the financial sector.

Recommendation 56

Consider the introduction of market-based mechanisms.

Obligations on energy companies to achieve energy saving targets among end-users have become popular and some programmes allow compliance to be traded between obliged parties in the form of a unit of energy savings under an energy efficiency certificate also known as white certificate schemes. In India, the Perform, Achieve and Trade Scheme combines a mandatory industrial energy policy with a market-based mechanism to achieve energy savings. The programme sets energy efficiency standards in energy-intensive sectors, known as designated consumers. The trading of energy saving certificates is central to the programme and serves as an incentive to reach or even surpass the targets.

APPENDIX A: PEER REVIEW TEAM MEMBERS

Name	Organisation	Economy	Position
Mr. Takato Ojimi	APERC	Japan	President and Team Leader
Mr. Andro Marcello	Ministry of Transport	Indonesia	Analyst
Dr. Horizon Gitano	Focus Applied Technologies Sdn. Bhd.	USA	Chief Technical Officer
Dr. Atit Tippichai	King Mongkut's Institute of Technology Ladkrabang	Thailand	Lecturer
Ms. Cecilia Tam	International Energy Agency (IEA)	International Organization	Senior Energy Analyst
Mr. My Ton	P&R Energy	USA	Principal and Director
Dr. David Ferrari	Sustainability Victoria	Australia	Project Lead
Dr. Kazutomo Irie	APERC	Japan	General Manager
Ms. Kirsten Smith	APERC	Canada	Researcher and report editor
Mr. Muhamad Izham Abd. Shukor	APERC	Malaysia	Researcher and project coordinator

APPENDIX B: FOLLOW-UP PREE AGENDA

DAY 1: 26 March 2018 (MONDAY)
Welcome Remarks
Message and briefing
Introduction of delegation and participants
1-1 Preliminary results of 7 th Edition of APEC Energy Demand and Supply Outlook – Malaysia chapter
1-2 Overview of Malaysia's Energy Landscape
1-3 Energy Information and Statistics
1-4 Overview of Demand Side Management in Malaysia (DSM Study)

1-5 Green Technology Master Plan (GTMP) Malaysia 2017-2030
DAY 2: 27 March 2018 (TUESDAY)
2-1 Overview of Malaysia's Transport Sector and Future Plans
2-2 Overview of Malaysia's Land Public Transport
2-3 National Automotive Policy 2014
2-4 Electric Vehicle (EV) Development in Malaysia
2-5 Urban Land-Use And Transportation Planning
DAY 3: 28 March 2018 (WEDNESDAY)
3-1 Policy and Law in Thermal Sub-Sector
3-2 Co-generation Development in Malaysia
3-3 Industrial Energy Efficiency for Malaysian Manufacturing Sector (IEMMS) Project
DAY 4: 29 March 2018 (THURSDAY) SITE VISIT: PERAK HANJOONG SIMEN SDN. BHD
Site visit to Waste Heat Recovery Plant
Farewell Dinner Hosted by APERC at Le Meridien, Putrajaya
DAY 5: 30 March 2018 (FRIDAY) SESSION 4: DISCUSSIONS AND RECOMMENDATIONS BY EXPERT TEAM
APERC Expert team discussion and draft recommendations preparation (At MESTECC)
Presentation of the initial draft recommendations to MESTECC
Closing Remarks

APPENDIX C: LOCAL PARTICIPANTS

Name	Organisation
YBhg. Datuk Badriyah Ab. Malek	Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC)*
Asdirhyme Abdul Rasib	MESTECC*
Wong Ting Song	MESTECC*
Inu Baizura Mohamad Zain	Ministry of Entrepreneur Development (MED)**
Ir. Mohd Zaini Abu Hassan	MESTECC*
Falisya Noor Azam	MESTECC*
Siti Sarah Sharuddin	MESTECC*
Wan Nurfazwina Mat Soti	MESTECC*
Roslina Mohamed	Ministry of Entrepreneur Development (MED)**
Siti Khalijah Jahya	MED**
Sabar Md Hashim	Economic Planning Unit, Ministry of Economic Affairs (EPU)
Siti Zulaikha Mohamad	EPU
Dr. Syed Fatimah Kamal Batcha	EPU
Ahmad Zuhairi Muzakir	EPU
Na'el Kamil Nor Hisham	Ministry of Transport
Nor Azam Abdul Rahman	Ministry of Transport
Wong Lim Ping	Ministry of Transport
Md Zakuan Arief Dato' Hj Alias	Ministry of International Trade and Industry (MITI)
Jonathan a/l Francis Xavier	MITI
Mohd Fadli Mohd Shariff	Ministry of Primary Industry
Nor Mohd Aris Raof bin Jali@Ali	Ministry of Natural Resources and Environment (NRE)
M. Arif Fadhilah	PETRONAS
Ir. Akmal Rahimi Abu Samah	Sustainability Energy Development Authority (SEDA)
Ishamuddin Mazlan	SEDA
Mohd Shah Hambali bin Ariffin	SEDA
Norhasliza Mohd Mokhtar	Malaysian Green Technology Corporation (MGTC)
Huzaimi Nor Omar	MGTC
Marina Yong	MGTC
Norzarifah Ismail	MGTC
Mohd Najib Hamsan	Tenaga Nasional Berhad (TNB)
Suraiya Mohd Shukri	TNB
Zuri Zurianah Hamzah	TNB
Siti Asza Shahiza Mohd Shariaf	Malaysian Public Works Department (JKR)

Faiz Fadzil	JKR
Hjh. Kamariah Ibrahim	PLANMalaysia
Chan Cheng San	Malaysian Iron & Steel Industry Federation (MISIF)
Rosman Hamzah	Malaysia Gas Association
Ir. Hj. Abd Rahim Ibrahim	Energy Commission (EC)
Zulkiflee Umar	EC
Hafizah Yob	EC
Kumareshan a/l Mardappan	EC
Mohamad Faiz Mohd Yusoff	EC
Wan Haslina Wan Hussin	Federation of Malaysian Manufacturers (FMM)
Peter Toh	FMM
Zakuan Mansor	The Cement and Concrete Association
Prof. Ir. Nasrudin Abd Rahim	UM Power Energy Dedicated Advanced Centre
Husna bin Shukur	Semiconductor Fabrication Association of Malaysia
Ir. Dr K S Kannan	UNIDO
Amin A. Majid	ZICO Law
Khoo Yu Lin	ZICO Law
Wong Kee Hooi	ZICO Law
Maria Amani Johan	ZICO Law
Mavis Tan Yong Kee	ZICO Law
Cheng Chee Kong	ZICO Law
Chelsea Lim Chaw Sea	ZICO Law
Loh Wei Liam	ZICO Law
Hua Sia Yen	ZICO Law
Cassandra Chung	ZICO Law
Liew Shu Min	ZICO Law
Ir. Leong Siew Meng	Consultant
Zaini Abdul Wahab	Consultant

* Formerly known as Ministry of Energy, Green Technology and Water

** Former staff of Ministry of Energy, Green Technology and Water

APPENDIX D: REFERENCES

- Al-Mofleh, A., Taib, S., & A.Salah, W. (2010, November 15). *Universiti Sains Malaysia*. Retrieved from MALAYSIAN ENERGY DEMAND AND EMISSIONS FROM THE TRANSPORTATION SECTOR.
- APERC. (2011, May). *Asia Pacific Energy Research Centre*. Retrieved from Peer Review on Energy Efficiency in Malaysia: https://aperc.ieej.or.jp/file/2013/7/23/PREE_201105_Malaysia.pdf
- APERC. (2017, October). *Asia Pacific Energy Research Centre*. Retrieved from Compendium of Energy Efficiency Policies in APEC Economies: <http://aperc.ieej.or.jp/file/2017/11/17/Compendium+2017.pdf>
- Bongardt, D. C.-B. (2013). *Low-Carbon Land Transport: Policy Handbook*. Abingdon, Oxon, UK.
- EC. (2017). *Energy Commission of Malaysia*. Retrieved from National Energy Balance 2015: <http://www.st.gov.my/index.php/en/downloads/category/111-national-energy-balance?download=658:national-energy-balance-2015>
- EGEDA. (2018). *Expert Group on Energy Data Analysis, APEC Energy Working Group*. Retrieved from APEC Energy Database: <http://www.ieej.or.jp/egeda/database/database-top.html>
- EPU. (2015). *Economic Planning Unit, Prime Minister Department*. Retrieved from Eleventh Malaysia Plan 2016–2020: <http://epu.gov.my/en/rmk/eleventh-malaysia-plan-2016-2020>
- EPU. (2018). *Economic Planning Unit, Prime Minister's Department*. Retrieved from Malaysia Economy in Figures 2017: http://www.epu.gov.my/sites/default/files/MEIF_2017.pdf
- KeTTHA. (2017, July). *Ministry of Energy, Green Technology and Water*. Retrieved from Green Technology Master Plan: <http://www.kettha.gov.my/portal/document/files/Green%20Technology%20Master%20Plan%20Malaysia%202017-2030.pdf>
- MAI. (2015). *MAI (Malaysia Automotive Institute)*. Retrieved from Malaysia's Energy Efficient Vehicle (EEV) Vision: <http://www.mai.org.my/v3/index.php/osvc/elib/send/22-publication/38-malaysia-s-energy-efficient-vehicle-eev-vision>
- MATRADE. (2017). *Malaysia External Trade Development Corporation*. Retrieved from Top 10 Major Export Products 2016: <http://www.matrade.gov.my/en/28-malaysian-exporters/trade-statistics/3447-top-10-major-export-products-2016>
- NRE. (2015, December). *Ministry of Natural Resources and Environment*. Retrieved from Malaysia Biennial Update Report to UNFCCC: http://www.nre.gov.my/sites/TNC-BUR/Documents/BUR_Malaysia_Final.pdf

SEDA. (2018, April 30). *Sustainable Energy Development Authority*. Retrieved from FIT Dashboard – RE Capacity: <http://seda.gov.my/>

The STAR. (2016, May 11). Retrieved from Sarawak Exporting Electricity to West Kalimantan: <http://www.thestar.com.my/news/nation/2016/05/11/sarawak-exporting-power-to-west-kalimantan>

UNPAN. (1999). *United Nations Public Administration Network*. Retrieved from Sustainable Energy Policy and Strategies: A Pre-Requisite for the Concerted Development and Promotion of the RE in Malaysia: <http://unpan1.un.org/intradoc/groups/public/documents/apcity/unpan003>