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Country Chapter
State of the 3Rs in Asia and the Pacific

Malaysia

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Disclaimer

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This publication is intended to provide expert-based assessment of regional progress of 3R policy implementation in selected countries and regions in Asia and the Pacific, particularly in response to the Hanoi 3R Goals (2013-2023) adopted at the 4th Regional 3R Forum in Asia and the Pacific in Hanoi in March 2013.

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A: WASTE DEFINITION

The laws of Malaysia (Act 672 – Solid Waste and Public Cleansing Management Act 2007) define "**solid waste**" as –

a. Any scrap material or other unwanted surplus substance or rejected products rising from the application of any process;
b. any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled; or
c. any other material that according to this Act or any other written law is required by the authority to be disposed of, but does not include scheduled wastes as prescribed under the Environmental Quality Act 1974 (Act 127), sewage as defined in the Water Services Industry Act 2006 (Act 655) or radioactive waste as defined in the Atomic Energy Licensing Act 1984 (Act 304).

Solid wastes have a mass, weight, and constant volume (World Bank, 1999a). However, solid waste does not include scheduled wastes as prescribed under the Environmental Quality Act 1974 [Act 127]. On the other hand, sewage and radioactive waste are defined accordingly as in the Water Services Industry Act 2006 [Act 655] and the Atomic Energy Licensing Act 1984 [Act 304], respectively. Solid wastes are generally categorized into five groups, namely municipal wastes, industrial wastes, hazardous wastes, agricultural wastes and e-wastes.

Municipal waste is part of solid waste, including the following;

a. any scrap material or other unwanted surplus substance or rejected products arising from the application of any process;
b. any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled; or any other material that, according to Solid Waste and Public Cleansing Management Act 2007 [Act 672] or
c. any other substance according to other written laws, that is required by the authority to be disposed of. This includes public solid waste, imported solid waste, household solid waste, institutional solid waste and special solid waste such as waste from commercial, construction, industrial and controlled activities (Municipal Waste Management Report, 2010)

According to Biomass-sp, (2014) the following are some consensus definitions of **biomass** at the European and International level:

a. United Nations Framework Convention on Climate Change (UNFCCC) Definition of renewable biomass: "The biomass is the non-fossil fraction of an industrial or municipal waste."
b. Organisation for Economic Co-operation and Development (OECD) Definition of solid biomass: "Biomass is defined as any plant matter used directly as fuel or converted into other forms before combustion."
c. EU's Waste Framework Directive: "bio-waste" means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants"
d. International Energy Agency (IEA) Definition of Biomass: "Renewable energy from living (or recently living) plants and animals; e.g. wood chippings, crops and manure."

e. European Biomass Association (AEBIOM) Definition of Biodegradable Waste: "Biodegradable waste is the biomass that can cover several forms of waste such as organic fraction of municipal solid waste, wood waste, refuse-derived fuels, sewage sludge, etc."

Food waste could be considered as agricultural wastes. The waste also includes both plant residue and animal waste. Some agricultural waste containing pesticides and herbicides is regarded as hazardous waste.

Industrial waste means any solid waste generated from any industrial activity (Solid Waste and Public Cleansing Management Act 672, 2007) which include rubbish, ashes, demolition and construction wastes. Some of the waste could also include hazardous and special waste.

Hazardous waste is defined as any waste falling within the categories of waste listed in the First Schedule of the Environment Quality (Scheduled Wastes) Regulations 2005. This is a special group of waste and could contain substances posing substantial danger or hazards to human, plant, or animals as well as the environment. The waste is categorized as such due to its ignitability, corrosive, reactivity, toxicity or infectivity. Usually clinical waste (causing infectivity) is categorized separately. Sometimes it could also be categorized as radioactive waste, chemical waste, biological waste, flammable waste and explosive waste.

E-waste, under the Environmental Quality Act 1974 (Act 127), is defined as 'waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated bi-phenyl capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl.

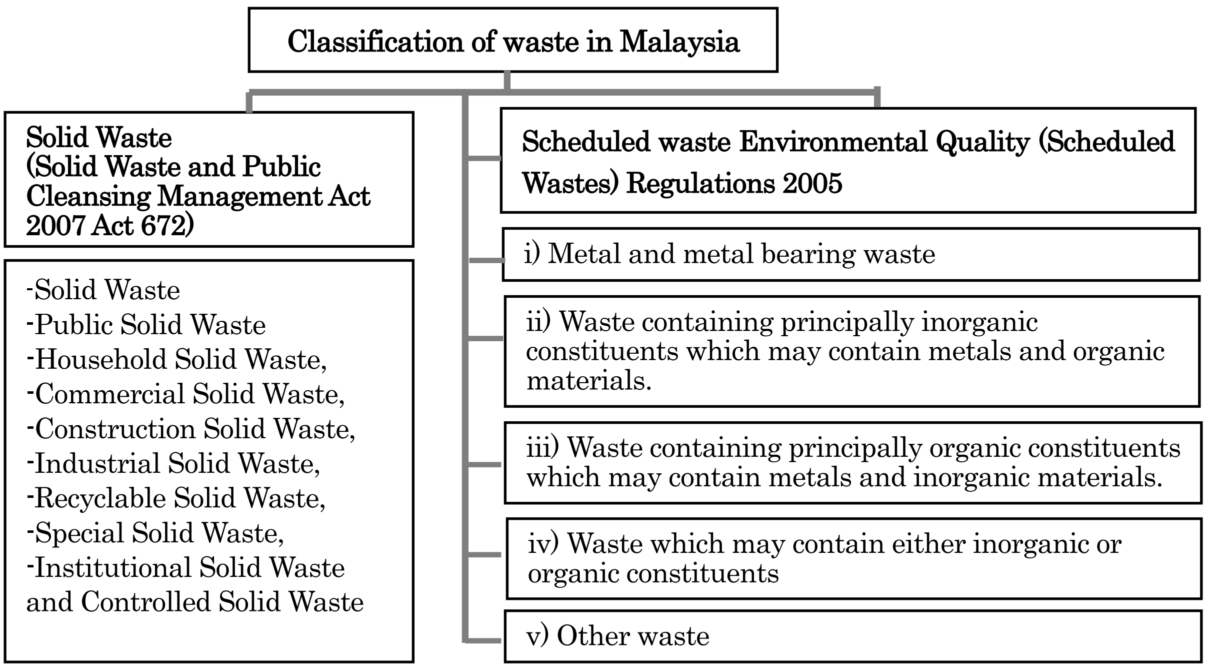


Figure A-1: Waste Classification in Malaysia

Waste Flow in Malaysia

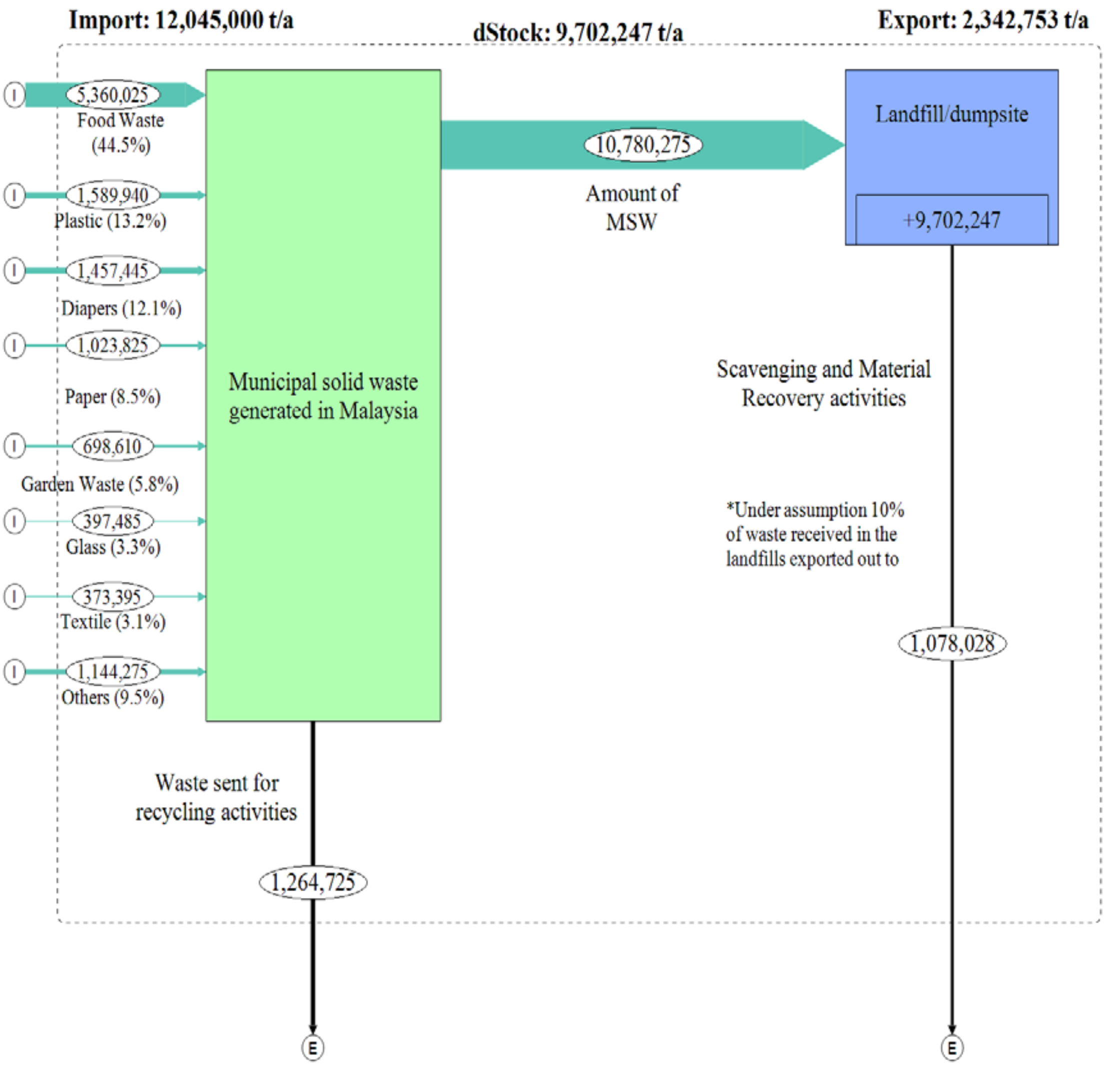
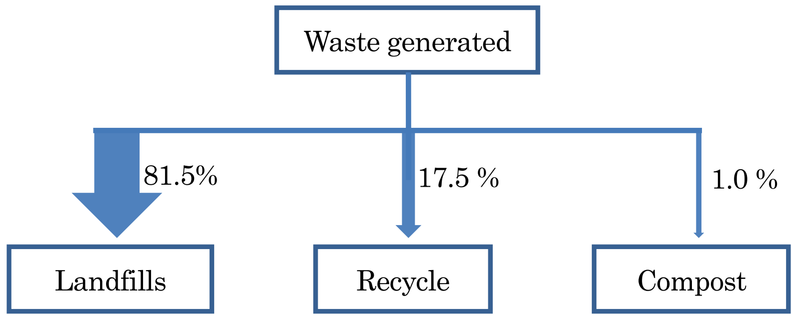


Figure A-2 MSW flow in Malaysia

The overall flow of the municipal solid waste is shown in Figure A-3:



(Source: Tan et al., 2014)

Figure A-3: Municipal Solid Waste Flow

B: COUNTRY SITUATION

Malaysia is a federal constitutional monarchy that is located in the South East Asia region. It is made up of 13 states and 3 federal territories (Figure B-1) with a total landmass of 329,847 square kilometers that is separated by the South China Sea. It is classified into two regions, namely Peninsular Malaysia and East Malaysia (Malaysian Borneo). The Malaysian population in 2015 is approximately 30 million. The capital city of Malaysia is Kuala Lumpur, with Islam being the official religion in the country. Besides that, being a country that was ruled by the British Empire prior to independence, the government system in Malaysia is closely modeled on the Westminster parliamentary system. The head of Malaysia is the Yang di-Pertuan Agong, commonly referred to as the King. However, executive power lies in the hands of the prime minister of the cabinet. Malaysia's economy was predominantly agricultural-based in the 1970s before transitioning into a multi-sector economy with the industrial sector being the main economy since the 1980s.

With the onset of industrialization and development, the increase in waste generation is fast out-growing the rate of urbanization. This will bring about a drop in the levels of hygiene and quality of urban life. Malaysia is categorized as a middle-income country with approximately 22.6 million people living in Peninsular Malaysia. The solid waste management scene in Malaysia has evolved dramatically since the early 1970s, when the population density was still low and the generation of waste was still manageable.

(Source: United Nations, 2012)

Figure B-1: South East Asia Region

Prior to the enforcement of the Solid Waste and Public Cleansing Management Act 2007 (Act 672) in 2011, the solid waste generated in Malaysia was being managed by state and local governments. During that period of time, solid waste management services were provided by the local authorities who engaged the services of small contractors. In 2007, the Solid Waste and Public Cleansing Management Act was passed by parliament. The subsequent enforcement of the Act on 1st September 2011 provided executive authority to the federal government on the solid waste management in eight states and federal territories.

The collection of municipal solid waste in Peninsular Malaysia was privatized and concessions were given to three companies to handle the waste collection in three different regions. Southern Waste Management Pvt Ltd (SWM) Enviro was given the concession to collect the waste in the southern region (Johor, Malacca and Negeri Sembilan). Meanwhile, in the northern region, E-Idaman Pvt Ltd was in charge of the waste collection in Perlis and Kedah. The contractor in charge of the central and eastern region (Kuala Lumpur, Putrajaya and Pahang) of Peninsular Malaysia is Alam Flora Pvt Ltd. The timeline below depicts the solid waste management history in Malaysia (Figure B-2). The goal of the National Solid Waste Management Department is to achieve a 40% reduction of waste going into landfills. Not only will this reduce the burden on the landfills in Malaysia, it will also directly reduce greenhouse gas emissions from landfills in Malaysia. Moreover, the department aims to achieve a 38% reduction in greenhouse gas emissions from solid waste disposal by year 2020.

(Source: cforum.cari.com.my, 2015)

Figure B-2: States in Malaysia

Under the Solid Waste and Public Cleansing Management Act 2007, the Department of National Solid Waste Management will work hand in hand with the Solid Waste and Public Cleansing Corporation. The Department of National Solid Waste Management is responsible for the proposition of policy, plans and strategies for the national solid waste management scene. Besides that, it is also responsible in setting standards, specifications and codes of practices, as well as, formulating plans for solid waste management facilities. Meanwhile, the Solid Waste and Public

Cleansing Corporation is responsible for the implementation of the policy and plans set by the department. Besides monitoring the compliance to the standards and codes of practice, it also plays a role in promoting public participation and improving public awareness on solid waste management. Since 1st September 2012, a '2+1 collection system' had been implemented in the eight states under the National Solid Waste Management Department with waste collection being carried out once every two days for residual wastes and once every week for recyclable wastes, bulky wastes and green wastes. Besides that, new standards on waste bins and garbage collection trucks were being implemented. Additionally, there was also the enforcement of Key Performance Index (KPI) on garbage collection schedule.

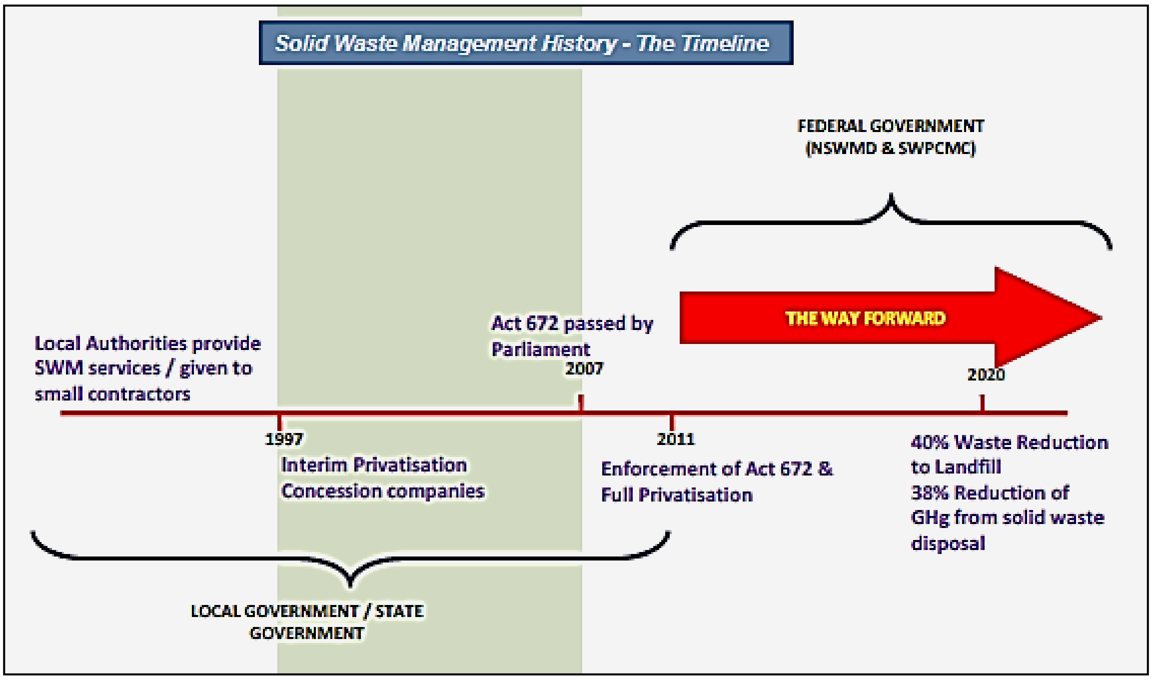


Figure B-3: The timeline of solid waste management history

In Malaysia, facilities for the recovery and treatment of waste are very limited with only one waste to energy (WtE) plant in Kajang and five incinerators, each in Labuan, Langkawi Island, Tioman Island, Pangkor Island and Cameron Highlands. The WtE plant which was commissioned in 2009 is Malaysia's first WtE plant where MSW is converted into refuse derived fuel (RDF) to fuel an integrated steam power plant.

Currently, Malaysia is still very dependent on landfills as the main method of waste disposal. Out of the 296 landfills in Malaysia, 165 are operational, with only eight of them being sanitary landfills. Almost 95% of the national waste enters the landfills with recycling at 5%. However, it should be noted that the national recycling rate might not be accurate since recycling activities in Malaysia are not regulated, resulting in the absence of proper data collection. According to market players, the national recycling rate is estimated to be higher than 15%. Besides that, the price of recyclables in Malaysia is highly market driven and seasonal in nature. The recycling price fluctuates according to demands, with collectors and traders hoarding the recyclables until the 'right' selling price is achieved. Some of the common recycling practices seen in Malaysia are the collection and recycling of old newspapers, glass bottles, plastic PET bottles, aluminum tin cans, vehicle tires, and also food waste. For instance, the Kuala Lumpur City Council (DBKL) had initiated campaigns to clean and beautify the Malaysian capital by converting food waste and organic waste into fertilizers through the Local Agenda 21 Kuala Lumpur (LA21KL) program. It is a program that is aimed to promote a cleaner and greener city through effective waste management.

The National Solid Waste Management Department recognized that the continued usage of landfills (business-as-usual) is not sustainable in the long run. The urgency to move away from landfill is fueled by the lack of areas for new landfills in major urban cities, as well as the negative public perception on landfills and greenhouse gas emissions from landfills. Therefore, a framework for recovery and treatment facilities has been established, with the objectives being:

1. Sustainable model of implementation
2. Minimum risk exposure to the government
3. Minimum impact to the environment and natural resources
4. Commercially proven technology and high reliability for long term solution
5. Maximum reduction of waste

Along the line, multiple plans and policies had been introduced by the Malaysian government in a bid to improve the environmental situation in the country. Some of these policies include the **Master Plan on National Waste Minimization** which was done by the Ministry of Housing and Local Government to provide visions, strategies and roles for stakeholders, as well as promoting awareness among the public on the reduction of waste. Besides the Solid Waste and Public Cleansing Act, the Solid Waste Management Corporation Strategic plan was also introduced to establish environmentally sustainable solid waste management through public awareness. In order to promote a climate resilient development in Malaysia, the Malaysian government also introduced the **National Policy on Climate Change** in 2009. The aim of this policy is to cut the 2005 greenhouse gas emissions by 50%.

Besides that, the government has also launched various campaigns and programs with the aim to create awareness on the 3Rs (reduce, reuse and recycle). Even though 3R campaigns were launched by the government in 1996 and again in 2000, the public reception has been relatively poor. Alam Flora Pvt Ltd, being one of the main players in the solid waste management scene in Malaysia, has recently worked together with the Solid Waste Management and Public Cleansing Corporation to promote awareness program in a bid to minimize waste generation and indiscriminate waste disposal. Recycling banks were also promoted in schools in Putrajaya besides having community programs that involves recycling center and mobile recycling centers in the city. Correspondingly, successful 3R programs in neighboring countries were also used as a benchmark by Alam Flora Pvt Ltd for its performance. Such successful 3R concept includes the Wongpanit Recycling system from Thailand, as well as the 3R implementation in Surabaya, Indonesia.

A **green technology** soft loan scheme of MYR 1.5 billion was also introduced by the Malaysian government in the 10th Malaysia Plan which aims to supply and utilize green technology. In this program, the government bears 2% of the total interest rate and a guarantee of 60% on the financing amount while the remaining 40% is born by banking institutions.

Moreover, in 2011, the Ministry of Domestic Trade, Cooperative and Consumerism had launched the **No Plastic Bag Day Campaign** to cut down excessive usage of plastic bags in Malaysia. In this campaign, a charge of MYR 0.20 was imposed on the purchase of plastic bags on No Plastic bag day, which is every Saturday. In this concept of plastic bag taxation, revenues from the plastic bag levy will be used to fund environmental programs nationwide. One state in Malaysia, Penang, further embraced this campaign by running the No Plastic Bags campaign in major shopping malls whole year round.

Table B-1 shows the difference in operating cost and capital cost of the various types of disposal methods that were being considered by the National Solid Waste Management Department of Malaysia. Landfilling remains the cheapest waste disposal method in Malaysia by costing less than MYR 50 as compared to other methods.

Table B-1: Various types of disposal methods used in Malaysia

Disposal method	Capital expenditure (MYR million)	Operating expenditure (MYR per tonne)
Landfill	30	28.80 – 49.00
Waste to Energy	250	101
Plasma gasification	650	202
Mass burn stoker	550	124

One USD = 3.621 MYR (as at 23/4/2015)

Source: (NSWMD, 2012)

Table B-2 shows the composition of the waste generated in Malaysia based on the economic status of the household. The composition namely paper, plastic and glass waste are inversely proportional to the composition of food waste along the socio-economic status line. This is because more processed products are being purchased by the higher income groups compared to the lower income groups, which explains the inverse proportion of the said waste types.

Table B-2: Composition of the waste generated in Malaysia based on the economic status of the household

Composition (%)	Socio-economic status		
	High	**Middle**	**Low**
Paper products	19.79	15.73	13.04
Plastic and rubber	21.05	18.61	13.01
Glass and ceramics	14.99	9.42	7.57
Food waste	24.13	29.77	31.86
Metals	8.80	12.75	9.15
Textiles	1.57	3.87	3.08
Garden waste	5.50	6.95	15.56
Wood	3.45	2.90	6.72
Total	**100.00**	**100.00**	**100.00**

Source: (Agamuthu & Tanaka, 2014)

C: 3R INDICATORS

I. Total MSW Generated and Disposed and MSW Generation Per Capita (by Weight)

Table C-1: Summary of MSW generation and disposal

Indicators	Data	Unit	Year	Reference
Total MSW Generation	12,982,685 (estimation)	Tonne/year	2014	NSWMD (2013)
MSW Generation per Capita	1.17	kg/capita/day	2012	NSWMD (2013)
Total MSW Disposal	12,982,685 (estimation)	Tonnes/year	2014	Agamuthu and Tanaka (2014)
	35,569	Tonnes/day		

According to the National Solid Waste Department of Malaysia, the MSW generation of Malaysians is approximately 1.2 kg per capita daily in 2014 (Figure B-3). The average daily disposal of solid waste in 2014 is approximately 12,982,685 tonne/year (=35,569 tonnes/day *356 days)
(Table C-1). This is a projected value from the original 2012 data (1.17kg per capita) with an estimated annual increase of 3.59%.

Meanwhile, Figure C-1 shows the quantity of solid wastes generated in major cities in Malaysia throughout the years from 1970 to 2012. Kuala Lumpur produces the highest amount of solid waste daily. The rapid growth of population and urbanization contributed greatly to the drastic increase in waste generation in Kuala Lumpur. According to the World Bank (2012), the MSW generation rate of urban cities in Malaysia is 1.52 kg per capita in 2012 based on a generation rate of 21,918 tonnes of MSW per day from a total of 14,429,641 city dwellers in Malaysia.

Table C-2: Average municipal solid waste disposal (tonnes/day) in Malaysia 2013

State	Average disposal (tonne/day)
Selangor	6,855.11
Johor	4,205.97
Sabah	4,030.20
Sarawak	3,101.12
Perak	2,950.46
Kedah	2,448.25
Federal Territory of Kuala Lumpur	2,096.71
Pulau Pinang	1,958.60
Kelantan	1,933.49
Pahang	1,883.27
Terengganu	1,305.73
Negeri Sembilan	1,280.62
Melaka	1,029.52
Perlis	288.77
Federal Territory of Labuan	113.00
Federal Territory of Putrajaya	87.89
Total	35,568.71

(Source: NSWMD, 2013)

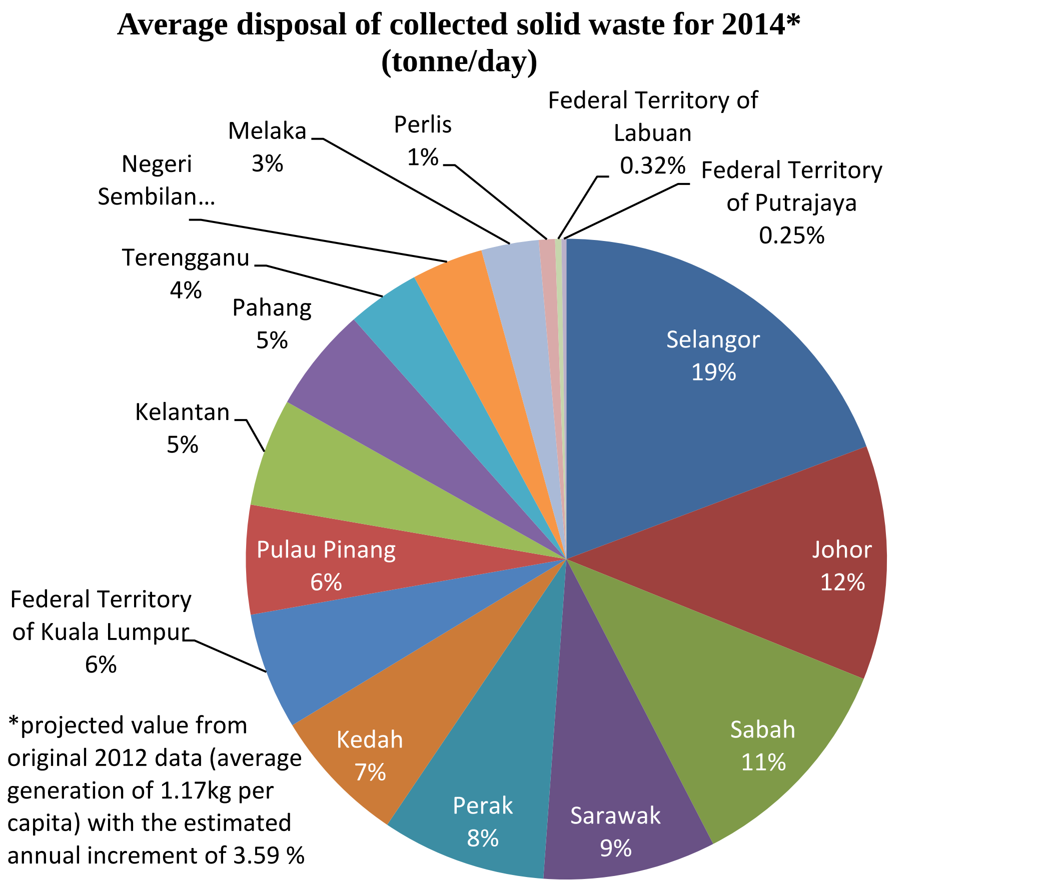
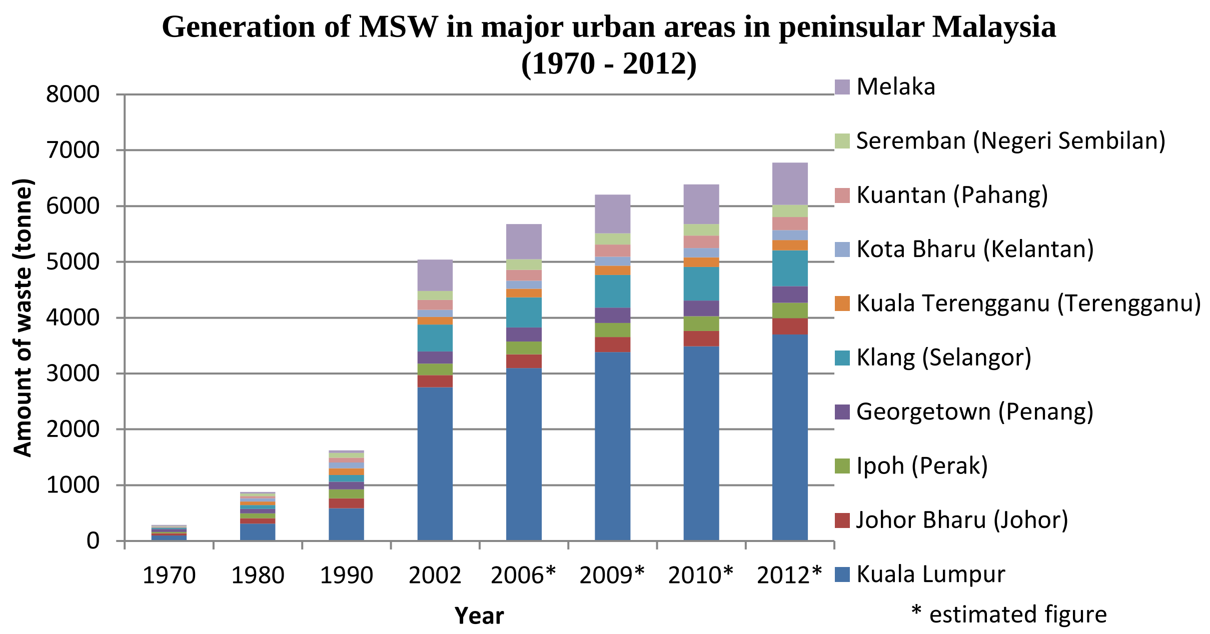


Figure C-1 Percentage of solid waste generated by states in Malaysia in 2014



(Source: Agamuthu& Tanaka, 2014)

Figure C-2 Generation of MSW in major urban areas in Peninsular Malaysia (1970 - 2012)

II. Overall Recycling Rate and Target (%) and Recycling Rate of Individual Components of MSW (Primary Indicator)

Table C-3: Summary of the Recycling rate

Indicators	Data	UNIT	Year	Reference
Overall Recycling Rate	5	%	2005	Table C-4
	10.5	%	2012	
	15	%	2014	Agamuthu & Tanaka 2014
	17.5	%	2016	MHLG
Target of Recycling Rate	22 by 2020	%	2002	Ministry of Housing and Local Government

Under Act 672, '**recycling**' is defined as "collecting and separating solid waste for the purpose of producing products", with 'recycling centers' being defined as "a place where the public can either drop or sell recyclable solid waste". The recycling industry was estimated at MYR 476 million in 2005 but increased to more than MYR 600 million in 2011. The price of recyclable is highly market driven and dependent of commodity prices which are highly seasonal in nature. As such, the uncertainty of demand prices and fluctuations leads to a lack of incentives to end customers. This practice leads to feedstock problem in recyclers. All this in turn, hampers recycling effort. The stated recycling rate in Table C-4 and Table C-5, are underestimated since recycling activities are still not regulated.

Table C-4: Waste composition and recycling rate (Agamuthu and Tanaka, 2014)

Year	2005	2012
Population	26,600,000	28,300,300
Waste Generation (tonne/day)	19,000	33,000
Generation Rate	0.8 kg/day/person	1.1 kg/day/person
Waste Composition (%)		
Food Waste	45	44.5
Plastic	24	13.2
Diapers	-	12.1
Paper	7	8.5
Garden Waste	-	5.8
Glass	-	3.3
Textile	24	3.1
Others	-	9.5
Recycling Rate (%)	5	10.5

Table C-5: Waste generation and recycling rate trend towards 2020 (Agamuthu and Tanaka, 2014)

Year	2005	2012	2020 (Projection)
Total Waste Generation (tonne/day)	19,000	33,000	30,000 (projected in 2005)
Recycling Rate (%)	5	10.5	22 (targeted)

III. Amount of Hazardous Waste Generated and Disposed in Environmentally Sound Manner (Primary Indicator)

Table C-6: Summary of Hazardous Waste Generation

Indicators	Data	UNIT	Year	Reference
Amount of HW Generation	1,880,928	Tonne/year	2010	Table 0-7
	1,659,537		2011	
	1,708,708		2012	
Amount of HW Disposal (to Kualiti Alam Pvt Ltd)	1,880,928		2010	
	1,659,537		2011	
	1,708,708		2012	

In Malaysia, hazardous waste is referred as Scheduled waste. Under Environmental Quality (Scheduled Wastes) Regulations 2005, scheduled waste refers to any waste falling within the 107 categories (grouped into specific and non-specific sources) of hazardous waste listed in the First Schedule of the EQA, 1974 (see APPENDIX 1). These wastes must be rendered as inert as possible prior to disposal.

Table C-7 shows the scheduled waste generated in Malaysia from 2005 to 2012. Figure C-3 shows obvious increase of scheduled waste generation from 2000 to 2012. Malaysia has been facing numerous assaults on its environment due to the accelerating pace of industrialization. Implementation of various development plans notably Industrial Master Plan (IMP) increased the number of polluting sources. Table C-7 shows the quantity of Scheduled Wastes generated by category for 2013, with the total waste of 1,387,861.64 metric tonnes.

Table C-7: Scheduled wastes generated in Malaysia, 2005 – 2012 (Source: DOE 2000 to 2012)

Year	Waste generated (tonnes)
2000	344,550.00
2001	420,168.00
2002	363,071.00
2003	460,856.00
2004	469,584.00
2005	548,916.11
2006	1,103,457.06
2007	1,138,839.49
2008	1,304,898.77
2009	1,705,308.14
2010	1,880,928.53
2011	1,659,537.00
2012	1,708,708.00

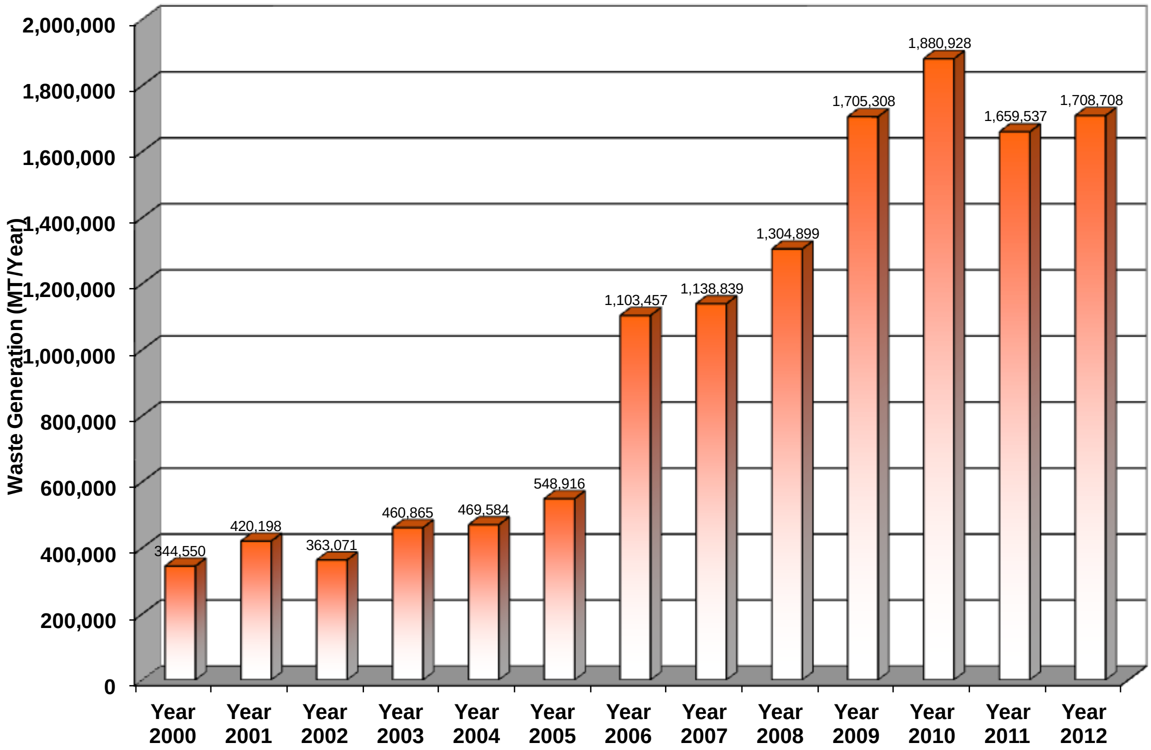


Figure C-3 Hazardous waste generation in Malaysia from 2000 to 2012 (Source: DOE 2000 to 2012)

Scheduled waste is managed under Environmental Quality Act 1974 which includes the following regulations:

i. Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment & Disposal Facilities) Regulations 1989
ii. Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment & Disposal Facilities) (Amendment) Regulations 2006
iii. Environmental Quality (Scheduled Wastes) Regulations 2005
iv. Environmental Quality (Scheduled Wastes) (Amendment) Regulations 2007
v. Environmental Quality (Dioxin and Furan) Regulations 2004
vi. Environmental Quality (Prescribed Conveyance) (Scheduled Wastes) Order 2005
vii. Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment And Disposal Facilities Order) 1989

In 2012, a total of 446 off-site recovery facilities have been licensed. The most issued licensed are for e-waste (153 facilities), oil/mineral sludge / spent coolant (58 facilities), heavy metal sludge / rubber (37 facilities), used container/contaminated waste/ink/paint/lacquer (34 facilities), solvent (31 facilities), and acid /alkaline (27 facilities) (Table C-9).

All premises must All premises must comply with Quality (prescribed activities) Environmental Impact Assessment) Order 1987. EIA is required to be submitted to the DOE. Licensing is also controlled by EQR, 1989.

Table C-8: Quantity of Scheduled Wastes Generated by Category, 2013

Waste Categories	Quantity of Wastes	
	(Metric Tonnes/Year)	Percentage (%)
Gypsum	577,801.55	41.6327
Dross/Slag/Clinker/Ash	122,262.25	8.8094
Spent Lubricating oil	105,482.65	7.6004
Heavy Metal Sludge	103,944.37	7.4896
Contaminated Container	609,62.17	4.3925
E-Waste	52,978.13	3.8173
Spent Acids	50,563.34	3.6433
Spent mineral oil-water emulsion	35,551.00	2.5616
Waste of Non-Halogenated Solvent	34,390.16	2.4779
Rubber/Latex Waste Containing Heavy Metal	28,066.75	2.0223
Mineral Sludge	21,811.41	1.5712
Mixture of Scheduled Waste & Non-Scheduled Waste	19,967.23	1.4387
Mixture of Scheduled Waste	19,083.09	1.3750
Pathogenic/Clinical Waste	18,152.95	1.3080
Residue From Recovery of Scheduled Waste	16,807.26	1.2110
Ink & Paints Sludge	15,233.83	1.0977
Waste of Inks & Paints	14,513.62	1.0458
Rags/Plastics/Papers contaminated with Scheduled Waste	13,429.22	0.9676
Discarded of Ink/Paint/Pigment/Lacquer Containing Organic Solvent	8,117.06	0.5849
Lab Waste	7,338.01	0.5287
Waste oil/Oily sludge	5,277.57	0.3803
Sludge Containing Fluoride	5,277.52	0.3803
Waste Catalyst	4,818.20	0.3472
Spent Hydraulic oil	4,641.05	0.3344
Waste Of Thermal Fluids	3,520.16	0.2536
Spent di-isocyanates	3,146.78	0.2267
Waste containing Mercury	2,986.31	0.2152
Spent Alkalis	2,397.45	0.1727
Spent Alkalis With PH > 11.5	2,356.11	0.1698
Contaminated Land/Soil	2,303.60	0.1660
Clinker/Slag/Ashes From Incinerator	2,231.85	0.1608
Waste Of Halogenated Solvents	2,208.63	0.1591
Acid Sludge	2,066.05	0.1489
Waste of Resin Containing Organic	1,965.74	0.1416
Spent Organic Acids	1,922.64	0.1385
Waste of lead acid batteries	1,645.70	0.1186
Expired Drug	1,470.14	0.1059
Oily Residue from Workshop	1,299.17	0.0936
Photographic Waste	1,220.84	0.0880
Waste Of Batteries Containing Cadmium/Hg/Lithium	1,120.03	0.0807
Oil -Water mixture	1,078.61	0.0777
Contaminated Active Carbon	1,036.77	0.0747

Waste Categories	Quantity of Wastes (Metric Tonnes/Year)	Percentage (%)
Oil Sludge from Oil Refinery	935.81	0.0674
Chemical Waste	706.01	0.0509
Sludge from mineral oil storage tank	615.56	0.0444
Waste Containing Formaldehyde	573.67	0.0413
Tar Residue From Oil Refinery/Petrochemical Plant	540.80	0.0390
Waste Of Phenols Its Compound	463.44	0.0334
Adhesive/Glue Containing Organic Solvent	442.57	0.0319
Spent Aqueous alkaline Containing Cyanide	207.50	0.0150
Contaminated Oil from re-refining/used lubricating Oil	200.49	0.0144
Stabilized Sludge	139.45	0.0100
Waste both Halogenated or Non Halogenated From Recovery	126.14	0.0091
Discarded Drug	120.36	0.0087
Asbestos	102.85	0.0074
Pesticide	80.52	0.0058
Flux Waste	68.75	0.0050
Waste of Organic phosphorus compound	18.50	0.0013
Waste From Manufacturing/Processing or use of explosive	17.26	0.0012
Residue from Recovery of Acid Pickling Liquor	16.01	0.0012
Used Pesticide/Herbicides/Biocides	11.34	0.0008
Sludges Containing Cyanide	8.06	0.0006
Waste Containing Peroxides	7.89	0.0006
Slag of Copper	3.88	0.0003
Waste From Wood Containing Heavy Metals	3.00	0.0002
Waste containing arsenic	1.99	0.0001
Spent Oxidizing Agent	1.07	0.0001
Spent Of Organometallic compound	1.03	0.0001
Spent salt containing Cyanide	0.56	0.0000
Zink Residue	0.11	0.0000
Waste containing PCB or PCT	0.08	0.0000
Total	1,387,861.64	100.00

Table C-9: Generated Scheduled Wastes Managed under Special Management, 2012

Waste Category	Source	Metric Tonnes	Percent (%)	Method of Disposal
Heavy Metal Sludge	Drinking Water Treatment Plant	190,622.00	16.64	Sanitary Landfill
	Industry	109,072.64	9.52	
Fly Ash & Bottom Ash	Coal-Fired Power Plant	743,329.06	64.87	Reuse as raw material for product
	Industry	22,457.72	1.96	

Waste Category	Source	Metric Tonnes	Percent (%)	Method of Disposal
Gypsum	Industry	68,734.50	6.00	Sanitary Landfill
Glue	Industry	1.80	0.00	Reuse as raw material for product
Petroleum By Product	Industry	439.77	0.04	Recovered
Waste Containing Formaldehyde, resin, discarded epoxy powder	Industry	7,182.20	0.63	Sanitary Landfill
Discarded Pharmaceutical Product, Discarded Product	Industry	31.42	0.00	Sanitary Landfill
Ash of Paper Sludge	Industry	3,936.94	0.34	Sanitary Landfill
Spent Mixed Oil	Industry	0.01	0.00	Reuse as releasing agent for mould cement
Total		1,145,808,05	100	

Figure C-4 illustrates the route of scheduled waste in Malaysia and the amount generated in 2013. Approximately 0.89 million tonnes were exported per annum. On the other hand, recovery of the materials only amounted to 122 tonnes per year. The exportation and recovery of this scheduled waste require written permission from the authorities. Figure C-5 depicts the different authoritative level within the scheduled waste management in Malaysia.

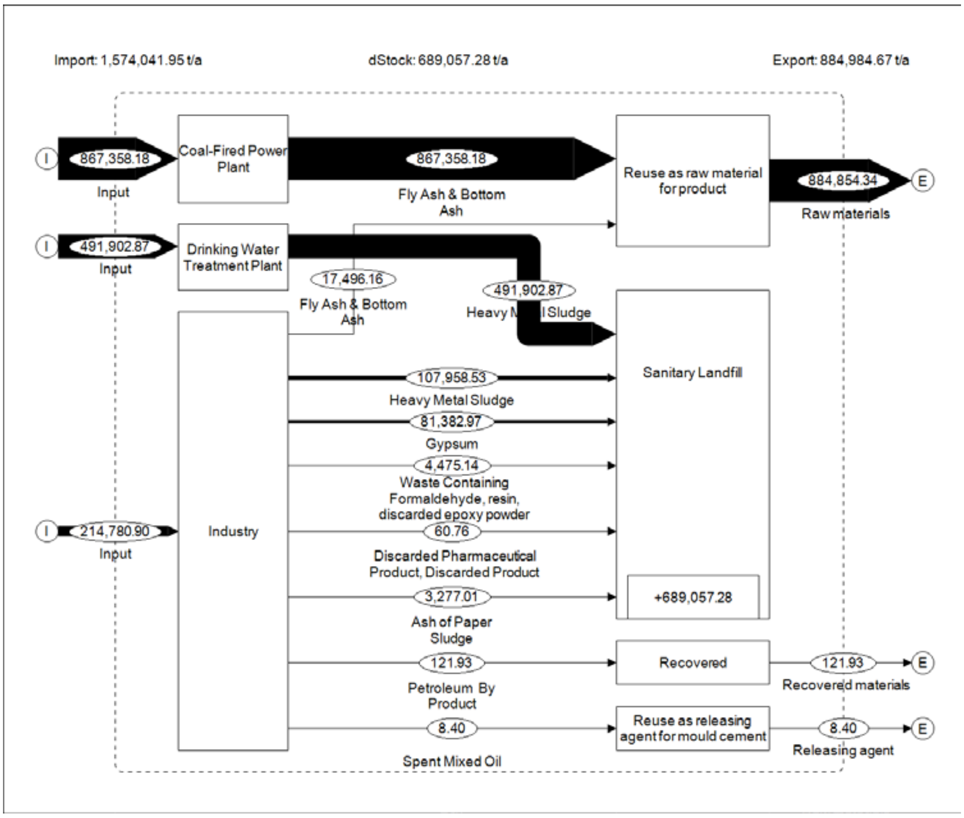


Figure C-1: Specially Managed Scheduled Waste Flow in Malaysia, 2013

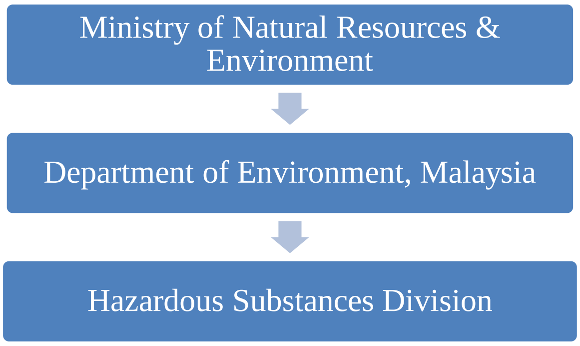


Figure C-2: Ministry/department in charge in hazardous waste management

The management of scheduled waste is considered to be proper when the most of the waste generated is recovered by the off-site recovery facilities. Only approximately 4% are handled by Kualiti Alam Sdn. Bhd. Table C-10 lists the percentage of waste being managed at the scheduled waste management facilities in Malaysia.

Table C-10: Facilities Handling Scheduled Waste, 2013

Type of Industries	Quantity of Waste	
	Metric tonnes/ year	Percentage (%)
Special Waste Management	1,574,041.95	53.08
On-site Treatment	630,221.40	21.25
Local Off-site Recovery Facilities	566,506.51	19.10
Kualiti Alam Sdn Bhd	111,860.20	3.77
On Site Storage	41,742.48	1.41
Trinekens (Sarawak) Sdn Bhd	19,330.00	0.65
Off-site Clinical Waste Incinerators	18,201.05	0.61
Foreign Facilities	3,708.07	0.13
Total	**2,965,611.65**	**100**

(Source: Malaysian Environmental Quality Report, 2013)

Clinical Waste

Hospital waste in Malaysia comprises general waste, clinical waste, pharmaceutical waste, hazardous chemicals, and radioactive waste where clinical waste is reported together with pharmaceutical waste. Although 75% to 90% of hospital waste is a non- hazardous waste which is general waste, the remaining 10% to 25% of the waste is regarded as hazardous or clinical waste and may carry a variety of health risks. Table C-11 summarizes the WHO categories of hospital waste.

Due to the heterogeneity within the waste stream, proper clinical waste management is very important to avoid health risks and damage to the flora, fauna and the environment. Hospital waste is a potential reservoir of pathogenic micro-organisms so appropriate, safe and reliable handling is crucial. There are recognized hazards associated with clinical waste where exposure can result in disease or injury. This is because clinical waste may be may be genotoxic, may hold infectious disease, contain hazardous chemicals, pharmaceutical residues, or radioactive compound, or and it may contain sharp items. All transportation and disposal of clinical waste in Malaysia is regulated under the Environmental Quality (Scheduled Waste) Regulations 2005.

i. The Ministry of Health reported that clinical waste under the Environmental Quality (Scheduled Waste) Regulations 2005 are defined as any waste which consists wholly or partly of human or animal tissue, blood or other body fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments, or waste which unless rendered safe may prove hazardous to any person coming into contact with it. Clinical waste also refer to any other waste arising from medical, nursing, dental, veterinary, pharmaceutical or similar practice, investigation, treatment, care, teaching or research, or the collection of blood for transfusion, being which may cause infection to any person coming into contact with it (Table C-11). Table C-12 lists the major classification of the waste and its recommended management procedure in Malaysia.

In Malaysia, clinical waste is classified as scheduled waste under the Environmental Quality (Scheduled Wastes) Regulations, 2005 which includes:

ii. SW403 – Discarded drugs containing psychotropic substances or containing substances that are toxic, harmful, carcinogenic, mutagenic or tetrogenic;

iii. SW404 – Pathogenic and clinical wastes and quarantined materials;

iv. SW421 – A mixture of scheduled wastes;

SW424 – A mixture of scheduled and non-scheduled wastes.

Table C-11: WHO Classification on Hospital Waste

Waste Categories	Description and Examples
1. General Waste	Domestic waste. No risk to human health. e.g. office paper, wrappers, kitchen wastes, general sweeping
2. Pathological Waste	Human tissues or fluids e.g. body parts; blood and other body fluids; fetuses
3. Sharps	Sharp waste e.g. needles; infusion sets; scalpels; knives; blades; broken; glass
4. Infectious Waste	Waste suspected to contain pathogens e.g. laboratory cultures; waste from isolation wards; tissues (swabs), materials, or equipment that have been in contact with infected patients; excreta
5. Chemical Waste	Waste containing chemical substances e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed; solvents
6. Radio-active Waste	Waste containing radioactive substances e.g. unused liquids from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radionuclide; sealed sources
7. Pharmaceutical Waste	Waste containing pharmaceuticals e.g. pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes)
8. Pressurized Containers	Gas cylinders, aerosol cans etc
9. Genotoxic Waste	Waste containing substances with genotoxic properties e.g. waste containing cytostatic drugs (often used in cancer therapy); genotoxic chemicals

Table C-12: Category of Clinical Waste in Malaysia

Category A	Category B	Category C	Category D	Category E
•Blood •Body fluids •excretions •Soiled surgical •dressings •Swabs •Material from infectious diseases	•Discarded syringes, needles, broken glass, and other contaminated disposable sharp instruments	•Lab or post mortem room waste	•Pharmaceutical and cytotoxic waste	•Used disposal bed pan liners, urine containers, incontinence and stoma pads

Table C-13: Major classification of clinical waste and its recommended management guidance in Malaysia

Description	Waste management guidance
1. Blood and body fluid waste i. Soiled surgical dressings, e.g. cotton wool, gloves, swabs. All contaminated waste from treatment area. Plasters, bandages which have come into contact with blood or wounds, cloths and wiping materials used to clear up body fluids and spills of blood. ii. Material other than reusable linen, from cases of infectious diseases (e.g. human biopsy materials, blood, urine, stools) iii. Pathological waste including all human tissues (whether infected or not), organs, limbs, body parts, placenta and human fetuses, animal carcasses and tissues from laboratories and all related swabs and dressings.	Special requirement on the management from the viewpoint of infection prevention. These categories of waste must always be incinerated completely in an appropriate incinerate or swabs and dressings.
2. Waste posing the risk of injury ("Sharps") All objects and materials which are closely linked with healthcare activities and pose a potential risk of injury and/ infection, e.g. needles, scalpel blades, blades and saw, any other instrument that could cause a cut or puncture.	Collected and managed separately from other waste. The collection container; must be puncture resistant and leak tight. This category of waste has to be disposed / destroyed completely as to prevent potential risk of injury / infection
3. Infectious waste Clinical waste arising from laboratories (e.g. pathology, hematology, blood transfusion, microbiology, histology) and post mortem rooms, other than waste included in Category 1 waste.	Special requirement on the management from the view point of infection prevention. This category of waste must always be incinerated completely in an appropriate incinerator.
4. Pharmaceutical and Cytotoxic Pharmaceutical Waste i. Pharmaceuticals which have become unusable for the following reasons: · expiry date exceeded, - expiry date exceeded after the packaging has been opened or the ready-to-use preparation prepared by the user, or · use is not possible for other reasons (e.g. call – back campaign)	Class I - pharmaceuticals such as chamomile tea, cough syrup, and the like which pose no hazard during collection, intermediate storage and waste management: managed jointly with municipal wastes. Class II - pharmaceuticals which pose a potential hazard when used improperly by unauthorized persons: managed in an appropriate waste disposal facility.

Description	Waste management guidance
ii. Wastes arising in the use, manufacture and preparation of, and in the oncological treatment of patients with, pharmaceuticals with a cytotoxic effect (mutagenic, carcinogenic and teratogenic properties).	Class III - Heavy metal- containing unidentifiable pharmaceuticals: managed in an appropriate waste disposal facility. Intermediate storage of these wastes takes place under controlled and locked conditions. For reasons of occupational safety, cytotoxic pharmaceutical wastes must be collected separately from pharmaceutical waste and disposed of in a hazardous waste incineration plant.
5. Other infectious waste All healthcare waste known or clinically assessed by a medical practitioner or veterinary/ surgeon to have the potential of transmitting infectious agents to humans or animals. Used disposable bed-pan inners, urine containers, incontinence pads and stoma bags.	Disposed of in a hazardous waste incineration plant licensed by the Department of Environment.

Healthcare establishments in Malaysia can be grouped into large source, medium source, and small source as the following:

Large Source
- University hospitals and clinics
- Maternity hospitals and clinics
- General hospitals

Medium Source
- Medical centres
- Out-patient clinics
- Mortuary/autopsy facilities
- Farm and equine centers
- Hospices
- Medical laboratories
- Medical research facilities
- Animal hospitals
- Blood banks and transfusion centres
- Emergency services

Small Source
- General medical practitioners
- Convalescent homes
- Nursing and remedial homes
- Medical consulting rooms
- Dental practitioners

- Animal boarding and hunt kennels
- Acupuncturist
- Veterinary Practitioners
- Pharmacies
- Cosmetic piercers

The generation of clinical waste is closely related to the size and growth of healthcare services. In Malaysia, the number of healthcare institutions is changing at a rapid rate as hospitals add new services and change procedures on an annual basis as they refocus and upgrade operating activities. The quantity of clinical waste disposed at incinerators in 2013 increase by 17.5% as compared to 2009 (Figure C-6).

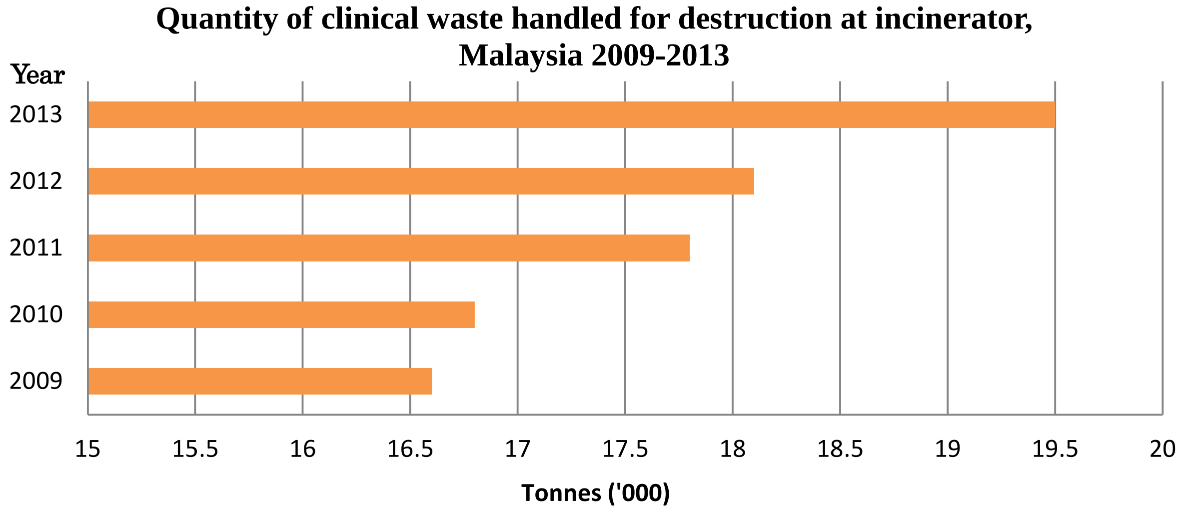


Figure C-6: Quantity of Clinical Waste handled for destruction at incinerator, Malaysia

More than a decade ago, serious concern has been raised regarding the potential for spreading pathogens, as well as, causing environmental contamination due to the improper handling and management of clinical and biomedical waste. Whilst full regulatory programs and guidelines to control waste from such institutions have been introduced in most developed countries, in Malaysia, the Ministry of Health had prepared preliminary guidelines for the management of hospital waste in 1998.

The Ministry of Health is the authority responsible for clinical waste management where concession companies are responsible for providing all the equipment and appropriate containers for clinical waste to healthcare facilities. In October 1996, the Ministry of Health and three concession companies have signed concessionaire agreements for clinical waste management in health care facilities. These concession companies are:

- Faber Medi-Serve Sdn Bhd for states of Perlis, Kedah, Penang, Perak, Sabah and Sarawak;
- Radicare (M) Sdn Bhd for Wilayah Persekutuan Kuala Lumpur and Putrajaya, Selangor, Pahang, Kelantan and Terengganu;
- Pantai Medivest Sdn Bhd for Negeri Sembilan, Melaka and Johor.

Clinical waste management in Malaysia is using the “cradle to grave” concept which is controlled by the Environmental Quality (Scheduled Waste) Regulations 1989 including its labeling and identification, on-site storage and management, transportation, treatment, and disposal. The concessionaires bear most of the responsibilities for every step in the life cycle of medical waste, which includes supply of the consumables, collection of waste at the generators' sites, storage, transportation to treatment sites, and disposal in treatment plants. However, healthcare providers perform the initial stage of waste disposal, which is waste segregation.

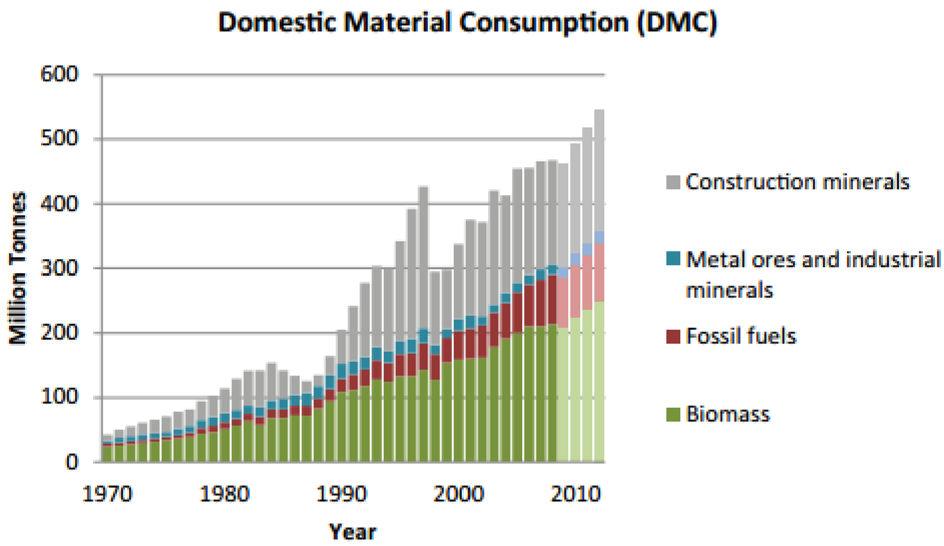
Agreement between concessionaires and government signed in 1992 stated that the service charge for handling and managing these clinical wastes is RM 5.20 per kilograms. These charges are including services from collection of waste in hospitals until the waste is incinerated.

IV. Indicators Based on Macro-Level Material Flows (Secondary Indicator)

Table C-14: Summary of Related Indicators

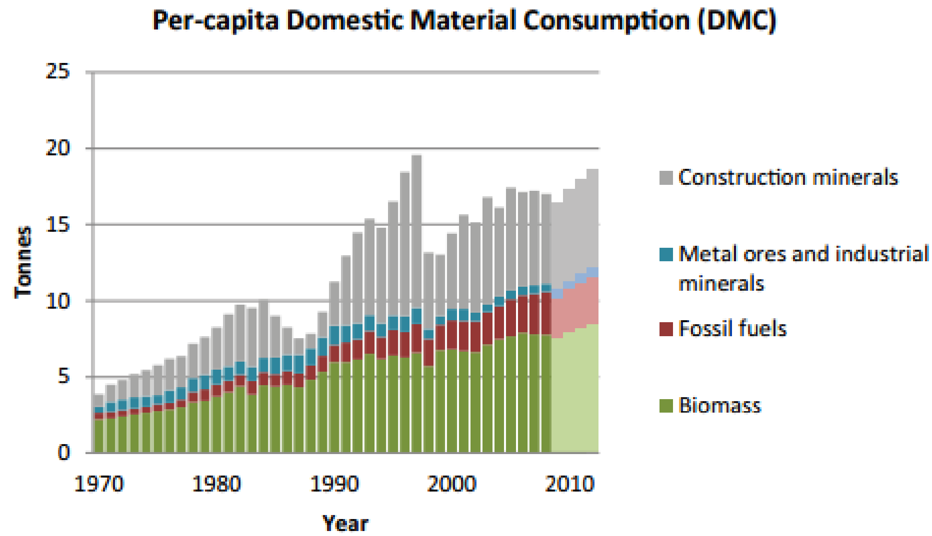
Indicators	Data	UNIT	Year	Reference
DMC	450,000,000	Tonne	2008	UNEP 2013
DMC per capita	17	Tonne/capita	2008	UNEP 2013
Resource Productivity		USD/tonne		
Material Intensity	3.3	kg/USD	2010	UNEP 2013

Malaysia is a developing country that has high population density, despite being at the lower end of population densities and higher range of per capita gross domestic production (GDP) for this classification. Domestic material consumption (DMC) per capita increased by 4% per annum, from 1970 to 2010 (UNEP, 2013). DMC is shown in Figure C-7, divided into four categories. It becomes clear that most of this volatility is due to major variations in construction minerals. An interesting feature of DMC per capita is that while this measure has increased quite rapidly, the overall share of biomass compared to construction minerals was roughly the same in 1975 as 2008, with biomass 1.39 times more than construction minerals in 1975, compared to 1.32 in 2008, having previously reached a low of under 0.66 in 1997 (Figure C-8**)**. Malaysia's material intensity (MI) remained static from 1970 to 2008, although it varied considerably during that time range (Figure C-9).



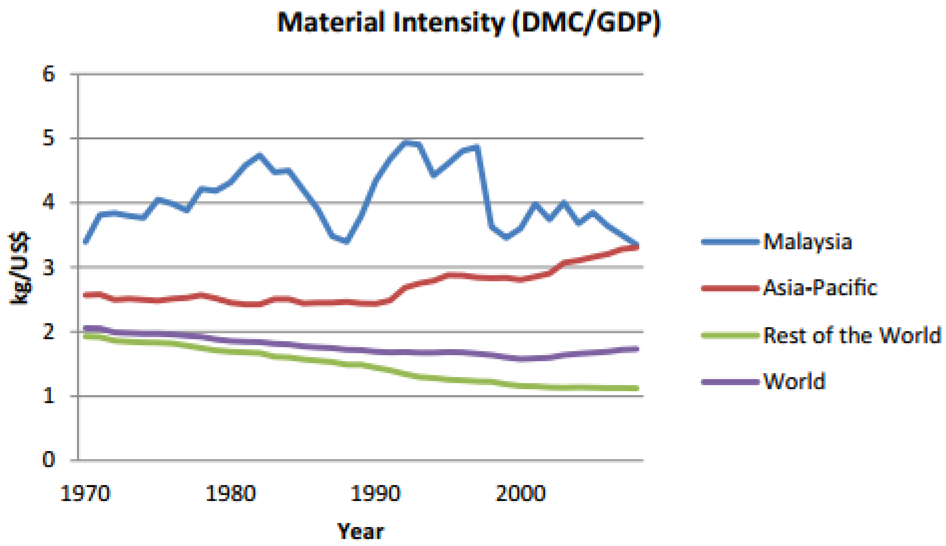
(Source: UNEP, 2013)

Figure C-7: Malaysia Domestic Material Consumption (DMC) from 1970 to 2010.



(Source: UNEP, 2013)

Figure C-8: Malaysia Domestic Material Consumption (DMC) Per-capita from 1970 to 2010



(Source: UNEP, 2013)

Figure C-9: Material Intensity (DMC/GDP) of Malaysia, Asia-Pacific, and the World from 1970 to 2010

V. Amount of Agricultural Biomass Used (Primary Indicator)

Table C-15: Summary of Related Indicators

Indicators	Biomass Generation	UNIT	Year	Reference
Amount of Agricultural Biomass Used				
Oil palm waste (empty fruit bunch (EFB), fibre, shell, palm oil mill effluent (POME), trunk and fronds)	129,498,829	Tonne	2013	MPOB
Rice (husk, straw)	1,669,000	Tonne	2014	Abdul, 2014
Coconut trunk fibers	273,000	Tonne	2012	DOA
Sugar cane waste (bagasse, molasses)	14,500	Tonne	2013	DOA
Livestock	21,739,603	Tonne	2013	DVS

Malaysia currently generates about 11% of (Gross National Income) GNI from the agricultural sector. This indicated that significant amount of biomass is generated from the sector. The main sources of biomass in Malaysia are coming from plantation residue and agricultural residue such as from palm oil, rubber and rice (Shafie et al. 2012). The major agriculture biomass waste in Malaysia are (Biomass-sp, 2014):

a. oil palm waste (empty fruit bunch (EFB), fibre, shell, palm oil mill effluent (POME), trunk/fronds)
b. rice (husk, straw)
c. coconut trunk fibers
d. sugar cane waste (bagasse, molasses)

Palm oil sector is the largest GNI contributor in Malaysia which indicates potential biomass generator. Figure C-10 shows total projected annual biomass availability in Malaysia (Tang, 2014). Figure C-11 shows the schematic flow established to provide a general concept of major agriculture biomass waste flow in Malaysia.

Definition of agriculture biomass

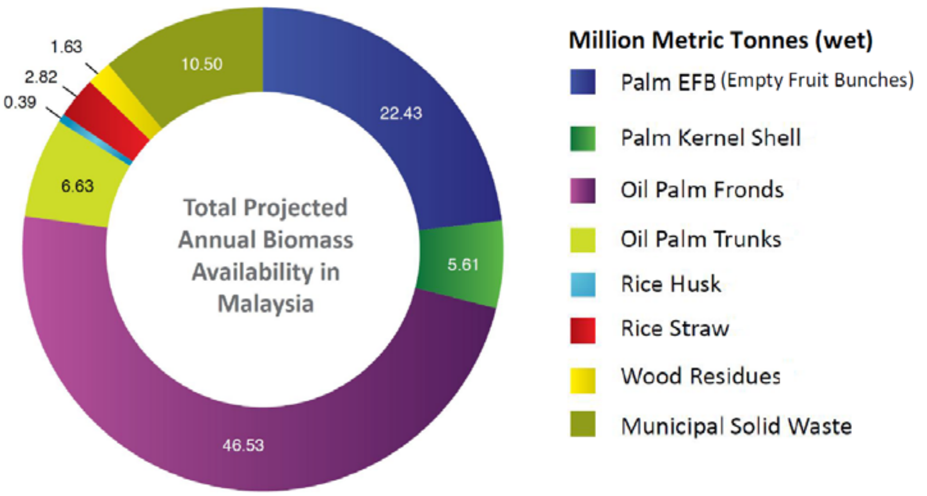


Figure C-3: Total projected annual biomass availability in Malaysia

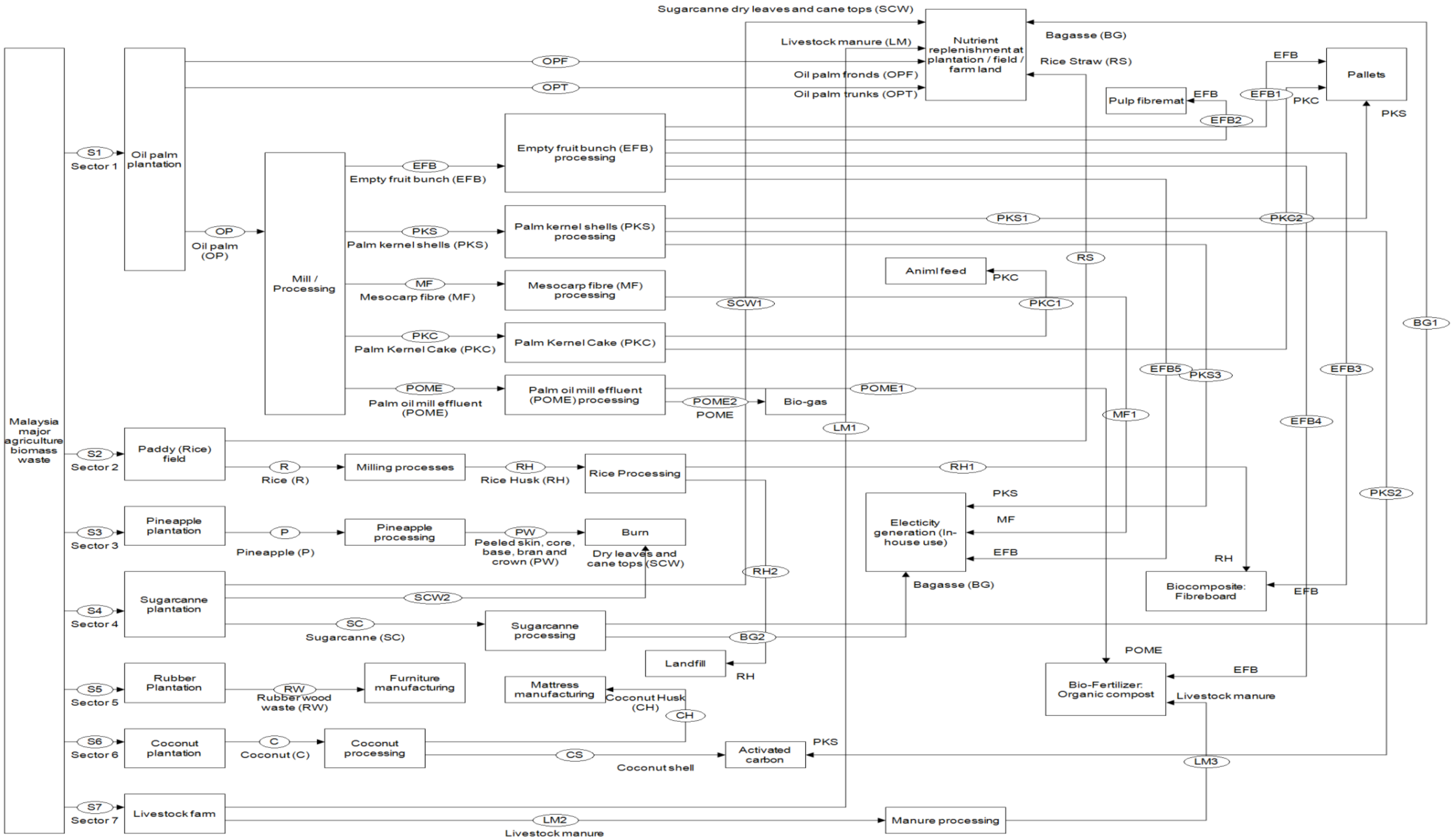


Figure C-4: Agriculture biomass flow diagram

1. Oil Palm

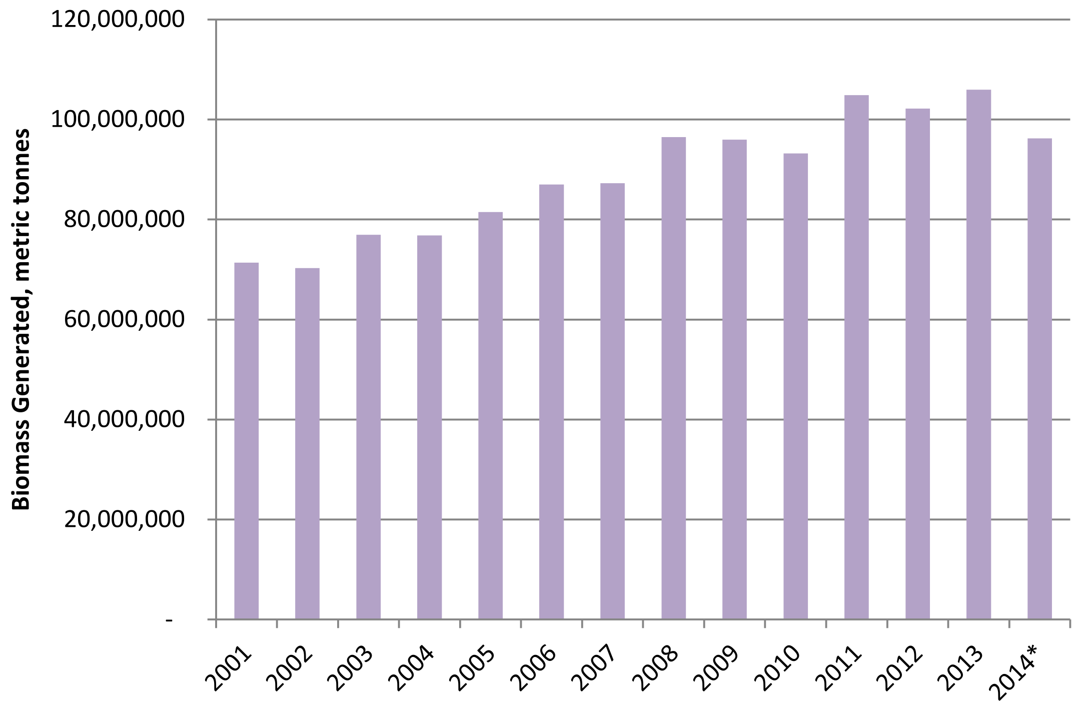
Malaysia is the second largest palm oil producer in the world after Indonesia. In 2009 Malaysia produced around 17,656,000 tonnes of palm oil with total area of is 4691,160 ha. (Shafie et al. 2012). The palm oil sector generates the largest amount of biomass, estimated at 80 million dry tonnes in 2010. This is expected to increase to about 100 million dry tonnes by 2020, primarily driven by increases in yield (National Biomass Strategy 2020).

Six types of oil palm biomass are produced as by-products of the palm oil industry: oil palm fronds (OPF), oil palm trunks (OPT), empty fruit bunches (EFB), palm kernel shells (PKS), mesocarp fibre (MF) and palm oil mill effluent. In the plantations, oil palm fronds (OPF) are available throughout the year as they are regularly cut during harvesting of fresh fruit bunches (FFBs) and pruning of the palm trees. Additional fronds as well as oil palm trunks (OPT) become available in the plantations during the replanting of oil palm trees every 25 to 30 years. In the mills, empty fruit bunches (EFBs) remain after the removal of the palm fruits from the fruit bunches. Mesocarp fibre (MF) and palm kernel shells (PKS) are recovered during the extraction of crude palm oil (CPO) and palm kernel oil (PKO), respectively. In addition, palm oil mill effluent (POME) accumulates as a liquid biomass at the mills (Shafie et al. 2012).

The biomass generated from the oil palm sector is estimated by multiplying the residue ration (Table C-16) with yearly oil palm FFBs production (Figure C-12). In this estimation only EFBs, PKS, MF and POME are considered. The estimation excluded OPF and OPT and this is because the vast majority of the oil palm biomass (especially OPF and OPT) being generated today is returned to the field to release its nutrients and replenish the soil. The biomass returned to the field as organic fertiliser plays an important role to ensure the sustainability of FFBs yields (Shafie et al. 2012). However, to provide a picture of how much biomass is generated from pruning activities, the amount of pruned OPF is estimated. According to MPOB, 12 tonnes of dry OPF is generated per hectare, 75% of oil palm planted areas were removed for pruning and only 50% were removed from the plantation. Based on this, the OPF generated from year 2001 to 2013 were calculated based the total plantation acreage every year (Figure C-13).

Table C-16: Biomass generation ratio

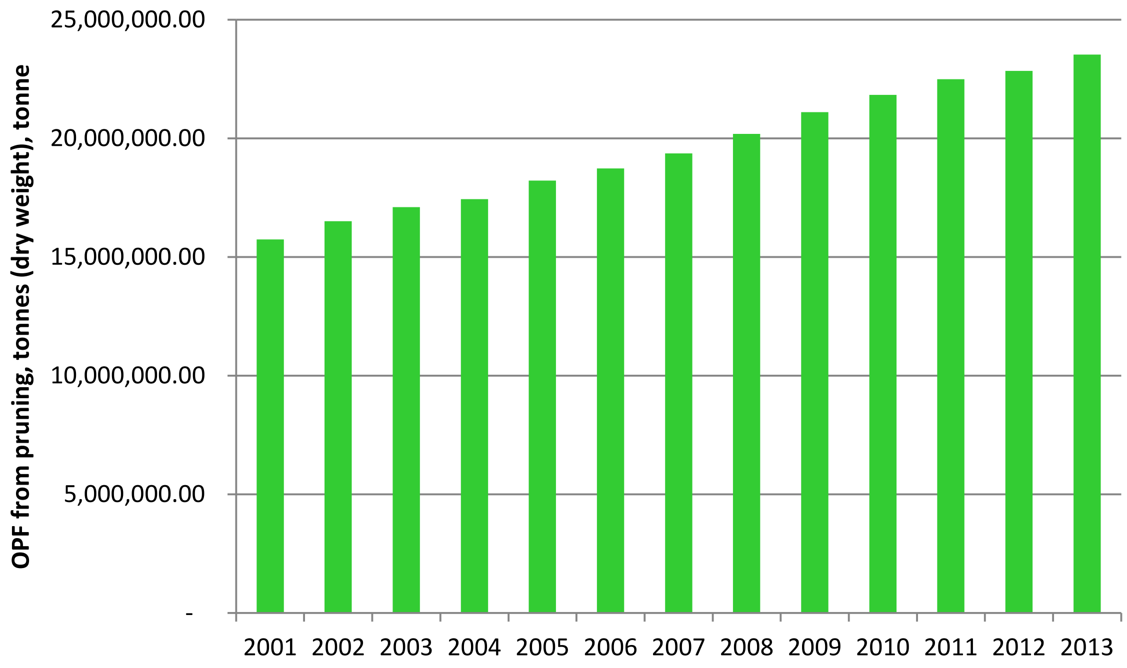
RESIDUE	RATIO
EFB	21.14% of FFB wet weight (Kyairul, 2007)
MF	12.72% of FFB wet weight (Kyairul, 2007)
PKS	5.67% of FFB wet weight (Kyairul, 2007)
POME	67% of FFB wet weight (Chan, 1999)



(Source from MPOB, 2014)

Figure C-5: Oil palm residue generated between years 2001-2014

**as of November 2014*



(Source from MPOB, 2014)

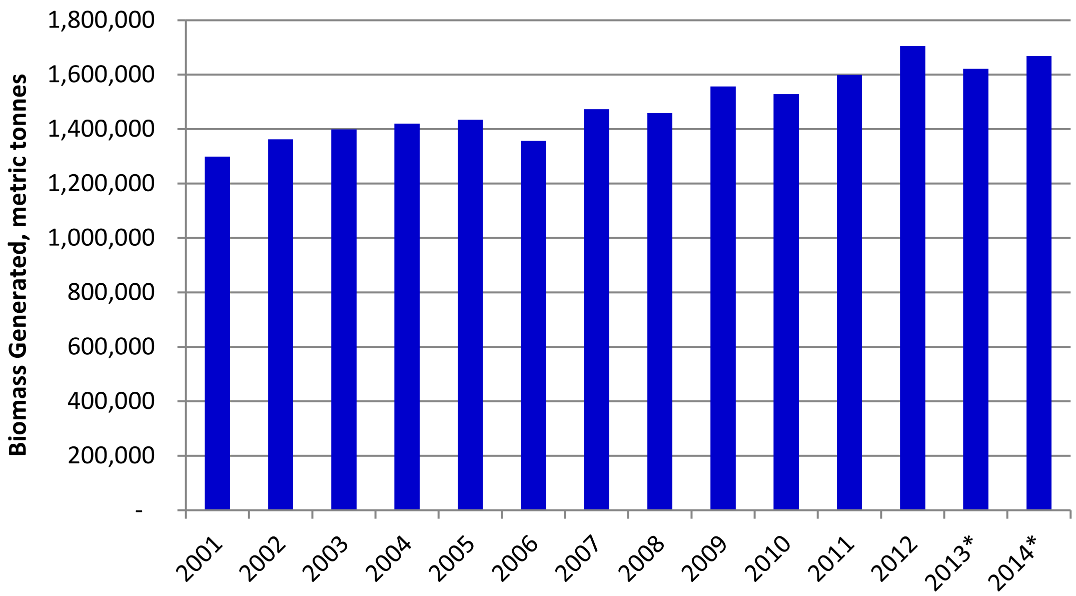
Figure C-6: Biomass generated from pruning activities between the years of 2001-2013

2. Paddy (Rice)

Rice husk is the major potential source of biomass in Malaysia after palm oil. The statistical data shows that in 2008 paddy production in this area was around 1632,507 tonnes. Paddy straws and rice husks are the main residues from paddy cultivation that are generated during the harvesting and milling processes (Shafie et al. 2012). The paddy straw is left in the paddy field and rice husk is disposed of into landfill or via open burning (Shafie et al. 2012). The biomass generated from the paddy sector is estimated by multiplying husk and straw residue ratio (Table C-17) with yearly paddy production (Figure C-14).

Table C-17: Biomass generation ratio

Residue	Ratio
Rice Husk	22% of paddy wet weight (Kyairul, 2007)
Straw	40% of paddy wet weight (Kyairul, 2007)



** Source from Abdul, 2014*
(Source from DOA, 2012)

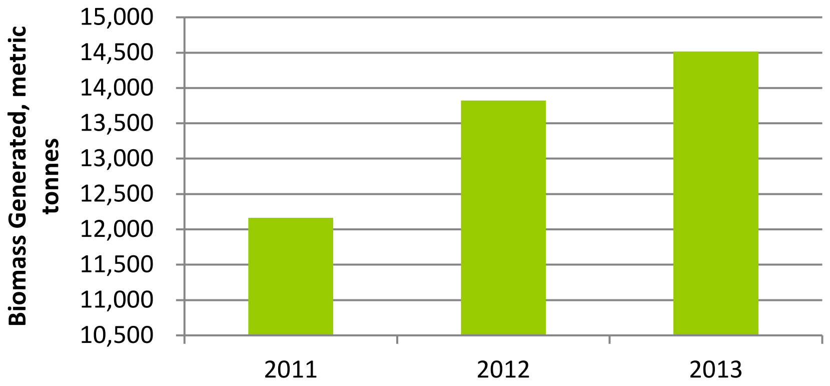
Figure C-7: Paddy residue generated between years 2001-2014

3. Sugarcane

Wide areas in Northern region of Malaysia are dedicated to sugarcane plantations to supply the required sugar (Shafie et al. 2012). Sugarcane cultivation produces granulated sugar, bagasse, dry leaves and cane tops. Dry leaves and cane tops waste are often left on the field to replenish the soil nutrient. Sugarcane bagasse is the fibrous waste that remains after recovery of sugar juice via crushing and extraction (Shafie et al. 2012). The biomass generated from sugarcane sector is estimated by multiplying bagasse ratio **(**Table C-18) with yearly sugarcane production (Figure C-15).

Table C-18: Biomass generation ratio

RESIDUE	RATIO
Bagasse	28% of sugarcane wet weight (DOA)



(Source from DOS, 2011; DOA, 2012)

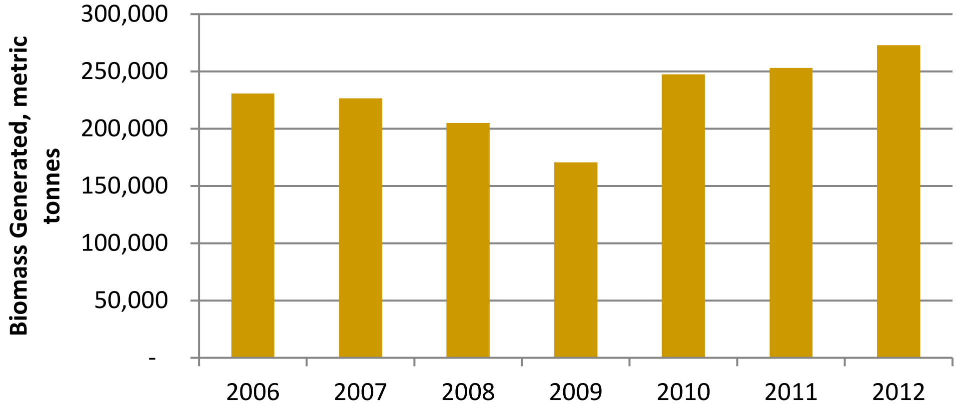
Figure C-15: Bagasse generated between years 2011-2013

4. Coconut

Coconut is the third most important industrial crop in terms of the total planted area in Malaysia. In 2009, local coconut oil production was reported to be around 455,000 tonnes (Shafie et al. 2012). The main biomass generated from the coconut sector is coconut husk and shell. The biomass generated from rubber plantation is estimated by multiplying husk and shell ratio (**Table 0-**8) with yearly coconut production (**Figure C-16**).

Table C-19: Biomass generation ratio

RESIDUE	RATIO
Husk	33% of coconut wet weight (Koopmans & Koppejan, 1997)
Shell	12% of coconut wet weight (Koopmans & Koppejan, 1997)



(Source from DOS, 2011; DOA, 2012)

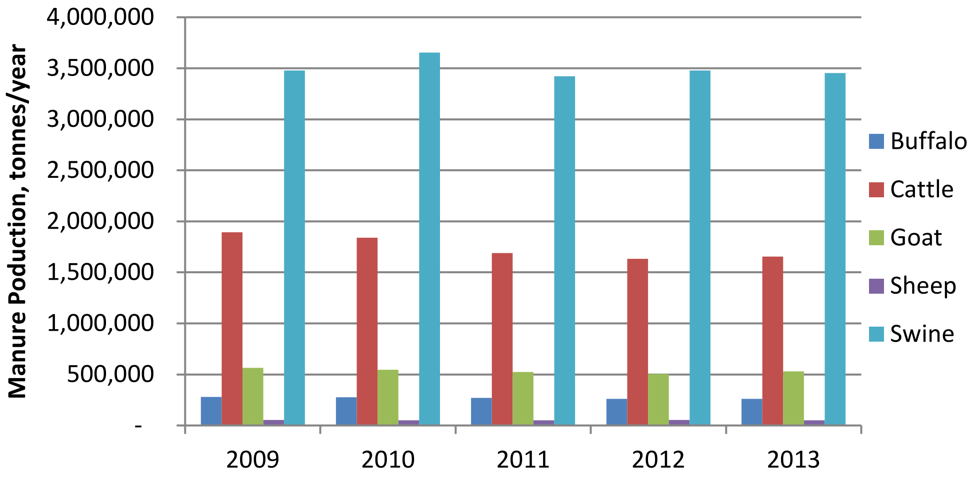
Figure C-16: Biomass waste generated between years 2006-2012

5. Livestock

Biomass manure generated from livestock is estimated by multiplying manure accumulation rate (Table C-20) with yearly livestock population (Figure C-17 and Figure C-18).

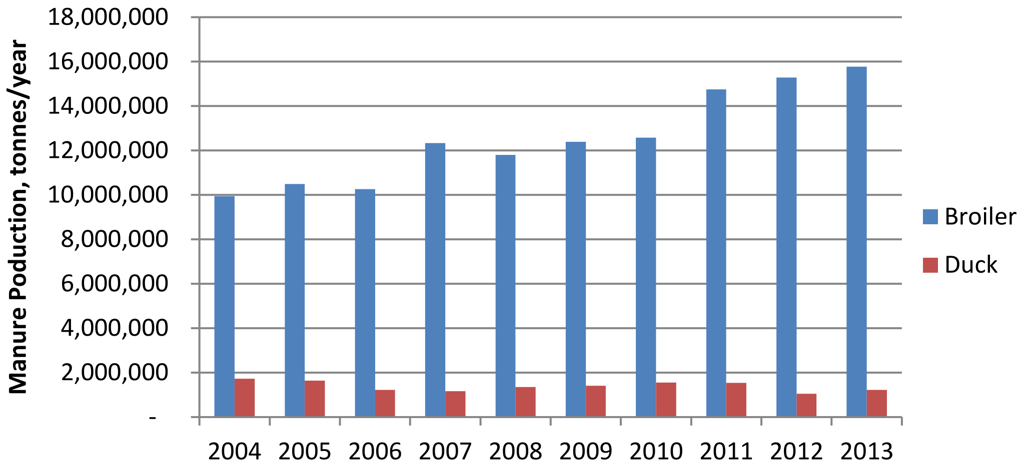
Table C-20: Biomass generation ratio

Manure Accumulation, tonnes per animal per year	
Swine	1.9 (Barker and Walls, 2011)
Sheep	0.4 (Barker and Walls, 2011)
Goat	1.1 (Barker and Walls, 2011)
Buffalo	2.2 (Crouse et al., 2014)
Cattle	2.2 (Crouse et al., 2014)
Broiler	0.024 (Barker and Walls, 2011)
Duck	0.05 (Barker and Walls, 2011)



(DVS, 2013)

Figure C-8: Manure generated by livestock in Malaysia between years 2009-2013



(DVS, 2013)

Figure C-9: Manure generated by poultry between years 2004-2013

6. Current Malaysian Scenario

Oil palm is the largest crop plantation in Malaysia, generating huge amounts of biomass. Due to lack of landfill space, a ban on agriculture open burning, and the large number of palm oil mills, oil palm biomass waste has been identified as having good potential for biomass projects (Shafie et al. 2012). Thus, biomass from oil palm has been given higher attention in Malaysia. Figure C-19 shows the current biomass utilization in Malaysia, where biomass is mainly used for bio-energy, green chemical and bio-polymers, bio-fertilizer and bio-composites products. Figure C-20 indicates the developing stages of each types of biomass in different sectors. Figure C-21 shows the monetary generated from each category of commercialized biomass.

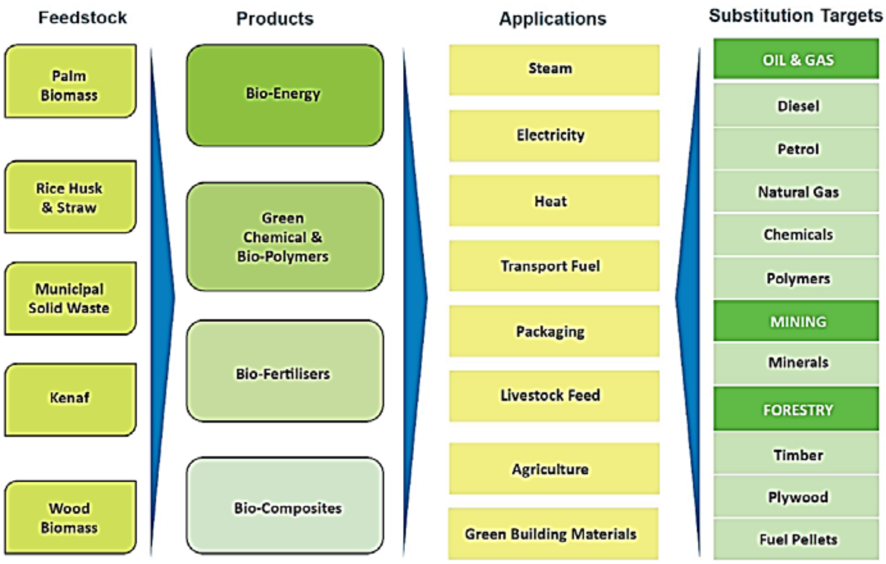


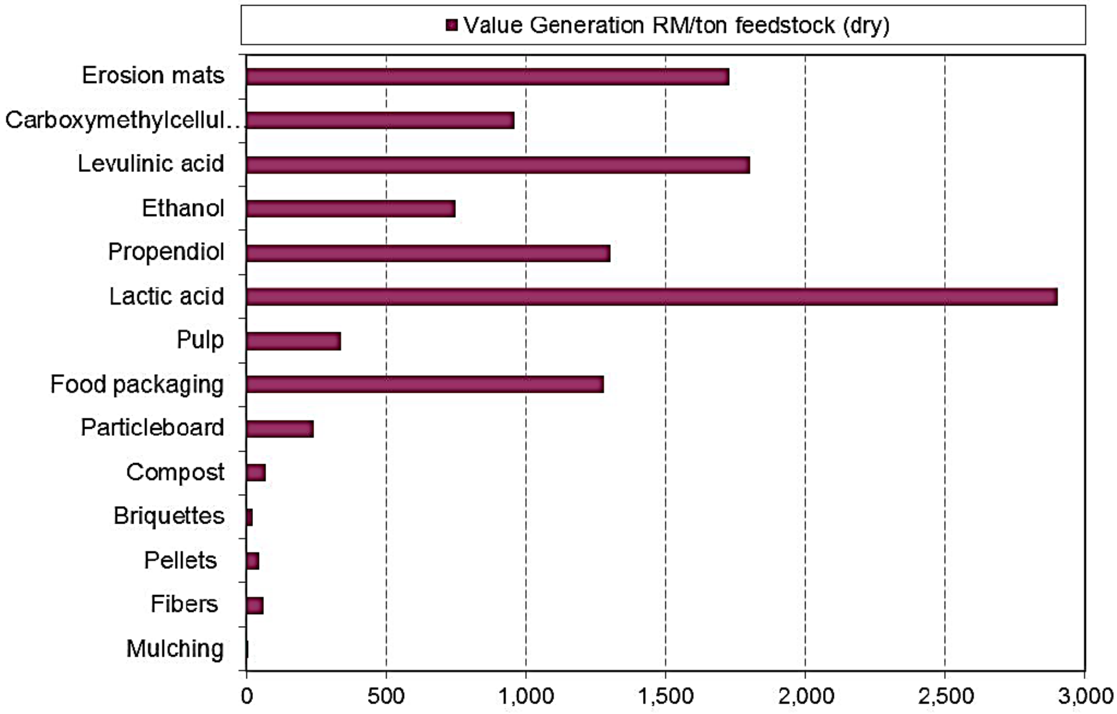
Figure C-10: Current biomass utilization

	PELLETS	BIOFUELS	BIOGAS	GREEN CHEMICAL	BIOFERTILISERS	BIOCHAR	BIOCOMPOSITES	OTHERS
EFB	EFB Pellets	Bioalcohol	Syngas	Industrial Sugars/ Chemical	Organic Compost	Carbon Fibers	Fibreboard	Pulp Fibremat
PKS	Coal substitute					Activated Carbon		
OPT	OPT Pellets	Bioalcohols	Syngas	Industrial Sugars/ Chemical	Organic Compost	Biochar	Engineered lumber	
OPF	OPF Pellets	Bioalcohols	Syngas	Industrial Sugars/ Chemical	Organic Compost	Biochar		Phytochemicals
PKC	PKC Pellets			Biopolymers				Animal Feed
POME		Bioalcohols	Methane	Biopolymers	Organic Compost			
SAW DUST	Wood Pellets	Bioalcohols	Syngas	Industrial Sugars/ Chemical	Mushroom Cultivation	Biochar	Fiberboard	
RICE HUSK							Biocomposite	Silica Aerogel
PADDY STRAW	Straw Pellets							
KENAF							Biocomposite	
SAGO WASTE	Fuel Pellets	Bioalcohols	Methane	Biopolymers				Animal Feed
MSW	RDF Pellets		Methane		Organic Compost			
SEWAGE								Phosphate Recovery

LEGEND ■ Commercialised ■ Development Stage ■ Potential

(Tang, 2014)

Figure C-11: Developing stages of each types of biomass in different sector



(Tang, 2014)

Figure C-12: Monetary value generated from biomass utilization

7. Recent Policy Trends

The recent government strategies, policies and actions involving biomass utilization are mainly focused on renewable energy (Tang, 2014):

1. Renewable energy policy & act
   - Feed-in-tariff for renewable energy generation
2. National biotechnology policy
   - Bio-conversion of biomass into high value chemicals and liquid fuels
3. Green technology policy
   - Investment tax incentives for green ventures in Malaysia
   - Green technology financing scheme USD 1 billion in subsidized loans
4. Palm oil industry biogas power generation
   - Generation of power to national electricity grid via biogas from effluent waste
5. Biomass industry strategic action plan
   - Promote high value utilization of biomass by small and medium companies
6. National biomass strategy
   - Development of market players and technologies for biomass pallets and biochemical
7. National Biomass Strategy 2020: New wealth creation for Malaysia's palm oil industry
   - To assess potential revenue from palm oil industry through utilisation of the associated biomass

8. Challenges

According to Tang (2014), there are six major challenges in utilizing agriculture biomass:

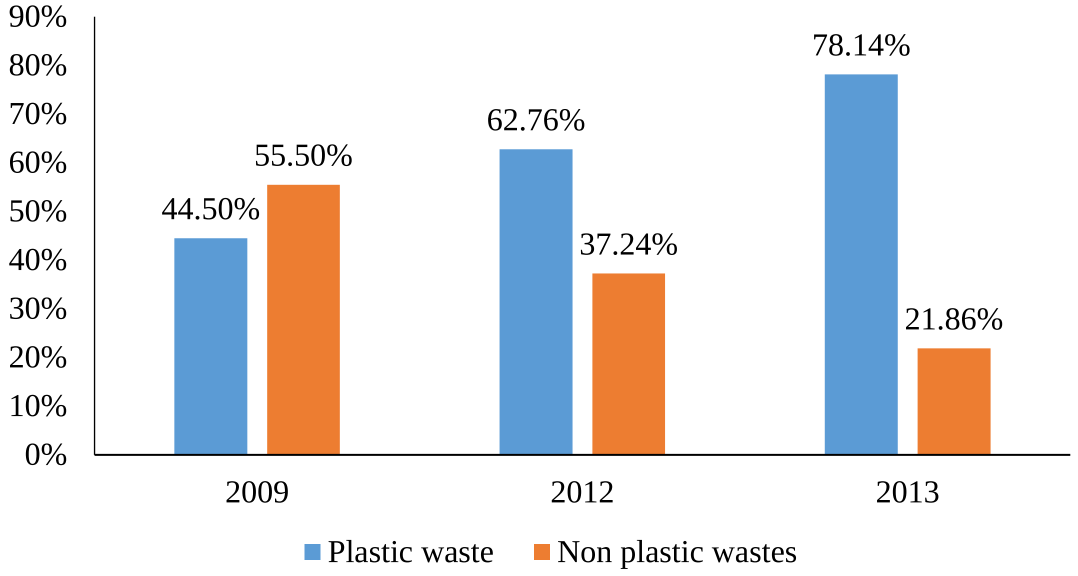
1. Access to biomass feedstock - volume & pricing
    - Current agricultural practice – return biomass waste to field
    - No commodity market for biomass trading
    - Remote locations of biomass sources - high cost of transportation
    - Biomass owners not favourable to long-term supply contract due to rising demand and pricing of biomass
2. Access to financing for biomass ventures
    - Biomass feedstock supply and pricing risks
    - Local financiers not familiar with biomass industry
    - Comparative high investment and long payback period for biomass ventures
3. Lack of support from domestic market
    - Switch to sustainable production not complemented by sustainable consumption locally
    - Most biomass products are for export market to meet demand for premium 'green' products
    - Sustainable market initiatives by government slow to be realized due to lack of commitment from government and businesses
4. Commercialisation of local technologies
    - Gaps between research and commercialization where the pilot or demo plant is lack of market-focused research and multi-disciplinary approach to commercialisation
    - Local market and financiers risk-averse to local technologies and products
5. Sustainability requirements and certifications
    - Existing and future requirements on biomass from sustainable sources especially contentious issues on exploitation of primary forests and peatland
    - Lack of local standards and certifications in biomass feedstock and products
    - Low awareness and slow adoption of carbon foot print to influence business decisions on sustainability
6. Low-value utilization of biomass by local companies
    - Existing biomass ventures mostly in production of commodity based products e.g. fibers, compost and fuel pellets
    - Lack of access technologies to create higher value from biomass feedstock e.g. eco-products, biochemical and polymers
    - Lack of technical capacities of local companies especially small and medium ones to adopt and apply high technologies in their ventures.

VI. Marine and Coastal Plastic Waste

Table C-21: Summary of Marine Coastal Waste

Indicators	Data	UNIT	Year	Reference
Marine/Coastal Waste Generation	1.52	kg/person/day	2010	Jambeck et al., 2015
Collected marine/coastal waste	0.14 to 0.37	million metric ton /year	2010	Jambeck et al., 2015

Study on plastic debris found that at least 33 out of 37 studies on marine debris worldwide had recorded plastic percentage of more than 50% (Derraik, 2002). Figure C-22 shows that the percentage of plastic waste found in coastal area increased every year from 2009 to 2013. The percentage of non-plastic waste reduced gradually from 2009 to 2013. In 2013, the Malaysian plastics industry registered a total turnover of RM17.94 billion representing an increase of 4.5% from RM17.16 billion in 2012 (Plastics and Rubber Asia, 2014). According to Department of Statistics (2014), the plastic manufacturing of the country has been achieving healthy growth rates of up to 8.2 % and were prospering on increasing demand from Europe and Japan, in particular. The increase in plastic production is indirectly related to the amount of plastic wastes found at marine and coastal area. It was estimated that 60–80% of marine litter starts out on land (ICC, 2010). Lakes, rivers, streams, and storm drains, helped by the wind, transport litter hundreds of miles to the ocean. Ocean currents and winds carry the marine debris all around the globe. Data on marine and coastal plastic waste helps to provide a roadmap for eliminating marine debris, by reducing the waste at source, change the behaviors that cause it, and support better policies to prevent marine debris from causing further harm to the ocean ecosystems.



(Source: ICC, 2010; ICC, 2012; ICC, 2014)

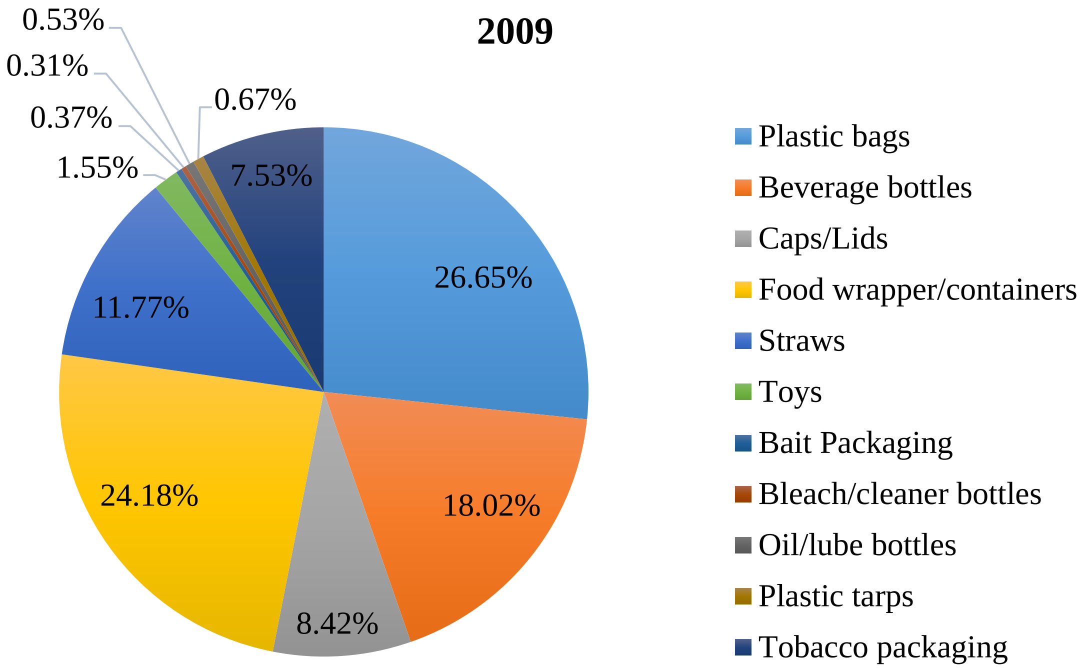
Figure C-22: Percentage of marine and coastal plastic waste in Malaysia from 2009 to 2013

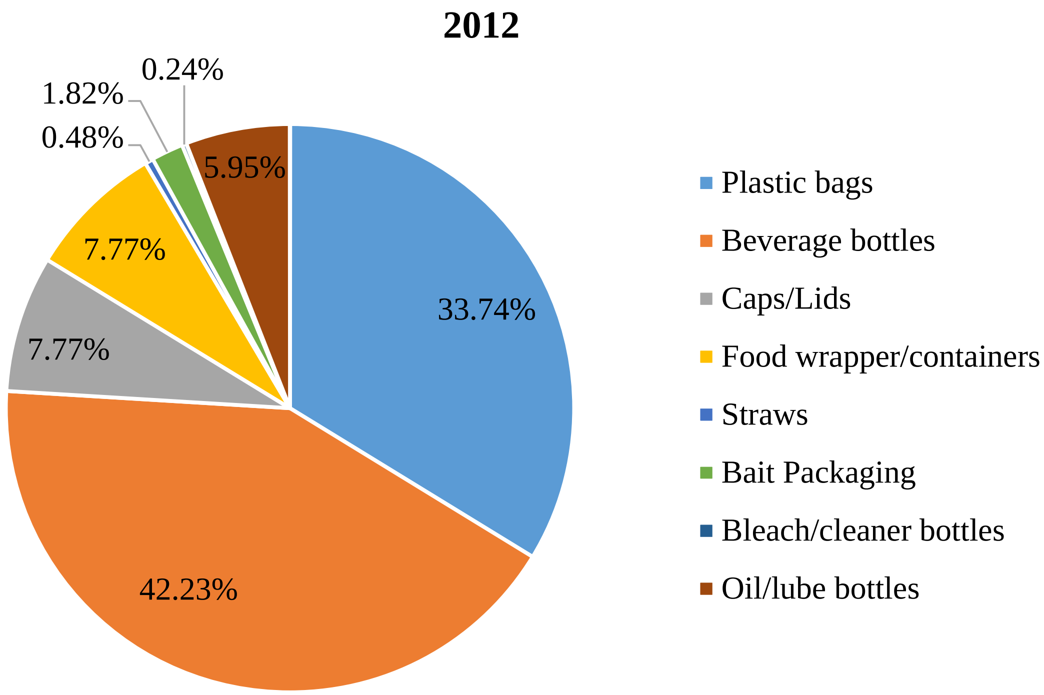
In 2009, it was found that 44.50% of marine waste collected in Malaysia comprised of plastics (ICC, 2010). The amount of plastic waste in marine and coastal areas increased to 62.76% in 2012 (ICC, 2012). Marine and coastal plastic waste collected include plastic bags, food wrappers, bait packaging, plastic tarps, beverage bottles, straws, cleaner bottles, tobacco packaging, caps/lids, toys and oil bottles. Figure 23 shows that the top three marine and coastal plastic wastes found in Malaysia in 2009 were plastic bags, food wrappers and beverage bottles with 26.65%, 24.18% and 18.02%, respectively. The majority of marine debris comes from land-based activities such as eating fast food and discarding the wrappers, beach trips and picnics, sports and recreation, and festivals. The top three marine and coastal plastic wastes found in Malaysia in 2012 were beverage bottles (42.23%), followed by plastic bags (33.74 %), food wrappers (7.77%) and caps/lids (7.77%). Figure C-23 and Figure C-24 show the comparison of percentage in marine and coastal plastic waste in Malaysia in 2009 and 2012. The high level of marine and coastal plastic waste found was likely due to human activities such as picnics. According to Market Watch (2012), the current total retail sales of food and beverages are estimated at USD11 billion. The forecast for this sector is likely to grow by around 10% per annum over the next three to five years. This is likely the reason of increased of beverage bottles found at marine and coastal area. Besides that, the import of beverage to Malaysia increased from USD295, 955,939 in 2009 to USD373, 696,894 in 2010 which caused more beverage bottles being disposed in Malaysia (Market Watch, 2012). Figure C-23 shows the flow diagram of marine and coastal plastic waste.

Recent studies found that about 8 million tonnes of plastic waste ended up in the world's oceans in 2010 which is equal to five grocery bags filled with plastic for every foot of coastline in the world (Fauziah et al, 2015; Jambeck et al., 2015). It warns that the trash could increase more than tenfold in the next decade unless the international community improves its waste management practices. Malaysia was listed as one of the twenty worst countries for dumping plastics into the ocean. According to Jambeck et al. (2015), Malaysia ranked number eight in the amount of plastic trash dumped into the sea. Malaysia has 22.9 million people who live on the coast with waste generation rate at 1.52 kg/person/day. Some 13 % of the waste generated was comprised of plastic. The total amount of marine plastics found in the sea in Malaysia was about 0.14 to 0.37 million metric ton /year.

Beach and waterway cleanup includes the cost to clean trash from beaches and waterways within cities. Table C-22 shows the annual cost for beach and waterway cleanups (Stickel et al., 2012). Based on the cost calculation in Table C-22 the coastal cleanup cost for Malaysia with a population of 22.9 million was in the range of USD0 to USD1, 837,398. The average per capita cost for beach and waterway cleanups in Malaysia was USD 0.83.

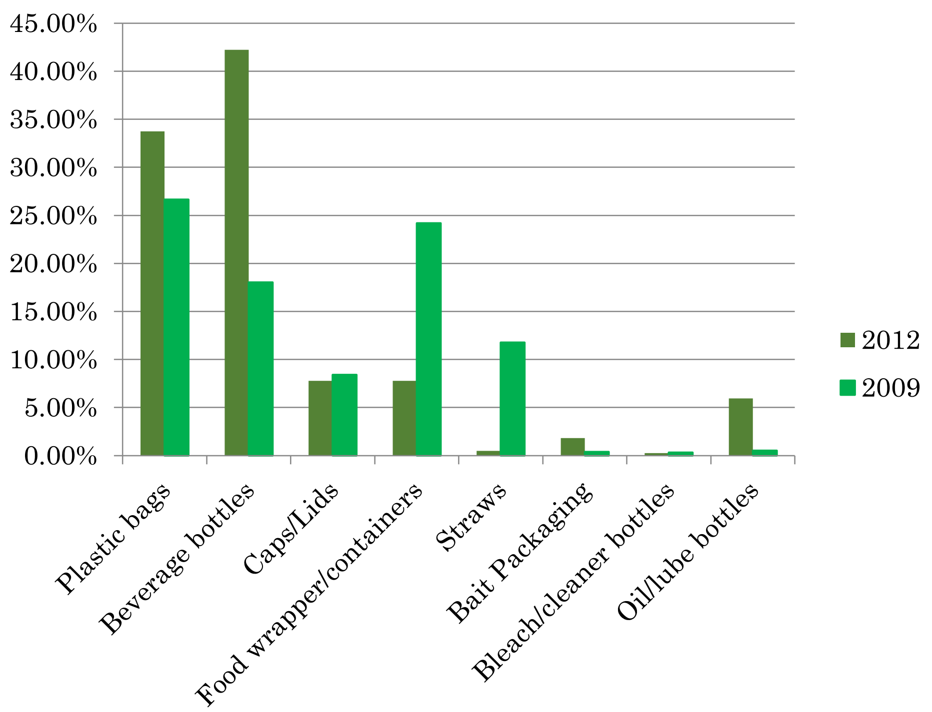
Once plastic reaches the oceans, it forms floating waste, washes up on coastlines, and accumulates on sea floors. Larger items like bags, wrapping and fishing gear can entangle dolphins, turtles and even whales. Small pieces are eaten by fish, turtles and seabirds. Over time, the material weathers down into tiny particles that can be ingested even by small marine animals (Ian, 2015).





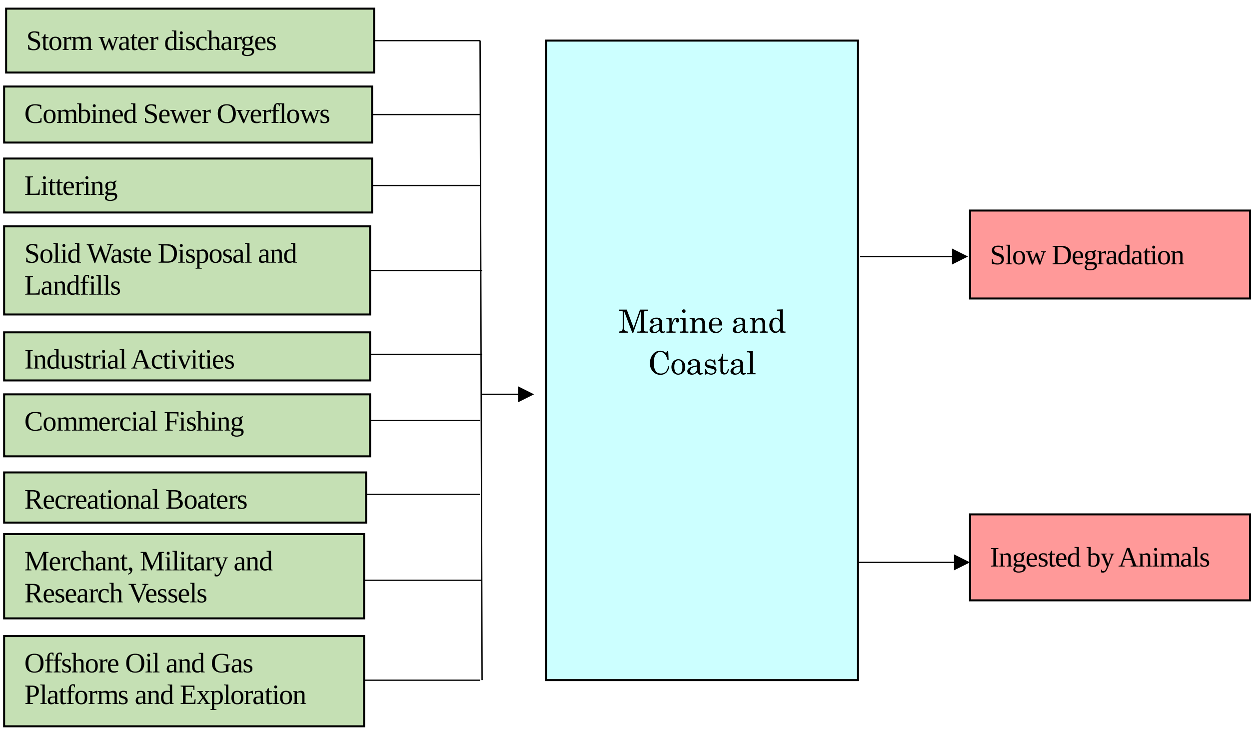
(Source: ICC, 2010; ICC, 2012)

Figure C-23: Percentage of marine and coastal plastic waste in Malaysia in 2009 and 2012



(Source: ICC, 2009; ICC, 2012)

Figure C-24: Comparison of Percentage in marine and coastal plastic waste in Malaysia in 2009 and 2012



(Source: Michelle et al., 2006)

Figure C-25: Flow Diagram of Marine and Coastal Plastic Waste

Table C-22: Annual Cost for Beach and Waterway Cleanups

City Size	Population Range	Range of Annual Costs Reported	Average Annual Cost	Average Per Capita Cost
Largest	Over 250,000	$0 - $1,837,398	$422,185	$0.83
Larger*	75,000-249,999	$0 - $17,500	$3,329	$0.03
Mid-Sized	15,000-74,999	$0 - $112,459	$12,746	$0.28
Smaller	Under 15,000	$0 - $114,005	$6,418	$1.28

VII. Amount of E-Waste Generation, Disposal and Recycling. Existence of Policies and Guidelines for E-Waste Management (Primary)

Table C-23: Summary of E-Waste Generation, Disposal and Recycling

Indicators	Data	UNIT	Year	Reference
Amount of E-Waste Generation	78,278	Tonne	2012	DOE, 2014
Amount of E-Waste Disposal and Recycling	NA	Tonne	NA	NA

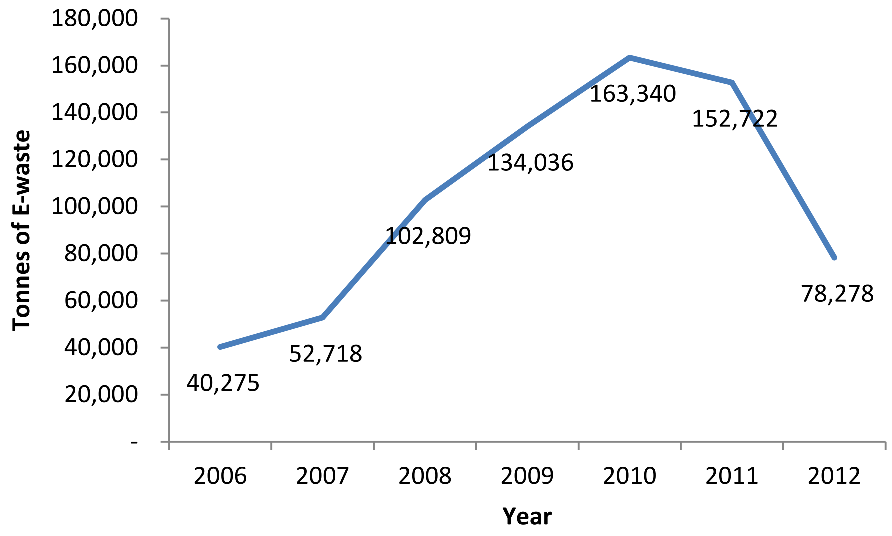
Table C-24: Summary of E-Waste Regulations

Existence of	Title of regulations/guideline
Policies for e-waste management	Environmental Quality (Scheduled Wastes) Regulations 2005 (DOE, 2006) has categorized e-waste into i. SW103: Waste of batteries containing cadmium and nickel or mercury or lithium ii. SW109: Waste containing mercury and its compound iii. SW110: Waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyls.
Guideline for e-waste management	Following the regulations stipulated under Environmental Quality (Scheduled Wastes) Regulations 2005 (DOE, 2006) particularly of SW110

Due to a sharp increase in electrical and electronic waste generation in 2006, DOE has introduced e-waste as a new waste category under the Environmental Quality (Scheduled Wastes) Regulations 2005 (DOE, 2006). The rise in e-waste generation year by year has become the driving force behind the development of waste and environmental management policies (Agamuthu & Victor, 2011).

The Department of Environment (DOE) within the Ministry of Natural Resources and the Environment (NRE) is responsible for the planning and enforcement of regulatory requirements related to e-waste. Although there are no direct regulations to deal with e-waste, the management of e-waste is incorporated within the Environmental Quality (Scheduled Waste) Regulations 2005 and the Environmental Quality (Prescribed Premises) (Treatment, Disposal Facilities for Scheduled Waste) Regulations, 1989 (control on collection, treatment, recycling and disposal of scheduled waste including e-waste).

As shown in Figure C-26, DOE recorded that Malaysia generated 40,275 tonnes of WEEE in 2006 (DOE, 2006), 52,718 tonnes in 2007 (DOE, 2007), rose to 102,808 tonnes in 2008 (DOE, 2008), 134,036 tonnes in 2009 (DOE, 2009), 163,340 tonnes in 2010 (DOE, 2010), 152,722 tonnes in 2011 (DOE, 2011), and dropped to 78,278 metric tonnes of e-waste in 2012 (DOE, 2012). Malaysian e-waste was estimated to be about 1.2 million tonnes in 2020 (Agamuthu & Victor, 2011). The significant increment of e-waste in Malaysia would lead to major problems in waste management.



(Source: DOE 2006 to 2012)

Figure C-26: E-waste generations in Malaysia

Environmental Quality (Scheduled Wastes) Regulations 2005 has categorized e-waste into:

- SW103: Waste of batteries containing cadmium and nickel or mercury or lithium
- SW109: Waste containing mercury and its compound
- SW110: Waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyls.

Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia provide guidance on determining whether used electrical and electronic equipment is e-waste or secondhand goods. It provides the criteria for classification of secondhand electrical and electronic equipment which can be imported for direct use.

In Malaysia, used electrical and electronic assemblies or otherwise commonly known as e-waste are categorized as scheduled wastes under the code SW 110, First Schedule, Environmental Quality (Scheduled Wastes) Regulations 2005. Under the Environmental Quality (Scheduled Wastes) Regulations 2005, SW 110 waste is defined as waste from the electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyls.

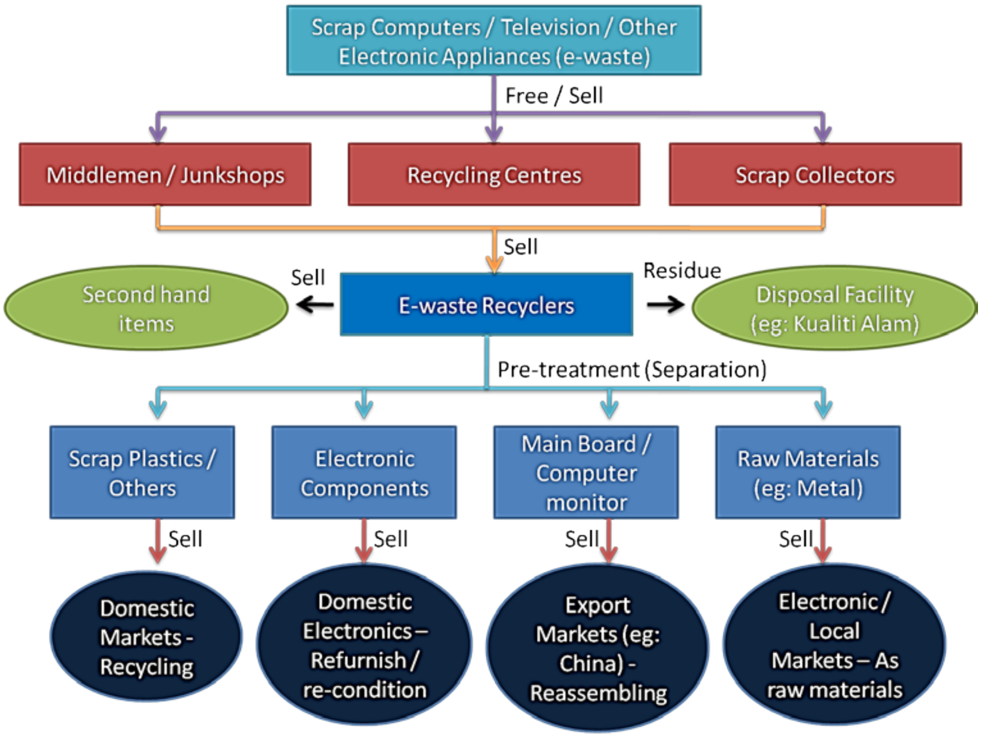
E-waste is also listed as code A1180 and code A2010 under Annex VIII, List A of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal 1989. As Malaysia is one of the Parties to the Basel Convention, the importation and exportation of such waste must follow the procedures of the Convention. Importation or exportation of the waste require prior written approval from the Department of Environment as mandated under Section 34B(1)(b)&(c), of the Environmental Quality Act, 1974. Any person who contravenes this section shall be guilty of an offence and shall on conviction be punished with imprisonment for a term not exceeding five years and shall also be liable to a fine not exceeding RM5,000 (~ USD1,200.00).

The scope of these guidelines is to assist all parties concerned in identifying and classifying a used electrical and electronic equipment or component, whether it is categorized as e-waste and thus prescribed under the First Schedule of the Environmental Quality (Scheduled Wastes) Regulations 2005 or otherwise. The parties are:

a. Waste generators;
b. Waste transporters;
c. Importers or exporters of wastes; and
d. Relevant authorities involved in the management of e-wastes.

A study conducted by Japan International Cooperation Agency (JICA) in 2005 found that the e-wastes generated in Malaysia are generally managed as illustrated in Figure C-27. As clearly illustrated in the figure, the junkshops, recycling centres and scrap collectors play an important role in bridging the gap between the waste generators and recyclers, by collecting e-wastes generated from various sources and sending these to e-waste recyclers. Consequently, as part of green environment practices, the e-waste generators should never mix and discard the e-waste into their waste bins, but instead sell or give them to dedicated collectors or middlemen for proper recycling. E-waste recovery facilities collect e-waste from various middlemen, collectors and recycling centres. Besides recycling of normal recyclable materials, such as plastics and metals, these recycling plants also extract precious metals, such as gold, platinum, silver and lead, from the circuit boards of e-waste.

EPR has been incorporated into Malaysian policy and legislation since the early 1980s. Environmental Quality (Recycling and Disposal of End-of Life Electrical and Electronic Equipment) Regulations has been set up by the DOE to enforce electronic manufacturers to design electrical and electronic equipment that have minimum hazardous components, and eventually facilitate the treatment and recycling process (Agamuthu and Victor, 2011). Dr Abdul Rahman Awang, director of the Department of Environment of Hazardous Waste Unit, says “We should go towards EPR. Industry should be responsible for its products and think how to design them to generate less waste” (The Star Malaysia, 2010).



(Source: Theng, 2008)

Figure C-27: Material flow of e-waste in Malaysia (Source: Theng, 2008)

Elements explicitly pertaining to EPR have been incorporated into Malaysian policy with the formulation of the first solid waste management policy which was the Action Plan for a Beautiful and Clean Malaysia (ABC) in 1988 followed by the Environmental Quality Act (EQA) 1974 in 1996. However, subsequent policy documents such as the National Strategic Plan for Solid Waste Management (NSP) in 2005, the Master Plan on National Waste Minimization (MWM) in 2006, and the National Solid Waste Management Policy (NSWMP) in 2006 did not develop the concept of EPR and formulate detailed strategies as part of the strategy for a sustainable waste management system in Malaysia. Nevertheless, this trend reversed as subsequent policy and legislation such as the Solid Waste and Public Cleansing Management Act (SWMA) in 2007 and the Tenth Malaysian Plan (10MP) 2010, explicitly incorporated elements of EPR. Generally, only the EQA and SWMA have detailed provisions for EPR which include requirements for take-back systems, deposit refund system and minimum recycled content, while policies such as the NPE, NSP and MWM only mention EPR as a general concept to be given consideration for implementation on a voluntary basis, even though they are considered key policy documents for waste management in Malaysia.

This trend is ironic because the two key legislations for solid waste and scheduled waste management have already legally empowered the Department of Solid Waste Management (DWSM) in 2007, and the DOE to implement EPR as early as the 1990s in Malaysia, but as of today both the DWSM and the DOE have not enacted supporting regulations to enforce EPR in Malaysia. This seems to indicate that when it comes to waste management, Malaysian policy-makers still focus on the basic priority of post-use collection, recovery and disposal of both solid waste and scheduled wastes. According to Malaysia DOE, despite the stringent regulation of transboundary movement of e-waste Malaysia's illegal importation of e-waste still persists.

Between 2008 and 2011, Malaysian authorities intercepted 38 containers containing e-waste and returned them to the exporting countries (DOE, 2012a). And in 2009, a Malaysian company manager was sentenced to a one-day jail sentence and was fined RM 180,000.00 (US60, 000) for illegally importing e-waste (DOE, 2012a).

Challenges related to e-waste management in Malaysia are shown below:

- Capacity building to manage household e-waste in an environmentally sound manner
- Collection, segregation and transportation of household e-waste
- Disposal/ collection fee for household e-waste
- Legislation and policy
- Transboundary movement of e-waste
- Managing the informal sectors

(Ibrahim, 2013)

VIII. Existence of Policies, Guidelines, and Regulations Based on the Principle of Extended Producer Responsibility (EPR)

Existence of Policies, Guidelines, and Regulations Based on the Principle of Extended Producer Responsibility (EPR) are summarized on the Table C-25.

Table C-25: Summary of Policies, Guidelines, and Regulations Based on the Principle of Extended Producer Responsibility (EPR)

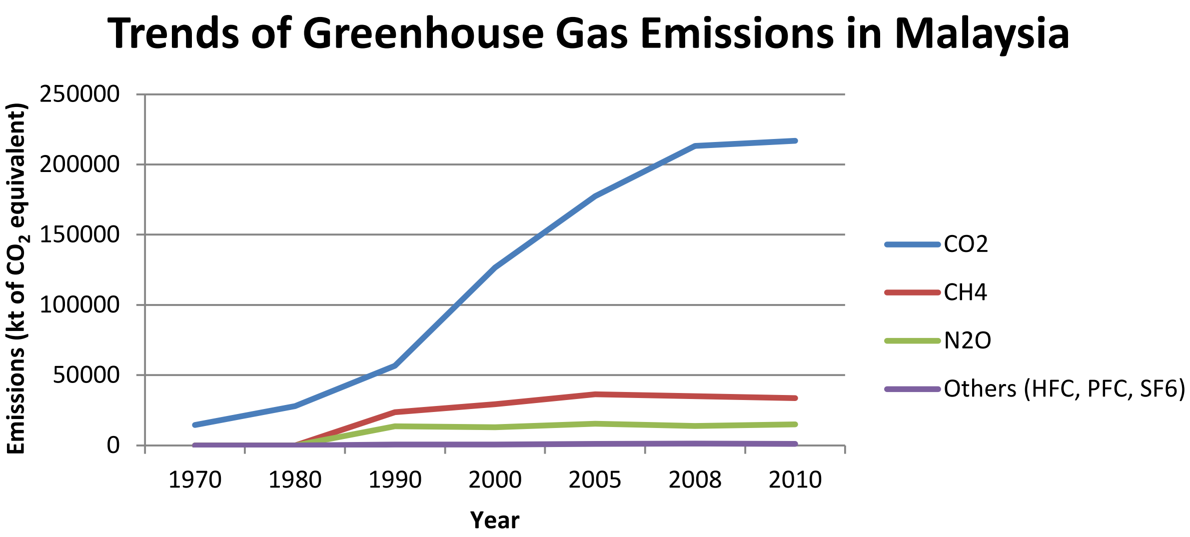
Status of implementation	Name of the policies (Year)	Product Items covered by the policy
Fully Implemented	Environmental Quality Act (1974)	• Section 30A: empowers the DOE to prescribe any substances to be reduced, recycled, recovered or regulated and to prescribe a minimum recycled content to producers on their products as well as matters relating to environmental labelling. • Section 30B: empowers the DOE to specify rules on deposit and rebate schemes especially for the disposal of products which are considered environmentally unfriendly or disposal of products that may cause adverse effects on the environment.
	Solid Waste and Public Cleansing Management Act (2007)	• Section 101: empowers the Department of Solid Waste Management (DSWM) to require the use of environmentally friendly material, specify the amount of recycled materials for specified products and limit the use of specified products or materials. • Section 102: empowers the DWSM to require that producers and manufacturers take back their products or goods for recycling or disposal at their own cost and establish a deposit refund system including the deposit refund amount.
Postponement period before full implementation	-	-
Under preparation of specific legislations	-	-
Existence of provisions supporting EPR principle	Action Plan for A Beautiful and Clean Malaysia (ABC) (1998)	• To reduce municipal solid waste generation especially those involving packaging waste and household chemical waste by involving the producers, distributors and the consumers.
	Master Plan on National Waste Minimization (2006)	• Suggests introducing laws on green purchasing and EPR as regulatory options to be explored • Suggests examination of voluntary taking-back of packages and containers based on EPR for producers and retailers but does not provide a detailed initiative on EPR
	The Tenth Malaysian plan (10MP) (2011)	• Explicitly mentions provisions of EPR as part of the Malaysian government's strategy for sustainable waste management and includes the initiate to obtain producer and manufacturer's commitment to implement a take-back system for producers and manufacturers as well as a deposit refund system
Based on voluntary approach/agreement	National Strategic Plan for Solid Waste Management in Malaysia (2002)	• Recommend legislation to place responsibility on packaging waste on the producer of packaged goods but does not formulate a detail strategy on EPR.

IX. Greenhouse Gas Emissions from Waste Sector

Table C-26: Summary of the Greenhouse Gas Emissions from Waste Sector

Indicators	Data	UNIT	Year	Reference
Total GHG Emissions from Malaysia	2.17×10^5	Gg of CO2-eq	2010	World Bank (2014)
Methane Emissions from landfill	318.0	Gg of CO2-eq	2011	Ministry of Housing and Local Government, (2009)

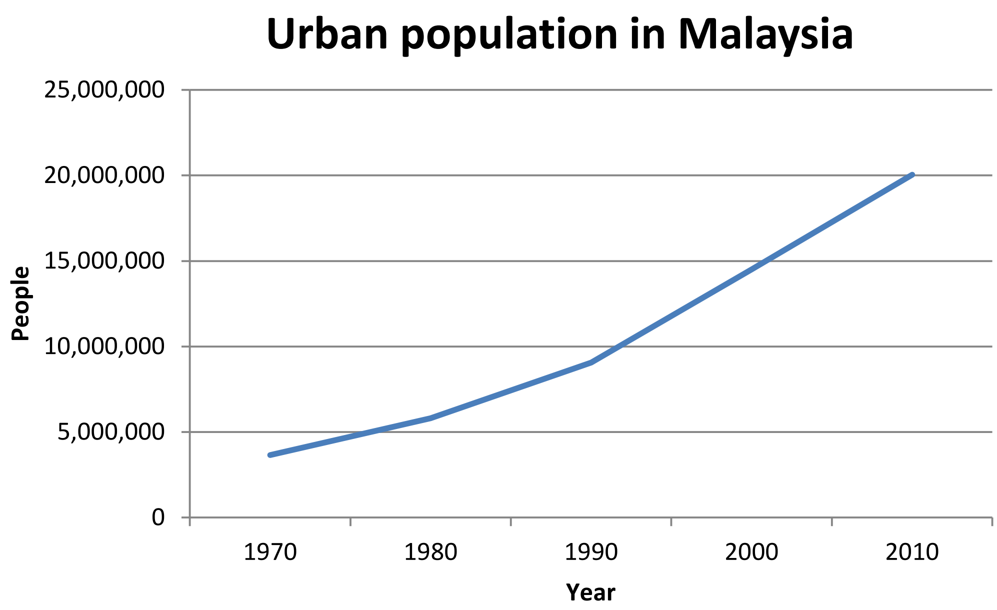
The Malaysian greenhouse gas inventory covers three major greenhouse gases. They are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Other greenhouse gases include hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulfur hexafluoride (SF_6). Figure C-28 shows the trends in greenhouse gas emissions in Malaysia from 1970 to 2010 by World Bank. The continuous increase in greenhouse gas is directly attributed to the increase in the total urban population (Figure C-29). The sharp increase in carbon dioxide emissions from 1990 onwards could be the result of the higher increase in urban population from the same time period. The drastic increase in greenhouse gas emissions from 1980 onwards is greatly contributed by the rapid industrialization in Malaysia during that period. Burning of fossil fuels to generate power for industrial processes is the main cause of the increase in carbon dioxide emissions.



(Source: World Bank, 2014)

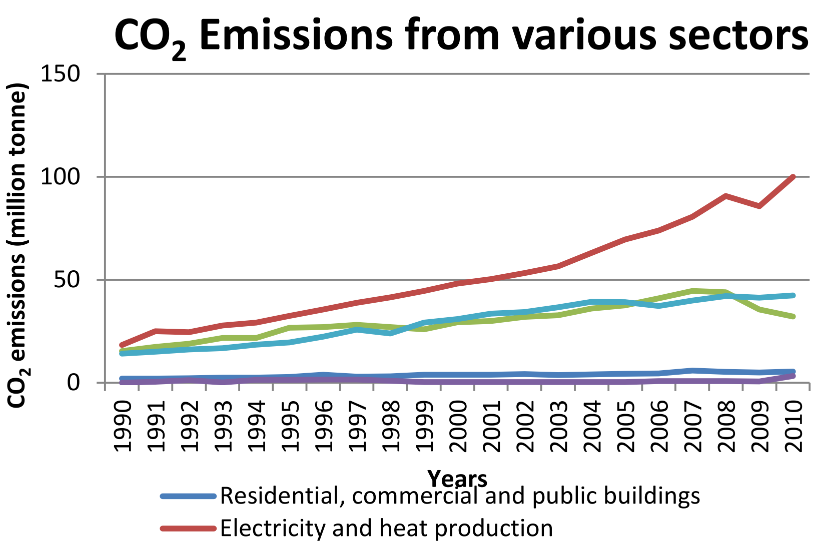
Figure C-28: Greenhouse emissions in Malaysia

Figure C-30 shows the various sectors that are responsible for the carbon dioxide emissions in Malaysia. Throughout the 20 year period, electricity and heat production contribute to the majority of the carbon dioxide emissions. This is because diesel-powered generators and coal-powered generators are widely used in Malaysia to generate electricity, causing an increase in the main byproduct of fossil fuel burning, which is carbon dioxide. The burning of fossil fuel is also contributed by the transport sector where the number of vehicles in Malaysia has been steadily increasing (Figure C-31). The increase in the number of vehicles is inevitable as Malaysia undergoes rapid urbanization where travelling around city areas greatly requires the use of motor vehicles. Besides that, the insufficient coverage of public transport as well as the unreliability of it also contributes greatly to the increase in motor vehicles in Malaysia.



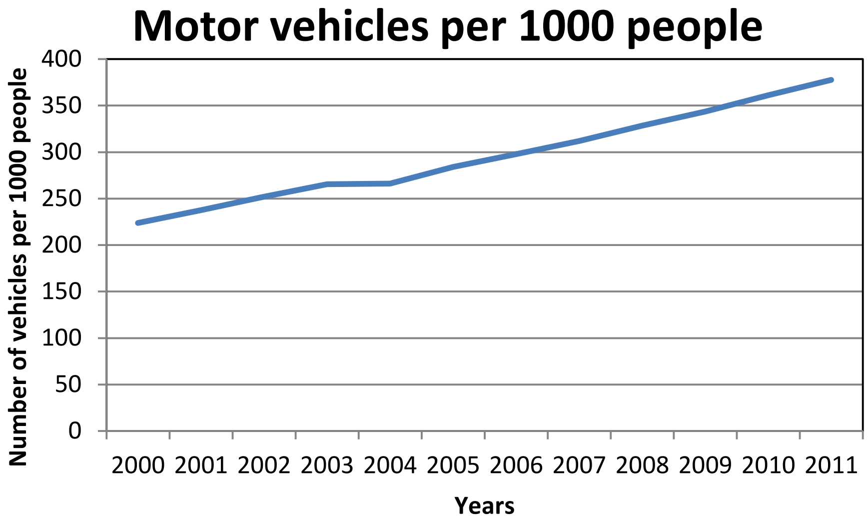
(Source: World Bank, 2014)

Figure C-29: Urban population in Malaysia



(Source: World Bank, 2014)

Figure C-30: CO_2 gas emissions from various sectors



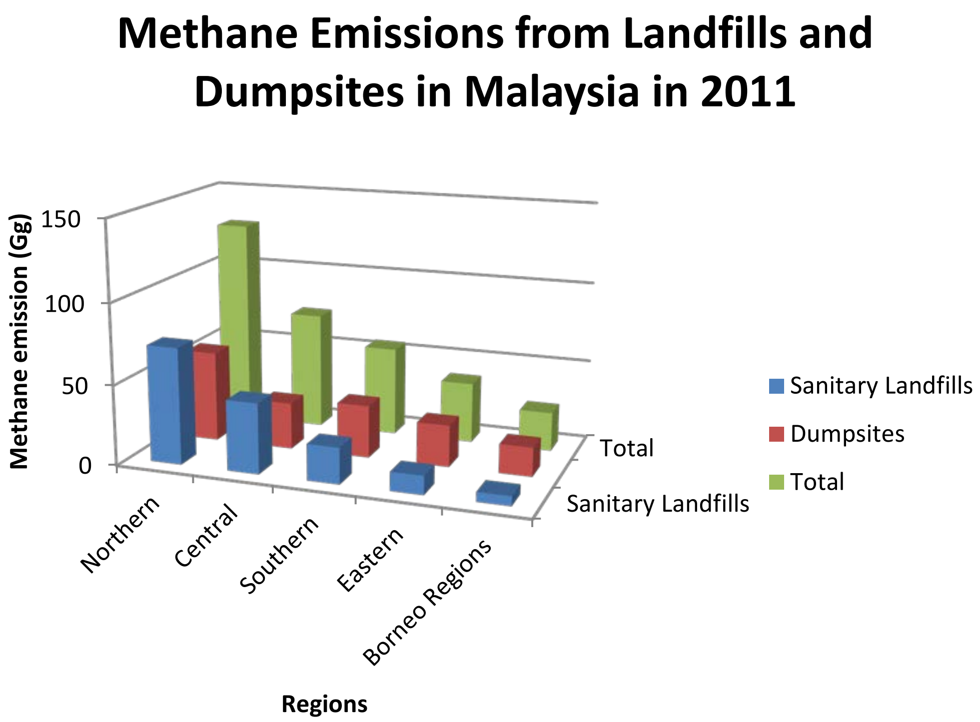
(Source: World Bank, 2014)

Figure C-31: Number of motor vehicles from 2000 to 2011

Meanwhile, Figure C-32 shows a closer look at the methane emissions from landfills and dumpsites in Malaysia in 2011. Dumpsites are the most common method of waste disposal in Malaysia, where there are a total of 212 sites. Correspondingly, the higher methane emissions from open dumpsites in the southern and eastern regions could be due to lack of sanitary landfills in those regions. This is because the open dump sites are not equipped with proper linings and gas collection system to prevent the emission of methane into the atmosphere. However, even though sanitary landfills are equipped with proper linings and gas collection system, the efficiency of the containment and collection of landfill gas is still rather low. Besides, the methane emissions from the northern and central regions are mainly coming from sanitary landfills because of the high amount of those sanitary landfills in the respective regions (four in the northern region and four in the central region). The emissions are categorized into regions in Malaysia, namely the northern, central, southern, eastern and Borneo. Table C-27 shows the states in the respective regions in Malaysia.

Table C-27: State categorization according to region

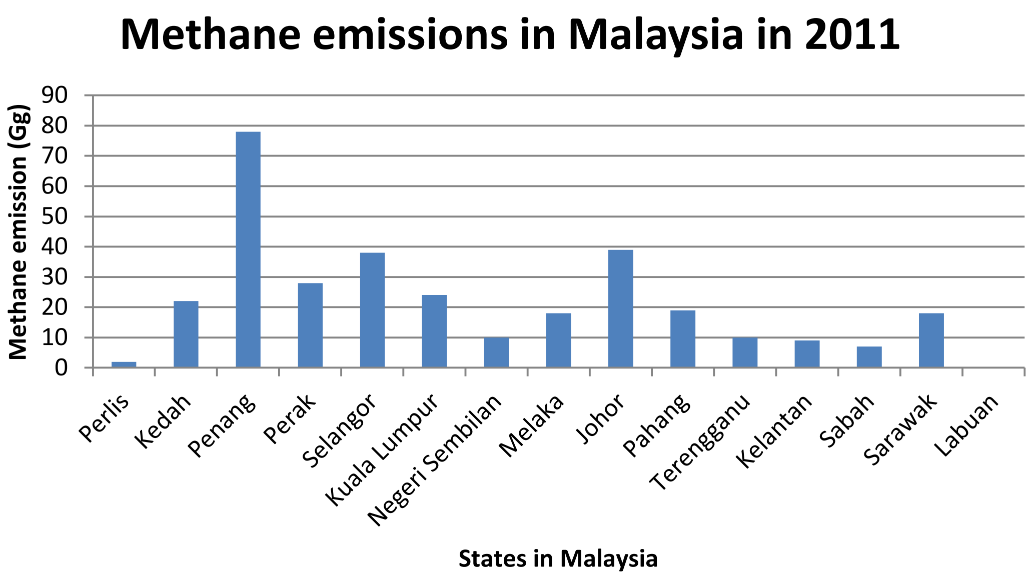
Regions				
Northern	**Central**	**Southern**	**Eastern**	**Borneo**
Kedah	Selangor	Malacca	Pahang	Sabah
Penang	Negeri Sembilan	Johor	Terengganu	Sarawak
Perak	Kuala Lumpur		Kelantan	Labuan
Perlis				



(Source: Ministry of Housing and Local Government, 2009)

Figure C-32: Methane emissions from landfill and dumpsites

Figure C-33 illustrates the methane emissions in Malaysia in 2011. Basically, well developed states like Penang, Selangor and Johor contributes to the majority of the emissions. The high methane emissions from those respective states is greatly influenced by the rate of urbanization in the states which contributes to increased waste generation. According to the Ministry of Housing and Local Government, Labuan has no methane emission data due to the absence of landfills.



(Source: Abushammala et al., 2011)

Figure C-33: Methane emissions in Malaysia (2011)

D: EXPERT SUMMARY / RECOMMENDATIONS

Municipal Solid waste management in Malaysia is at a crossroads following several changes that are being implemented or planned for improvement in the overall services rendered to the public. Waste collection is on a par with developed nations and almost all urban MSW is being collected for disposal. However illegal dumping still occurs sporadically and it can account for 10% of the total MSW generated.

Several recommendations are given to further enhance the quality of waste management, particularly to increase 3R activities.

a. Implementation of an Integrated Waste Management policy especially 3R inclusive, at an early stage is urgently required.
b. Application of waste separation among the states should be enforced. Currently it is only partially imposed and not for all types of households. 3R goals have been achieved only partially.
c. A clear transparent strategy on incineration or waste to energy should be established. This will ensure public support if relevant education is given in advance.
d. Biomass utilization should be enhanced. There is tremendous potential in biomass utilization for bioenergy, bio-chemicals, etc.
e. Policy on plastic bag usage should be reviewed. A total ban on plastic bags should be considered and bags should gradually be replaced with those made from biodegradable starch-based plastics.
f. Role of informal recyclers should be coordinated and formalized. Their contributions should be recognized and data included in the 3R Reports.
g. Climate change or global warming could be reduced significantly if these recommendations are applied.
h. Hazardous waste management is on a par with developed nations and it should be further improved with more 3R activities within Malaysia thus reducing transboundary movement of hazardous waste. Clear policies on e-waste will reduce the wastage of these resources and increase 3R output.

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APPENDIX 1

Environmental Quality (Scheduled Wastes) Regulations 2005 has listed 107 categories of toxic and hazardous waste in the **Table AP-1** below:

Table AP-1 Categories of Scheduled Waste in Malaysia

Code	Categories of Scheduled Waste
SW 1	**Metal and metal-bearing waste**
SW 101	Waste containing arsenic or its compound
SW 102	Waste of lead acid batteries in whole or crushed form
SW 103	Waste of batteries containing cadmium and nickel or mercury or lithium
SW 104	Dust, slag, dross or ash containing arsenic, mercury, lead, cadmium, chromium, nickel, copper, vanadium, beryllium, antimony, tellurium, thallium or selenium excluding slag from iron and steel factory
SW 105	Galvanic sludge
SW 106	Residues from recovery of acid pickling liquor
SW 107	Slags from copper processing for further processing or refining containing arsenic, lead or cadmium
SW 108	Leaching residues from zinc processing in dust and sludge form
SW 109	Waste containing mercury or its compound
SW 110	Waste from electrical and electronic assemblies containing components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl
SW 2	**Waste containing principally inorganic constituents which may contain metals and organic materials**
SW 201	Asbestos waste in sludge, dust or fibre forms
SW 202	Waste catalysts

Code	Categories of Scheduled Waste
SW 203	Immobilized scheduled waste including chemically fixed, encapsulated, solidified or stabilized sludge
SW 204	Sludge containing one or several metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium
SW 205	Waste gypsum arising from chemical industry or power plant
SW 206	Spent inorganic acids
SW 207	Sludge containing fluoride
SW 3	**Waste containing principally organic constituents which may contain metals and inorganic materials**
SW 301	Spent organic acids with pH less or equal to 2 which are corrosive or hazardous
SW 302	Flux waste containing mixture of organic acids, solvents or compounds of ammonium chloride
SW 303	Adhesive or glue waste containing organic solvents excluding solid polymeric materials
SW 304	Press cake from pretreatment of glycerol soap lye
SW 305	Spent lubricating oil
SW 306	Spent hydraulic oil
SW 307	Spent mineral oil-water emulsion
SW 308	Oil tanker sludge
SW 309	Oil-water mixture such as ballast water
SW 310	Sludge from mineral oil storage tank
SW 311	Waste oil or oily sludge
SW 312	Oily residue from automotive workshop, service station, oil or grease interceptor
SW 313	Oil contaminated earth from re-refining of used lubricating oil

Code	Categories of Scheduled Waste
SW 314	Oil or sludge from oil refinery plant maintenance operation
SW 315	Tar or tarry residues from oil refinery or petrochemical plant
SW 316	Acid sludge
SW 317	Spent organometallic compounds including tetraethyl lead, tetramethyl lead and organotin compounds
SW 318	Waste, substances and articles containing or contaminated with polychlorinated biphenyls (PCB) or polychlorinated triphenyls (PCT)
SW 319	Waste of phenols or phenol compounds including chlorophenol in the form of liquids or sludge
SW 320	Waste containing formaldehyde
SW 321	Rubber or latex wastes or sludge containing organic solvents or heavy metals
SW 322	Waste of non-halogenated organic solvents
SW 323	Waste of halogenated organic solvents
SW 324	Waste of halogenated or unhalogenated non-aqueous distillation residues arising from organic solvents recovery process
SW 325	Uncured resin waste containing organic solvents or heavy metals including epoxy resin and phenolic resin
SW 326	Waste of organic phosphorus compound
SW 327	Waste of thermal fluids (heat transfer) such as ethylene glycol
SW 4	**Wastes which may contain either inorganic or organic constituents**
SW 401	Spent alkalis containing heavy metals
SW 402	Spent alkalis with pH more or equal to 11.5 which are corrosive or hazardous
SW 403	Discarded drugs containing psychotropic substances or containing substances that are toxic, harmful, carcinogenic, mutagenic or teratogenic
SW 404	Pathogenic wastes, clinical wastes or quarantined materials

Code	Categories of Scheduled Waste
SW 405	Waste arising from the preparation and production of pharmaceutical product
SW 406	Clinker, slag and ashes from scheduled wastes incinerator
SW 407	Waste containing dioxins or furans
SW 408	Contaminated soil, debris or matter resulting from cleaning-up of a spill of chemical, mineral oil or scheduled wastes
SW 409	Disposed containers, bags or equipment contaminated with chemicals, pesticides, mineral oil or scheduled wastes
SW 410	Rags, plastics, papers or filters contaminated with scheduled wastes
SW 411	Spent activated carbon excluding carbon from the treatment of potable water and processes of the food industry and vitamin production
SW 412	Sludge containing cyanide
SW 413	Spent salt containing cyanide
SW 414	Spent aqueous alkaline solution containing cyanide
SW 415	Spent quenching oils containing cyanides
SW 416	Sludge of inks, paints, pigments, lacquer, dye or varnish
SW 417	Waste of inks, paints, pigments, lacquer, dye or varnish
SW 418	Discarded or off-specification inks, paints, pigments, lacquer, dye or varnish products containing organic solvent
SW 419	Spent di-isocyanates and residues of isocyanate compounds excluding solid polymeric material from foam manufacturing process
SW 420	Leachate from scheduled waste landfill
SW 421	A mixture of scheduled wastes
SW 422	A mixture of scheduled and non-scheduled wastes
SW 423	Spent processing solution, discarded photographic chemicals or discarded

Code	Categories of Scheduled Waste
	photographic wastes
SW 424	Spent oxidizing agent
SW 425	Wastes from the production, formulation, trade or use of pesticides, herbicides or biocides
SW 426	Off-specification products from the production, formulation, trade or use of pesticides, herbicides or biocides
SW 427	Mineral sludge including calcium hydroxide sludge, phosphating sludge, calcium sulphite sludge and carbonates sludge
SW 428	Wastes from wood preserving operation using inorganic salts containing copper, chromium or arsenic of fluoride compounds or using compound containing chlorinated phenol or creosote
SW 429	Chemicals that are discarded or off-specification
SW 430	Obsolete laboratory chemicals
SW 431	Waste from manufacturing or processing or use of explosives
SW 432	Waste containing, consisting of or contaminated with, peroxides
SW 5	**Other waste**
SW 501	Any residues from treatment or recovery of scheduled waste