

CHAPTER 1 INTRODUCTION

1.1 Municipal Solid Waste

According to Malaysia's Solid Waste and Public Cleansing Management Act 2007, solid waste is any scrap material or other unwanted surplus substance or rejected products arising from the application of any process or any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled or 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*].

The definition of municipal solid waste (MSW) varied between countries. For instance, in New York City, it is called as 'managed waste' which covers putrescible and non-putrescible waste collected, recycled or disposed by Department of Sanitation New York (DSNY) from, all residential, not-for-profit institutions, state and federal agencies, waste from special DSNY operations such as lot cleaning, street cleaning and other operations (Department of Sanitation City of New York, 2006). While in Taipei, MSW is defined as solid waste that arise from domestic and non-industrial activities (US EPA, 2007). In Hong Kong, it covers domestic, commercial and non-hazardous waste (Chung, 2010). Singapore's definition is the most extensive among all the four countries. It covers all the solid waste landfilled and incinerated (Ministry of the Environment and

Water Resources, 2009).

The world population grew to 7.06 billion in mid-2012, with 97% of the growth came from developing countries (Population Reference Bureau, 2012). The world population has a direct impact on the amount of solid waste being generated globally. By increasing 6% per annum, 585 million tonnes of solid waste would be generated in 2010 (Agamuthu et al., 2009). The annual waste generation increase has pushed solid waste disposal becomes a challenging issue. It is a serious problem in many cities in developing Asian countries (Mufeed et al., 2007).

Municipal solid waste management (MSWM) is a process that involves collecting, transporting and disposing of household, commercial, institutional and some industrial waste (Jessica, 2009). Many studies had focused on MSW generation and composition as it is necessary to indentify it before implementing integrated MSW management (Gidakos et al., 2006; Gómez et al., 2008; McDougal et al., 2001). In the process of integrated waste management and disposal, in most cases, more than one option will be implemented to cater different compositions of MSW.

MSW is an important source of anthropogenic GHG. As a result of global warming it has become a hotly debated global issue, MSWM is switching from landfill-based systems to resource-recovery-based (Burnley, 2007; Burnley et al., 2007). Hence, integrated MSWM which emphasizes 3Rs (reduce, reuse, and recycle) approach is highly practiced especially in developed countries to simultaneously mitigating MSW

disposal and GHG emissions.

However, in developing countries, especially in urban areas, it is a neglected issue and it is not properly managed (F ériel & Marc, 2009; Issam et al., 2010). Hence, the improper handling of MSW will eventually affect public health, such as environmental pollution (air, water and soil) which lead to losses in economic, environmental and biological aspects (Issam et al., 2010; Kapepula et al., 2007; Sharholy et al., 2008; Wilson et al., 2006).

1.2 Landfill Gas and Climate Change

The major GHG emissions from the waste sector are landfill methane (CH_4) (IPCC, 2007b). The main components of landfill gas (LFG) are 40%-60% carbon dioxide (CO_2), and 45%-60% CH_4 (ATSDR, 2001) and these are released under anaerobic condition during decomposition of organic matter of waste in landfills (Vikash et al., 2007). CH_4 emissions from landfills are higher than from open dumpsites, because the former is more anaerobic due to cover material deposited from above, preventing oxygen exposure (Chiemchaisri et al., 2007). CH_4 is the second largest anthropogenic GHG, after CO_2 (IPCC, 1996a). However, CO_2 emissions from biomass sources such as CO_2 in LFG, composting and incineration are biogenic origins, hence there are excluded from GHG inventories (IPCC, 2007b).

Climate change is a growing concern nowadays. This is why an international treaty, called Kyoto Protocol was adopted in 1997 and enforced since 2005 to mitigate climate change. Countries especially developed countries (Annex I countries) which have signed and ratified the Protocol are advocating alternatives to meet their obligations on GHG emission reductions for the first commitment period of 2008-2012. They are committed to reduce their collective GHG emissions through few specified mechanisms, by as much as 5.2% from the 1990 level. The mechanisms include Emissions Trading (ET), Clean Development Mechanism (CDM) and Joint Implementations (JI). Developed countries offset their carbon footprint by purchasing certified emission reductions (CERs). Each unit is equivalent to one tonne of CO₂ being prevented from being released into the atmosphere.

The global warming potential (GWP) of CH₄ is 25 times higher than CO₂, thus, the importance of aerobic landfills become apparent (Hansen & Agamuthu, 2008). Compared to developed countries, developing countries are still practising anaerobic landfilling. Hence, there is a huge amount of landfill CH₄ available for reduction. Under the mechanisms of the Protocol and other LFG recovery systems, the potential global landfill CH₄ emissions was projected to exceed 1000 MtCO₂e in 2030 (or 70% of projected emissions) with reduction costs below US\$100 tCO₂e/year (IPCC, 2007b). 20–30% of estimated emissions reduction can be reached at negative cost and 30–50% at costs below US\$20 tCO₂e/year (IPCC, 2007b).

1.3 Problem Statement

Malaysia is one of the fastest developing countries in Southeast Asia with a land area of 329,847 km², is populated by 28.31 million people in July 2009 (Department of Statistic, 2009). The population has been escalating since 1994 at an annual increase rate of 2.4% or approximately 600,000 (Latifah et al., 2009). In 2009, Malaysia generated 30,000 tonnes of waste daily (1.3kg/capita/day) compared to 18,000 tonnes in 2004 (Agamuthu et al., 2005; Agamuthu et al., 2009). This increase was in proportion to the rise of population, increase in per-capita income, urbanisation, industrialization and changes in the consumption pattern (Mohamed et al., 2009).

There were about 303 dumps and landfills in 2011 in Malaysia (Fauziah & Agamuthu, 2012). Mohammed et al., (2010) showed that the total landfill CH₄ emissions in Malaysia by using the IPCC 1996 First Decay Order (FOD) model was estimated at 318.8 Gg in 2009. It is forecasted to increase to 397.7 Gg by 2020. The CH₄ emissions in the Northern region of the country recorded the highest, with 128.8 Gg compared to the lowest CH₄ emissions in the Borneo regions, with 24.2 Gg only. Among all the states, Pulau Pinang emitted the highest amount of CH₄, 77.6 Gg while the CH₄ emissions of other states ranged from 38.5 Gg to 1.5 Gg.

The above study indicated a huge potential for landfill CH₄ emissions reduction in Malaysia as developing countries which still practiced anaerobic landfilling, compared to developed countries, LFG recovery system and other alternative waste management technologies which aimed to reduce landfill CH₄ emissions are well implemented (IPCC, 2007b). Though Malaysia does not have any emission reduction obligation under the

Protocol, Malaysian Prime Minister Datuk Seri Najib Abdul Razak offered the country's commitment to reduce 40% CO₂ by the year 2020 compared to the 2005 level, subject to assistance from developed countries, when he attended the 15th Conference of the Parties in Copenhagen (COP 15) held from 7-19 December 2009 (Agencies, 2009). Hence, sooner or later, Malaysia will move from landfill-based to resource recovery based solutions such as 3Rs, composting, and incineration.

CDM is one of the mechanisms can be used to reach the emissions reduction target. To date, Malaysian corporate sectors which are actively involved in CDM projects include palm oil, agricultural, transportation, manufacturing, oil and gas and wastewater sectors. Only one CDM project is on MSW composting, the rest are composting of palm oil mill effluent (POME). The first MSW composting project was initiated in Dhaka, Bangladesh (UNFCCC, 2006c). Due to the increasing demand by European Union countries to meet their emissions reduction target, CDM projects certainly have great potential in Malaysia and project types may become more varied.

The present literature does not highlight the emissions reduction contributed by MSW composting in Malaysia. Hence, this research will evaluate the potential of a small-scale MSW composting project. The baseline scenario is where MSW is left to degrade in the landfill and CH₄ is emitted to the atmosphere without the presence of project activity. In this study, the baseline scenario Bukit Tagar Sanitary Landfill where the MSW is disposed off. By doing composting (project activity), MSW will be converted into compost. The emissions reduction of CH₄ resulting from composting will be traded as emission reduction credits. If the result is positive, it will encourage more small-scale waste MSW composting projects to be ventured as an alternative towards global

warming.

1.4 Objectives

The objectives of this research are as below:

- 1) To identify and characterize the baseline scenario.

It refers to the scenario where the collected MSW from Rawang and Selayang is currently disposed off into the Bukit Tagar Sanitary Landfill.

- 2) To identify the project activity.

It refers to the scenario where the organic components in the collected MSW is avoided to be disposed off at the landfill, but directed to a MSW composting plant.

- 3) To estimate the amount of baseline emissions, project emissions and emission reductions.

Emissions reduction is the difference between baseline emissions and project emissions.

- 4) To evaluate the economic potential of the project activity based on UNFCCC for regulatory and voluntary markets.

1.5 Hypotheses

The hypotheses of this research are as below:

- 1) By converting MSW into compost, carbon emissions released into the atmosphere can be reduced.
- 2) CDM project (converting MSW into compost) is feasible economically.