

## **Research Paper**

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# **Waste Management Challenges in Cambodia and Experiences from other countries**

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## **Executive Summary**

Waste is created in every country. In Cambodia, population growth and the rise of the industrial and service sectors has contributed to an increase in waste generation. This increase has presented challenges particularly in respect of waste collection and management.

This research paper examines the issue of waste management in Cambodia, and provides an analysis of the impacts of waste on human health and the environment. The paper also reviews the practices of waste management and its impacts in Singapore, Vietnam, Thailand, the United Kingdom and Germany. The relevant policies and guidelines of waste management of each country are also.

### **Waste management practices in the studied countries**

Waste management practices in Cambodia tend to focus on traditional methods including landfills with poor design, waste burning in dumpsites or open spaces, and composting and recycling programs. Moreover, except for medical waste incinerators in hospitals, burning waste in incineration plants is not widely used. This echoes practices in Vietnam. However, Vietnam and Thailand seem to have more sanitary landfills than Cambodia. Also, Thailand and Vietnam use various waste management methods including recycling and composting.

Singapore has employed more modern waste management methods if compared with those in Cambodia, Thailand and Vietnam. Those methods include: (i) Waste-to-Energy incineration and (ii) well-designed sanitary landfill and recycling methods. Similarly, the United Kingdom (UK) uses waste management methods, which consist of: (i) Waste-to-Energy incineration and, (ii) Recovery and Recycling methods. With regard to landfills, the UK has considered this method as a last option for waste management because of its negative impacts on the environment, and because of an EU Landfill Directive setting targets for the UK to reduce biodegradable municipal waste (such as food waste, green waste, paper waste, etc.) disposed of at landfills. Meanwhile, Germany has also used similar methods of waste management including: (i) waste recycling and recovery, (ii) sanitary landfills, and (iii) incineration plants to transform energy from waste.

### **Impacts of waste management in the studied countries**

Waste management practices in Cambodia tend to have negative impacts on the environment and human health. Even though there is no specific study on the impact of waste management in Cambodia, it is generally found that littering in public, waste burning and disposing of waste in landfills without proper design has negative effects on the environment and human health. This is also the case in Thailand and Vietnam as these two countries still use some traditional methods of waste management (e.g. some insanitary landfills). However, disposing of waste in the landfill in Singapore does not have significant harmful effects on human health

and the environment because the landfill site in Singapore has been technically designed to prevent these problems. This landfill site is similar to the design of those in the UK and Germany that has been adopted over the last few years, and that have to comply with strict technical requirements as stated in Landfill Directives.

With regard to the impact of other methods of waste management, the Waste-to-Energy incineration plants in Singapore seem to cause air pollution, which contributes to climate change, although the plants also produce energy. This shows that incineration plants tend to have some impact on environmental pollution. However, in the UK and Germany, the Waste-to-Energy incineration plants are permitted to operate only if they are constructed in compliance with high technical design standards and strict environmental regulations. The incineration plants in the UK and Germany contribute to reducing the effects of waste on climate change because they avoid the methane emissions of landfills.

### **Policies and guidelines related to waste management in the countries studied**

The governments of the countries studied have prepared and implemented various regulations, policies and programs related to waste management. Cambodia has established a number of waste management regulations, policies and programs including awareness-raising initiatives. However, the implementation of these policies and programs is limited.

Besides the relevant regulations on waste management, Vietnam and Thailand have prepared their specific national strategies. For instance, Vietnam has the National Strategy for Solid Waste Management in industrial and urban areas up to 2020, and Thailand has a National Integrated Waste Management Plan. In addition, Thailand has established a number of waste management programmes (e.g. Take-back schemes for end-of-life products and waste exchange programmes). Singapore also uses best practices in implementing and enforcing its regulations, policies and programmes related to waste management and has carried out awareness-raising programs including the Keep Singapore Clean Movement and the Clean and Green Singapore campaign.

Meanwhile, government agencies in the UK and Germany have a high commitment to enforcing regulations related to waste management and implements a waste hierarchy concept in a progressive manner. The waste hierarchy concept includes: (i) prevention, (ii) preparing for re-use, (iii) recycling, (iv) other recovery; and (v) disposal.

This paper highlights some of the best practices from a number of countries regarding waste management which may be useful to Cambodia as examples of what might be adopted for programs in the Cambodian context.



## 1. Introduction

Cambodia is encountering an increasing number of environmental pollution challenges including air, water, and solid waste pollution. Waste generation in Cambodia has been exacerbated by the expansion of the industrial and service sectors and a rise in rural-urban population<sup>1</sup>. Waste collection and management is widely recognized as an issue that needs to be addressed<sup>2</sup>.

This research paper will use secondary data to examine the current situation of waste management in Cambodia, and analyse the impacts of waste on human health and the environment. It then reviews relevant policies, guidelines and practices to address this issue. Finally, the paper will document the case studies of waste management and its impacts in Singapore, Vietnam, Thailand, the United Kingdom and Germany.

## 2. The Current Situation Regarding Waste Management in Cambodia

Population growth and rural-to-urban migration have increased remarkably over the last decade in Cambodia and led to an increase in waste generation in cities<sup>3</sup>. It is calculated that 14 million people can generate approximately 6, 818, 000 tons of waste per year<sup>4</sup>. This calculation is based on a 2005 study arguing that a person in Phnom Penh is likely to generate 0.478 kg of waste per day<sup>5</sup>. It is also observed that most of the waste generated in urban areas is thrown into surface water, deposited at public spaces, along streets or at vacant areas near to residential homes<sup>6</sup>.

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<sup>1</sup> Ministry of Environment, Cambodia Environment Outlook, (Thailand: Thai Graphic and Print Co.,Ltd), 2009, accessed on 25 March 2015, URL: [http://geodata.rccap.unep.org/all\\_reports/cambodia\\_081010.pdf](http://geodata.rccap.unep.org/all_reports/cambodia_081010.pdf)

<sup>2</sup> Turton, Shaun. "Fund Intended to Improve Country's Urban Sanitation," *the Phnom Penh Post*, 3 March 2015, accessed 25 March 2015, URL: <http://www.phnompenhpost.com/fund-intended-improve-countrys-urban-sanitation>.

<sup>3</sup> Sethy Sour, Sothun Chin and Rachel Wildblood, "Municipal Solid Waste Management in Cambodia," in *Municipal Solid Waste Management in Asia and the Pacific Islands: Challenges and Strategic Solutions*, ed. Agamuthu Pariatamby et al. (Singapore, 2014), accessed on 25 March 2015, URL: [https://books.google.com.kh/books?id=nRXHBAAQBAJ&pg=PA77&dq=Municipal+Solid+Waste+Management+in+Cambodia&hl=en&sa=X&ei=G2ESVeIEGZbr8AWG-oHICw&redir\\_esc=y#v=onepage&q=Municipal%20Solid%20Waste%20Management%20in%20Cambodia&f=false](https://books.google.com.kh/books?id=nRXHBAAQBAJ&pg=PA77&dq=Municipal+Solid+Waste+Management+in+Cambodia&hl=en&sa=X&ei=G2ESVeIEGZbr8AWG-oHICw&redir_esc=y#v=onepage&q=Municipal%20Solid%20Waste%20Management%20in%20Cambodia&f=false)

<sup>4</sup> Ibid

<sup>5</sup> This figure was made available by the JICA's study on solid waste management in the municipality of Phnom Penh in the Kingdom of Cambodia in 2005. It is the country's only available data of per capita waste generation, according to Sour et al, "Municipal Solid Waste Management in Cambodia", 2014.

<sup>6</sup> "Cambodia Environment Outlook", 61.

Article 3 of the Sub-Decree on Solid Waste Management in 1999 defines some technical terms regarding waste as follows<sup>7</sup>:

- Solid waste refers to hard objects, hard substances, and products or refuse, which are useless and disposed of;
- Household waste is the portion of solid waste which does not contain toxins or hazardous substances, and is discarded from dwellings, public buildings, factories, markets, hotels, commercial buildings, restaurants, transportation, recreation sites, etc.; and
- Hazardous waste refers to substances that are radioactive, explosive, toxic, inflammable, pathogenic, irritating, corrosive, oxidizing, or other chemical materials which might cause danger to human and animal health or damage plants, public property and the environment.

Waste in Cambodia is categorized into three main types : (i) domestic/household, (ii) commercial and (iii) industrial and hazardous including hospital waste<sup>8</sup>. However, there is no consensus on this categorization. Moreover, there is no specific up-to-date data on each type of waste . For instance, it is recognized by the Ministry of Environment that hospital waste data, and information on waste for the whole country, is based on estimates and is not up-to-date<sup>9</sup>. An example of this is found in a report by the Ministry of Environment in 2009, which still used 2000-2002 data, stating that<sup>10</sup>:

*"In 2000, hospital waste was estimated at 182 tonnes and that estimate was increased to 462 tonnes in 2001 and an additional 300 tonnes (in addition to liquid waste of about 66, 430 litres) in 2002. Notably, this amount relates only to Phnom Penh."*

The information on waste management for the country as a whole is limited<sup>11</sup>. However, Table 1 gives figures relating to municipal solid waste composition in Phnom Penh, Siem Reap, Battambang and Kampong Cham provinces. It shows that food waste makes up the largest proportion of total waste composition, accounting for 70 percent in Phnom Penh, 54 percent in Siem Reap, 71 percent in Battambang and 60 percent in Kampong Cham. Second is plastic waste accounting for 6 percent in Phnom Penh, 11 percent in Siem Reap, 10 percent in Battambang and 12 percent in Kampong Cham province.

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<sup>7</sup> Council of Minister of Cambodia. Sub-Decree on Solid Waste Management. Phnom Penh.1999, accessed on 25 March 2015, URL: [http://www.cambodiainvestment.gov.kh/content/uploads/2011/09/Sub-Degree-36-on-Solid-Waste-Management\\_990427.pdf](http://www.cambodiainvestment.gov.kh/content/uploads/2011/09/Sub-Degree-36-on-Solid-Waste-Management_990427.pdf)

<sup>8</sup> Sour et al, "Municipal Solid," 78

<sup>9</sup> Ministry of Environment, "Cambodia Environment", 67

<sup>10</sup> Ibid, 67

<sup>11</sup> Ibid, 60

**Table 1: Municipal solid waste composition in four locations<sup>12</sup>**

Composition (%)	Phnom Penh	Battambang	Siem Reap	Kampong Cham
Food waste	70	71	54	60
Paper/Cardboard	5	2	6	5
Wood/Glass	6	6	11	3
Plastic	6	10	11	12
Metal	2	3	1	1
Textile	3	2	3	1
Glass	2	4	3	2
Other	6	2	11	16

Source: COMPED, "Preparatory research for the development for an action plan for solid waste management in Battambang, Cambodia", 2011, accessed on 2 April, 2015, URL: <http://www.comped-cam.org/wastesurvey.php>

It appears that there is little or no information related to types of waste including oil, batteries, and waste from construction and building demolition in Cambodia.

### 3. Methods of Waste Management in Cambodia

There appears to be a lack of awareness on the part of Cambodian citizens about waste disposal. This is evident from the fact that garbage or solid waste is routinely thrown into open spaces, along the street or into vacant areas near to residential buildings<sup>13</sup>. Moreover, in most cities and towns in the provinces there is still a lack of appropriate systems to collect, transport, and dispose of solid waste properly<sup>14</sup>.

#### 3.1 Methods of waste disposal used by citizens

There are a number of ways Cambodian people dispose of waste. The first is by separating solid waste at source. This separation of recyclable, tradable, waste is done on a voluntarily basis<sup>15</sup>. Waste pickers also play an important role in dividing sellable waste from waste bins and at disposal sites. For example, there are more than 2,000 waste



<sup>12</sup> Municipal solid waste is mainly generated from household waste and how Waste separation by citizens; Source: dwellings, public buildings, factories, markets, hotels, business buildings, recreation sites, etc. This is according to the Ministry of Environment and COMPED, "Environmental Guideline on Solid Waste Management in Kingdom of Cambodia", 2006, accessed on 2 April 2015, URL: <http://www.comped-cam.org/documents.php>. The Municipal solid waste is similarly likened to "household waste" in the Sub-Decree on Solid Waste Management.

<sup>13</sup> Sour et al, "Municipal Solid", 79

<sup>14</sup> Ministry of Environment, "Cambodia Environment", 62

<sup>15</sup> Janya Sang-Arun and Chau Kim Heng, *A Guide for Technology Selection and Implementation of Urban Organic Waste Utilisation Projects in Cambodia*, (Japan: IGES, 2011)

pickers who remove sellable waste from downtown waste bins and from the Phnom Penh landfill sites<sup>16</sup>.

Waste is also disposed of through burning, although this is more common in rural than urban areas<sup>17</sup>. This can be attributed to the fact that waste collection services and dumpsites are limited in rural areas<sup>18</sup>. This leads to different ways of waste management practices at the suburban level including (i) burning (66 percent), (ii) burying near or behind houses (11 percent), disposal in rice fields, along public roads and in open spaces (9 percent), (iii) disposal in water (5 percent), and (iv) others (9 percent)<sup>19</sup>.



Waste burning by citizens; source: Google image

## 3.2 Methods of waste management used by government institutions/local authorities

### ▪ Landfill

Solid waste management in Cambodia, as in most developing Asian countries, is conventional<sup>20</sup> and mostly involves waste collection, treatment and, disposal at dumpsites and landfills<sup>21</sup>. Most is disposed of at dumpsites (i.e. at the Dang Kor landfill in Phnom Penh<sup>22</sup>, at the dumpsites in Battambang and Kampot and in other provinces). There are approximately 60 dumpsites operating across Cambodia<sup>23</sup> but the majority are of poor quality with limited technical design<sup>24</sup>. An exception is the

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<sup>16</sup> Ibid

<sup>17</sup> Samphoasphalyka Sok and Kimsour Kim, "Side Effects of Burning Waste," *The Phnom Penh Post*, 18 April 2012, accessed on 1 April 2015, URL: <http://www.phnompenhpost.com/lift/side-effects-burning-waste>

<sup>18</sup> Ibid

<sup>19</sup> Sour Sethy, "Solid Waste Management in Cambodia" (slide presentation shown at Okayama, 2 February 2013), accessed on 2 April 2015, URL: [http://ambiente.okayama-u.ac.jp/management/upload\\_files/gakkan/2012\\_en/2012\\_en\\_3-13.pdf](http://ambiente.okayama-u.ac.jp/management/upload_files/gakkan/2012_en/2012_en_3-13.pdf)

<sup>20</sup> COMPED, "Urban Organic Waste Management in Cambodia," accessed on 2 April 2015, URL: <http://www.comped-cam.org/compostingone.php>

<sup>21</sup> Prasad Modak, "Municipal Solid Waste Management: Turning Waste into Resources," in *Shanghai Manual- A Guide for Sustainable Urban Development in the 21<sup>st</sup> Century*, 6, accessed on 2 April 2015, URL: [http://www.un.org/esa/dsd/susdevtopics/sdt\\_pdfs/shanghaimanual/Chapter%205%20-%20Waste\\_management.pdf](http://www.un.org/esa/dsd/susdevtopics/sdt_pdfs/shanghaimanual/Chapter%205%20-%20Waste_management.pdf)

<sup>22</sup> Yim Mongtoeun, Takeshi Fujiwara, and Sour Sethy, "Current Status of Commercial Solid Waste Generation, Composition and Management in Phnom Penh City, Cambodia," *Journal of Environment and Waste Management* (2014), accessed on 2 April 2015, URL: [https://www.researchgate.net/publication/270506884\\_Current\\_status\\_of\\_commercial\\_solid\\_waste\\_generation\\_composition\\_and\\_management\\_in\\_Phnom\\_Penh\\_city\\_Cambodia](https://www.researchgate.net/publication/270506884_Current_status_of_commercial_solid_waste_generation_composition_and_management_in_Phnom_Penh_city_Cambodia)

<sup>23</sup> Sour Sethy, "Solid Waste."

<sup>24</sup> Ibid; interview with Mr. Sam Phalla, Vice Director and Composting Project Manager at COMPED on 2 April 2015.

Dang Kor landfill in Phnom Penh that was built in 2009 incorporating advanced techniques including compaction and a leachate drainage system<sup>25</sup>.

## ▪ Recycling

Besides landfills, the (local) governments (e.g., at the city, town and provincial levels) have cooperated with contracted private companies and relevant NGOs working in the field of waste management to implement composting and recycling programs<sup>26</sup>.

Waste composting and recycling has been established in major cities and provinces of Cambodia. For example, in Battambang province a composting plant is being operated close to the dumpsite. The plant was financially supported by the German Federal Ministry of Economic Cooperation and Development and the Thuringian-Cambodian Association (TKG) and is run by the COMPED NGO<sup>27</sup>. The plant receives approximately 14 tons of waste per day, of which 86.5 percent is likely to be organic. The plant produces a monthly output of 7 tons of compost, most of which is sold at a price of 300 riel (USD 0.075) per kg<sup>28</sup>.

In Phnom Penh, a composting project has been implemented by Phnom Penh Waste Management (PPWM) Authority<sup>29</sup> in cooperation with NGOs such as COMPED and SCARO. The PPWM is responsible for collecting organic solid waste in particular areas (i.e., Sangkat Boeung Keng Kang I and II, and Phsar Doeum Kor Market and slaughter houses), and supplying this to SCARO and COMPED for the composting

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<sup>25</sup> Janya Sang-Arun and Chau Kim Heng, *A Guide for Technology Selection and Implementation of Urban Organic Waste Utilisation Projects in Cambodia*, (Japan: IGES, 2011). Compaction is the process of pushing waste into less space (mainly through the weight of the machine and the pressure of the compactor wheels), and is also the process of breaking waste materials into smaller pieces (mainly through the action of the compactor's teeth), according to [http://www.mswmanagement.com/MSW/Editorial/The\\_Mechanics\\_of\\_Waste\\_Compaction\\_24717.aspx](http://www.mswmanagement.com/MSW/Editorial/The_Mechanics_of_Waste_Compaction_24717.aspx), accessed on 3 May 2015.

Leachate is liquid generated from rainfall and the natural decomposition of waste that is filtered through the landfill to a leachate collection system. The leachate drainage system's job is to direct the leachate to collection sumps so it can be properly removed from the landfill, according to <http://austincommunitylandfill.wm.com/environmental-protection/leachate-collection.jsp>, accessed on 3 May 2015.

<sup>26</sup> Janya Sang-Arun and Chau Kim Heng, *A Guide for Technology*, 54.

<sup>27</sup> ESCAP, "Battambang: Solid Waste Management," accessed on 3 April 2015, URL: <http://waste2resource.org/wp-content/uploads/2012/05/email-version-BATTAMBANG-CITY-PROFILE.pdf>

<sup>28</sup> Ibid

<sup>29</sup> Phnom Penh Waste Management (PPWM) Authority was created by the Municipality of Phnom Penh (MPP) in order to be responsible for overall solid waste management in Phnom Penh, according to Keo Rathana, "Solid Waste Management in Cambodia," May 2009, accessed on 31 March 2015, URL: [http://www.cicp.org.kh/userfiles/file/Working%20Paper/CICP%20Working%20Paper%2027%20solid%20waste%20management\\_Edited.pdf](http://www.cicp.org.kh/userfiles/file/Working%20Paper/CICP%20Working%20Paper%2027%20solid%20waste%20management_Edited.pdf).

project<sup>30</sup>. In addition, the PPWM offers composting units for COMPED at the landfill to operate the composting project<sup>31</sup>.

With regard to waste recycling, the CINTRI Company has planned to establish a recycling plant with the Phnom Penh Municipality to reduce waste to zero<sup>32</sup>. However, no firm information about this is available at present.

## ▪ **Incineration**

Medical waste is disposed of through incineration.<sup>33</sup> Hospitals, polyclinics, clinics, and health centres that do not have their own incinerators send their waste to hospitals that have on-site facilities<sup>34</sup>. Nonetheless, only small amounts of medical waste - approximately 357 kgs and 68 litres - are reported to be incinerated daily in on-site incinerators at a small number of hospitals<sup>35</sup>.

Some of the ash and residue generated from incineration is disposed of at sites in the vicinity of the incinerators, while the rest is gathered by the PSBK Company to be disposed of at open dumpsites<sup>36</sup>.

## **4. Impacts of waste management in Cambodia**

### **4.1 Impacts of public littering**

Despite the fact that waste collection services and transportation are available in several urban areas and provincial towns in Cambodia, waste littering remains a problem in these areas. The likely impacts can be summarized as follows:



## ▪ **Environmental Impacts**<sup>37</sup>

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<sup>30</sup> 3RKH, “3R Good Practices in Cambodia: Phnom Penh Waste Management (PPWM)”, accessed on 6 April 2015, URL: <http://www.faculty.ait.ac.th/visu/NGOs/pdfs/cambodia-%20NGO/SJ-PPWM.pdf>

<sup>31</sup> Ibid

<sup>32</sup> CINTRI, “Recycling Project,” last modified 2011, accessed on 6 April 2015, URL:

<http://www.cintri.com.kh/PHP/RecyclingProject.php>

<sup>33</sup> Meeting with Denis Schrey, Country Representative for Cambodia of the Konrad-Adenauer-Stiftung (KAS) on 3 April 2015

<sup>34</sup> Ministry of Environment, “Cambodia Environment”, 67

<sup>35</sup> Ibid

<sup>36</sup> Ibid

<sup>37</sup> Ashfield Council, “Litter,” last modified 2013, accessed on 29 April 2015, URL:

<http://www.ashfield.nsw.gov.au/page/litter.html>



- Litter can directly and indirectly kill aquatic life and adversely affect the quality of water by reducing the amount of oxygen in waterways. For instance, cigarette butts release harmful toxins into water when they break down.
- Litter downgrades the beauty of public areas.
- Litter can damage waterways and drainage systems<sup>38</sup>. For example, it has been noted that throwing away non-biodegradable waste in Phnom Penh can block the city's drainage pipes, thus contributing to flooding in the city<sup>39</sup>.

*The garbage near Chamkar Mon district's Phsar Doeum Thkoy commune (credit to Siy Channa). This photo by Simon Henderson and Aun Pheap appeared in the Cambodia Daily newspaper on 6 May 2013.*

#### ▪ Impacts of littering to human health<sup>40</sup>

- Littering poses a threat to public health as it attracts pests and is a breeding ground for bacteria.
- Littering of broken glass and syringes is a serious health hazard for humans.

## 4.2 Impacts of waste burning

Although waste burning tends to be practised mostly by rural Cambodians<sup>41</sup>, some perceive it to have negative impacts on human health and the environment<sup>42</sup>. A Cambodian resident interviewed by the *Phnom Penh Post* newspaper stated that<sup>43</sup>:

*"Waste burning might be an expedient way of cleaning up dump areas, but repeated fires pollute the air and the ground as well as being hazardous for human health. The villagers normally burn rubbish including plastic bags which badly affects the environment. It's difficult for me to take a breath of fresh air here in my village."*

It is generally accepted that burning waste in open areas is likely to have a negative impact on human health and the environment<sup>44</sup> because it releases air pollutants, ash and dense smoke<sup>45</sup>. The ash from the waste is likely to be

<sup>38</sup> Ibid

<sup>39</sup> Simon Henderson and Aun Pheap, "Cambodia's Excess Baggage," *The Cambodia Daily*, 6 May 2013, accessed on 29 April 2015, URL: <https://www.cambodiadaily.com/archives/cambodias-excess-baggage-22003/>

<sup>40</sup> Frankston City Council, "Impacts of Litter," accessed on 29 April 2015, URL: [http://www.frankston.vic.gov.au/Environment and Waste/Waste and Recycling/Litter and Illegal Dumping/Impacts of Litter](http://www.frankston.vic.gov.au/Environment%20and%20Waste/Waste%20and%20Recycling/Litter%20and%20Illegal%20Dumping/Impacts%20of%20Litter)

<sup>41</sup> Sour Sethy, "Solid Waste."

<sup>42</sup> Samphoasphalyka Sok and Kimsour Kim, "Side Effects,"

<sup>43</sup> Thik Kaliyann, "Rubbish burning becomes a burning issue," *The Phnom Penh Post*, 7 March 2014, accessed on 2 April 2015, URL: <http://www.phnompenhpost.com/lift/side-effects-burning-waste>

<sup>44</sup> Manitoba, "Implications of Open Burning of Garbage at Waste Disposal Grounds," accessed on 9 April 2015, URL: [http://www.gov.mb.ca/conservation/envprograms/airquality/brochures/waste\\_burning\\_e.html](http://www.gov.mb.ca/conservation/envprograms/airquality/brochures/waste_burning_e.html)

<sup>45</sup> Ibid

contaminated with toxic chemicals such as dioxins and furans, polycyclic aromatic hydrocarbons (PAHs), heavy metals, and other carcinogenic compounds. In addition, the smoke, too, might include aldehydes, acids, nitrogen oxides, sulphur oxides, PAH, dioxins, furans and other chemicals<sup>46</sup>.

- **Impacts on human health**

- The pollutants, which are toxic, might cause irritation, and skin and respiratory problems. The severity of these depends on the distance from the fire, duration of exposure, amount and type of waste burned, and individual sensitivity<sup>47</sup>; and
- People with respiratory problems such as asthma or allergies are likely to be more sensitive to the smoke<sup>48</sup>.

- **Impacts on the environment<sup>49</sup>**

- Ash, which might be dispersed by the wind or leached by water, could contain toxic contaminants; and
- Toxins from any remaining ash might leach and contaminate surface or ground water.

### **4.3 Impacts of landfills**

The majority of the landfills in Cambodia are situated in flood prone areas<sup>50</sup>. This can lead to environmental pollution because, during the decomposition process of waste in the landfill, leachate is generated which can contaminate the groundwater table and the surrounding paddy fields<sup>51</sup>. Moreover, people living near to landfills are exposed to health risks caused by houseflies and harmful insects<sup>52</sup>.

A research study on the "Health Effects on Residences Near Hazardous Waste Landfill Sites: A Review of Epidemiologic Literature" concluded that an increase in the risk of adverse health effects (e.g. low birth rate, birth defects, certain types of cancers) has been reported near individual landfill sites<sup>53</sup>. However, the study recognized that risks to health from landfill sites are hard to quantify. This is because there is a lack of information on the effects of low-level environmental exposure on the general population<sup>54</sup>.

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<sup>46</sup> Ibid

<sup>47</sup> Ibid

<sup>48</sup> Ibid

<sup>49</sup> Ibid

<sup>50</sup> Janya Sang-Arun and Chau Kim Heng, *A Guide for Technology*, 10.

<sup>51</sup> Ibid

<sup>52</sup> Ibid

<sup>53</sup> Martine Vrijheid, "Health Effects of Residence Near Hazardous Waste Landfill Sites: A Review of Epidemiologic Literature," *London School of Hygiene and Tropical Medicine*, Vol 108, 2000, accessed on 5 May 2015, URL: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637771/pdf/envhper00310-0106.pdf>

<sup>54</sup> Ibid.



## 5. Responsibilities of the national and local governments in Cambodia

### 5.1 National government

In Cambodia, Article 4 of the Sub-Decree on solid waste management in 1999 tasks the Ministry of Environment (MoE) to “establish guidelines on disposal, collection, transportation, storage, recycling, minimizing, and dumping of household waste in provinces and cities in order to ensure the safe management of household waste.” The provinces and cities are responsible for “developing the short, medium and long-term waste management plans for their areas.”<sup>55</sup>

In 2006, the MoE in cooperation with an NGO, COMPED, and international experts developed the Environmental Guidelines on Solid Waste Management in Cambodia in order to implement the existing environmental regulations, and to increase the awareness and knowledge of stakeholders on this subject<sup>56</sup>.

### 5.2 Local governments

Article 5 of the Sub-Decree on Solid Waste Management states that: “the collection, transport, recycling, minimizing and dumping of waste in the provinces and cities is the responsibility of the authorities of provinces and cities<sup>57</sup>.”

However, lacking financial and human resources, the provincial, municipal and local authorities have contracted the tasks of collecting, transporting and disposing of waste at landfills out to private companies<sup>58</sup>. For example, the Municipality of Phnom Penh (MPP), since 2002, has agreed a 49-year contract with CINTRI (Cambodia) Ltd. for them to collect city waste and clean the streets<sup>59</sup>. Sarom Trading Company Co. Ltd has also been given a licence by the Ministry of Environment to collect, transport, and dispose of all of Cambodia’s hazardous waste at its site in Phnom Penh<sup>60</sup>.

Kampot Municipality oversees waste collection services in urban areas of their province, while the Communes/ Sangkats oversee any problems that emerge

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<sup>55</sup> Council of Minister of Cambodia, “Sub-Decree on Solid,” 3.

<sup>56</sup> AIT & UNEP, *Municipal Waste Management Report: Status-quo and Issues in Southeast and East Asian Countries*, (2010), accessed on 14 April 2015, URL:

[http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CD0QFjAG&url=http%3A%2F%2Fwww.environment-](http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CD0QFjAG&url=http%3A%2F%2Fwww.environment-health.asia%2Fuserfiles%2Ffile%2FMunicipal%2520Waste%2520Report.pdf&ei=yy8uVYmiNOTDmQX--YH4Dw&usg=AFQjCNEQgOe6igO9RpTlsg7s2sIUyPAHgQ&sig2=WlwG2tWXMMGafy550joVMQ)

[Fwww.environment-health.asia%2Fuserfiles%2Ffile%2FMunicipal%2520Waste%2520Report.pdf&ei=yy8uVYmiNOTDmQX--YH4Dw&usg=AFQjCNEQgOe6igO9RpTlsg7s2sIUyPAHgQ&sig2=WlwG2tWXMMGafy550joVMQ](http://www.environment-health.asia%2Fuserfiles%2Ffile%2FMunicipal%2520Waste%2520Report.pdf&ei=yy8uVYmiNOTDmQX--YH4Dw&usg=AFQjCNEQgOe6igO9RpTlsg7s2sIUyPAHgQ&sig2=WlwG2tWXMMGafy550joVMQ)

<sup>57</sup> Council of Minister of Cambodia, “Sub-Decree on Solid,” 3.

<sup>58</sup> Janya Sang-Arun and Chau Kim Heng, *A Guide for Technology*, 8.

<sup>59</sup> CINTRI, “About Us,” last modified 2011, accessed on 31 March 2015, URL: <http://www.cintri.com.kh/index.php#>

<sup>60</sup> 3RKH, “City Waste Profile: Phnom Penh,” 2012, accessed on 31 March 2015, URL:

[http://www.3rkh.net/index.php?option=com\\_phocadownload&view=file&id=628:city-waste-profile-phnom-penh&start=10&order\\_by=ordering&Itemid=238](http://www.3rkh.net/index.php?option=com_phocadownload&view=file&id=628:city-waste-profile-phnom-penh&start=10&order_by=ordering&Itemid=238)

between villagers and the waste collection service provider<sup>61</sup>. A private company, named GAEA, is contracted by the Kampot Provincial authority to collect waste, to improve service and expand areas for waste collection. The company also manages the dumpsite<sup>62</sup>. In addition<sup>63</sup>:

- The Department of Environment: (i) works closely with the private company (i.e. GAEA) for regulatory enforcement and with the Provincial Cabinet and Department of Land Management, Urban Planning and Construction and the Khan of Forest Administration to identify land for landfill, (ii) works closely with GAEA to place waste bins, and (iii) gathers waste data for the Ministry of Interior (MoI)/Ministry of Environment (MoE);
- The Department of Health educates villagers about health and sanitation;
- The Department of Public Works and Transport provides transport licences to waste collection companies (i.e. GAEA); and
- The Department of Economy and Finance plays a role in setting fees based on the fees charged by CINTRI in Phnom Penh.

It should be noted that the responsibilities of relevant local authorities and provincial technical departments are set out in the sub-decree on solid waste management and the inter-ministerial Prakas on waste and solid waste management for Provinces/Municipalities<sup>64</sup>. However, the contracting out to private companies for waste management services seems to vary among the provinces, and is subject to negotiation between the provincial/municipality authority and the relevant private company.

### **5.3 Policies and programs for waste management**

The Royal Government of Cambodia (RGC) has established several regulations, policies, and guidelines to govern solid waste disposal in Cambodia. These regulatory documents include<sup>65</sup>:

- The Law on Environmental Protection and Natural Resource Management 1996;
- The Sub-decree on Solid Waste Management 1999;
- The Sub-decree on Environmental Impact Assessment 1999;
- The Prakas on the delegation of responsibilities to the provincial/municipality departments by implementation of the Sub-decree on the Monitoring of Water Pollution and Waste Management 2 June 1999;
- The Prakas on the Organisation and Functioning of the Environmental Provincial-Municipal Department 19 July 1999;

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<sup>61</sup> G.Hadrich and C. Westphalen, "Wrap-up to the workshop: Decentralised Solid Waste Management in Kampot-Towards a realistic, sustainable, feasible (economically, socially and culturally) and implementable solid waste management system in Kampot (Province/Municipality/Commune/Sangkat), 2013 [draft version]"

<sup>62</sup> Ibid

<sup>63</sup> Ibid

<sup>64</sup> RGC, "Inter-Ministerial Prakas of the Ministry of Interior-Ministry of Environment on the Waste and Solid Waste Management in Province/Municipalities of the Kingdom of Cambodia." Phnom Penh, 2003.

<sup>65</sup> G.Hadrich and C. Westphalen, "Wrap-up to the workshop," 17

- Guidelines prepared by the Ministry of Environment and the NGO, COMPED, to recommend the implementation of the 1999 Sub-decree on Solid Waste Management ; and
- The Inter-Ministerial Prakas of the Ministry of Interior and Ministry of Environment on Waste and Solid Waste Management in Provinces/Municipalities of the Kingdom of Cambodia 25 February 2003

In addition to the above regulations, there are guidelines and decisions made by various city and provincial authorities to manage waste in their jurisdictions<sup>66</sup>. Also, in 2008, a draft National 3R (reduce, reuse and recycle) Strategy on Waste Management in Cambodia was developed. To date, there appears to be no indication that the draft has been finalized.

A number of educational and awareness-raising activities on waste management have been undertaken by the government. For instance, on 27 February 2012, the Cambodian government initiated a nationwide campaign to clean up cities. This included a Clean City Contest in which 26 cities and nine districts of Phnom Penh competed to beautify urban areas to attract more tourists<sup>67</sup>. They were also assessed on the development of infrastructure, strengthening public services and implementing environmentally friendly initiatives<sup>68</sup>.



Youth cleaning activity during the Clean City Campaign; source: Google image

As part of the clean city program, the government, including the Ministry of Tourism and Ministry of Environment planned to establish Eco-Clubs to promote environmental awareness and improve the image of Cambodian cities through better management and disposal of plastic bags<sup>69</sup>. The Eco-Clubs were to be set up at schools, universities, factories, and radio and television stations, and young people engaged to further promote and educate the wider community on the benefits of clean cities<sup>70</sup>. However, there is little information at present to indicate how successful this initiative has been.

<sup>66</sup> Ibid

<sup>67</sup> Phorn Bopha, "Gov't Launches Campaign to Clean Up Cities Nationwide," *The Cambodia Daily*, 28 February 2012, accessed on 7 April 2015, URL: <http://www.opendevdevelopmentcambodia.net/news/govt-launches-campaign-to-clean-up-cities-nationwide/>

<sup>68</sup> Ibid

<sup>69</sup> Rann Reuy, "Government promotes clean cities in Cambodia," *The Phnom Penh Post*, 19 February, 2013, accessed on 7 April 2015, URL: <http://www.phnompenhpost.com/business/government-promotes-clean-cities-cambodia>

<sup>70</sup> Ibid

## 6. Solid Waste Management in Other Countries

### 6.1 Singapore

#### 6.1.1 The current situation regarding waste management

Singapore is a small island nation with a land area of 697 km<sup>2</sup><sup>71</sup> and a population in 2014 of 5.47 million <sup>72</sup>. The country is highly developed and industrialized, with an increasing population. The amount of waste generated increased from 4.7 million tonnes in 2000 to 7.5 million tonnes in 2014. Each person generates approximately 1,370 kg of waste per year<sup>73</sup>. Of the waste generated in 2014, 60 percent was recycled, 38 percent incinerated at waste-to-energy plants, and 2 percent was disposed of at the Semakau landfill<sup>74</sup>. The National Environment Agency of Singapore makes the following definitions<sup>75</sup>:

- Waste generated refers to “the total amount of waste generated in Singapore which is the sum of waste disposed and waste recycled”;
- Waste disposed means “the total amount of waste disposed at waste-to-energy plants and at the offshore Semakau Landfill”; and
- Waste recycled refers to “the total amount of waste that is recycled locally or exported overseas for recycling”.

In addition, solid waste in Singapore is divided into three main categories<sup>76</sup>:

- Domestic refuse - (solid waste generated by households, markets, food centers and commercial premises such as hotels, restaurants and shops);
- Industrial refuse - (not including toxic and hazardous waste that requires special handling, treatment and disposal); and
- Institutional refuse - (solid waste from various Government and Statutory Board installations, hospitals, schools, recreational facilities and public development projects).

The top five components, accounting for 75 percent of total waste generated in Singapore, are:

- Ferrous metal (19 percent);

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<sup>71</sup> National Environment Agency, Integrated Thinking: Solid Waste Management in Singapore, by Vincent Teo, accessed on 7 April 2015, URL: <http://www.waste-management-world.com/articles/print/volume-8/issue-1/features/integrated-thinking-solid-waste-management-in-singapore.html>

<sup>72</sup> Department of Statistics, Ministry of Trade and Industry, Population Trends 2014, (Singapore, 2014), 3, accessed on 8 April 2015, URL: [http://www.singstat.gov.sg/docs/default-source/default-document-library/publications/publications\\_and\\_papers/population\\_and\\_population\\_structure/population2014.pdf](http://www.singstat.gov.sg/docs/default-source/default-document-library/publications/publications_and_papers/population_and_population_structure/population2014.pdf)

<sup>73</sup> Zerowastesg, “Singapore Waste Statistics 2014,” last modified 18 March 2015, accessed on 8 April 2015, URL: <http://www.zerowastesg.com/2015/03/18/singapore-waste-statistics-2014/>

<sup>74</sup> Zerowastesg, “Singapore Waste Statistics 2014.”

<sup>75</sup> Ibid

<sup>76</sup> Dongqing Zhang, Tan Soon Keat and Richard M. Gersberg, “A Comparison of Municipal Solid Waste Management in Berlin and Singapore,” *International Journal of Integrated Waste Management, Science & Technology* (2010), 921-933, accessed on 8 April 2015, URL: [http://scholar.google.com/scholar?hl=en&q=A+comparison+of+municipal+solid+waste+management+in+Berlin+and+Singapore+&btnG=&as\\_sdt=1%2C5&as\\_sdt](http://scholar.google.com/scholar?hl=en&q=A+comparison+of+municipal+solid+waste+management+in+Berlin+and+Singapore+&btnG=&as_sdt=1%2C5&as_sdt)

- Construction debris (17 percent);
- Paper/cardboard (16 percent);
- Plastic (12 percent); and
- Food waste (10 percent).

Other types of waste include:

- Wood (5 percent);
- Used slag (5 percent);
- Horticultural waste (3.4 percent);
- Textile/Leather (2 percent);
- Ash and Sludge (2 percent);
- Non-Ferrous metals (1.4 percent);
- Glass (1 percent);
- Scrap Tyres (0.2 percent);
- Others (5 percent).

### 6.1.2 Methods of waste management

Methods of waste disposal in Singapore include: (i) waste-to-energy incineration; (ii) sanitary landfill; and (iii) waste recycling<sup>77</sup>.

- **Waste-to-energy incineration**

Waste-to-energy (WTE) incineration was adopted by Singapore’s National Environment Agency (NEA) because of concern regarding land-space and landfill constraints<sup>78</sup>. The first WTE incineration plant began operations in 1979.

In the WTE process: (i) waste is transported to refuse bunkers before burning; (ii) high-capacity rotary crushers are used to break down bulky wastes so that they are suitable for incineration; (iii) waste from the bunker is fed into the incinerator for burning; (iv) the heat from the combustion process is used to produce superheated steam in boilers; and (v) the steam is in turn used to drive turbo generators to generate electricity<sup>79</sup>. Currently, there are four WTE plants operating in Singapore<sup>80</sup> that dispose of 37.6 percent of total waste<sup>81</sup>.

**Table 2: Incineration plants in Singapore**<sup>82</sup>

Location of incineration	Year built	Construction cost (SG\$)	Capacity (tonnes/day)
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<sup>77</sup> The National Environment Agency, “Overview: Waste Management,” last modified in 2013, accessed on 8 April 2015, URL: <http://www.nea.gov.sg/energy-waste/waste-management/overview>

<sup>78</sup> The National Environment Agency, “Overview: Waste Management.”

<sup>79</sup> The National Environment Agency, “Waste-to-energy (WTE)/Incineration Plants,” accessed on 3 May 2015, URL: <http://www.nea.gov.sg/energy-waste/waste-management/waste-to-energy-%28wte%29-incineration-plants>

<sup>80</sup> Ibid; Zhang, Keat, and Gersberg, “A Comparison of Municipal,” 926

<sup>81</sup> Zerowastesg, “Singapore Waste Statistics 2014.”

<sup>82</sup> Zhang, Keat, and Gersberg, “A Comparison of Municipal,” 926

plant		million)	
Ulu Pandan <sup>83</sup>	1979	130	1100
Tuas	1986	200	1700
Senoko	1992	560	2400
Tuas South	2000	900	3000
Keppel Segghers	2009	-	800

Source: Dongqing Zhang, Tan Soon Keat and Richard M. Gersberg, 2010

## ▪ Sanitary Landfill

While landfill remains important for waste disposal in many countries, the government of Singapore has considered this as the last option for its waste management program. This is probably the result of land scarcity in Singapore<sup>84</sup>. There are three landfills in Singapore with two of them having reached capacity in 1992 and 1999<sup>85</sup>.

Currently, only the Semakau landfill is operating for waste disposal. This facility covers a total area of 350 ha and has a landfill capacity of 63 million m<sup>3</sup><sup>86</sup>. It is the only offshore sanitary landfill in Singapore. It is estimated that Phase 1 of this landfill will have reached its capacity by 2019, phase 2 by 2027 and phase 3 by 2045<sup>87</sup>.

Non-incinerable wastes are disposed of in the Semakau Landfill and accounted for 2 percent of the total waste generated in 2014 (this waste consists of construction and demolition materials, used slag [stoney material] and treated sludge)<sup>88</sup>.

It is worth noting that sanitary landfill employs strict pollution control measures to ensure that leachate from the waste is contained within the landfill area<sup>89</sup>.

The Semakau Landfill Facility



Source: <http://www.nea.gov.sg/energy-waste/waste-management/semakau-landfill>

## ▪ Waste Recycling

Waste recycling is one of the key strategies for waste management initiated by the NEA of Singapore. It promotes waste recycling in the commercial and industrial sectors, and within households<sup>90</sup>. The National Recycling Programme (NRP)

<sup>83</sup> It is now closed, according to <http://www.thejakartapost.com/news/2013/05/22/waste-energy-singapore-s-experience.html>.

<sup>84</sup> Ibid

<sup>85</sup> Ibid

<sup>86</sup> Ibid

<sup>87</sup> Ibid

<sup>88</sup> Zerowastesg, "Singapore Waste Statistics 2014."

<sup>89</sup> The National Environment Agency, "Overview."

<sup>90</sup> National Environment Agency, "Integrated Thinking."



launched in April 2001<sup>91</sup> provides recycling bags or bins for each residential household to store recyclables. Licensed companies contracted by the NEA are responsible for collecting the recyclable waste every two weeks<sup>92</sup>.

The types of recyclable waste include ferrous metal, construction debris, paper/cardboard, used slag, wood, horticultural waste, food, non-ferrous metals, plastics, scrap tyres, ash and sludge, textiles/leather, glass and others<sup>93</sup>. The top three recyclables are ferrous metal (31 percent), construction debris (28 percent) and paper/cardboard (14 percent), accounting for 73 percent of the total waste recycled in Singapore<sup>94</sup>. Recycling facilities have been established by private companies to recycle this waste. Table 3 shows a number of examples of recycling facilities, which are classified based on the type of waste to be recycled<sup>95</sup>.

**Table 3: Recycling facilities and the type of waste processed**

<b>Type of waste</b>	<b>Name &amp; Location of facility</b>	<b>Capacity (tonnes/day)</b>
Construction and Demolition	M/s Hock Chuan Waste Management Pte Ltd, located at Sarimbun Recycling Park.	Processes mixed construction and demolition waste to recover the various recyclable materials such as metals, plastic, wood, etc. The company also manufactures pre-cast concrete products such as road kerbs and drains from recovered aggregates and sand.
Electronic	M/s TES-AMM (Singapore) Pte Ltd, located at Benoi Sector	Recovers precious metals from electronic waste. Other recyclable materials such as metals, plastic, etc. are also recovered from electronic waste. In addition, lithium batteries are processed to recover metals, plastic and other materials.
Food	M/s Eng Cheong Leong Agri Chem Pte Ltd, located at Benoi Lane	Processes bread waste to make animal feed.

Source: National Environment Agency of Singapore, 2013

<sup>91</sup> National Environment Agency, "National Recycling Programme," last modified in 2013, accessed on 8 April 2015, URL: <http://www.nea.gov.sg/energy-waste/3rs/national-recycling-programme>

<sup>92</sup> National Environment Agency, "Integrated Thinking"

<sup>93</sup> Ibid

<sup>94</sup> Ibid

<sup>95</sup> National Environment Agency, "Collectors, Traders and Local Recycling Facilities," last modified in 2013, accessed on 8 April 2015, URL: <http://www.nea.gov.sg/energy-waste/3rs/collectors-traders-and-local-recycling-facilities>

### 6.1.3 Impacts of waste management

A research study on the "Impact Assessment of Waste Management Options in Singapore" conducted in 2006 found that:

- **Incineration method**

- The incineration of waste through WTE plants generated harmful emissions, which outweighed the gains in energy produced by the WTE plants. The air pollution from the incineration of wastes has contributed considerably to climate change, acidification, and ecotoxicity<sup>96</sup>. The Singaporean people are also at risk of health effects from pollution as the country is small with a high population density and high humidity<sup>97</sup>.

- **Recycling method**

- Waste recycling tends to be the best waste management option for environmental protection and improved human health<sup>98</sup>.
- Recycling plastic saves 2.7-4.3 times more energy, and recycling metal saves 30-888 times more energy than is gained through incineration plants<sup>99</sup>.

- **Landfill method**

- Leachate generated from landfill has contributed minimally to ecotoxicity. This is because the landfill was constructed to ensure that the leachate remains within the landfill area<sup>100</sup>.
- Landfill tends to minimally contribute to environmental damage in Singapore<sup>101</sup>. Even though most of the landfills in other countries produce large amounts of greenhouse gas, this is not the case in Singapore<sup>102</sup>.
- Nonetheless, the pollution (the emitting of acidic gases resulting from the transportation of wastes by barge from Tuas Marine station to Semakau landfill) is threatening to several species of vegetation and aquatic life around the island's coastal areas<sup>103</sup>.

### 6.1.4 Responsibilities of the national and local governments

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<sup>96</sup> Reginald B.H. Tan & Hsien H. Khoo, "Impact Assessment of Waste Management Options in Singapore," *Journal of the Air & Waste Management Association* (2006), accessed on 8 April 2015, doi: 10.1080/10473289.2006.10464463. See also Ecotoxicity results from the incineration of materials, especially from ferrous metals, plastics, textiles, and paperboard, according to Tan & Khoo, "Impact Assessment," 253

<sup>97</sup> Reginald B.H. Tan & Hsien H. Khoo, "Impact Assessment," 252

<sup>98</sup> Ibid, 252

<sup>99</sup> Ibid, 252

<sup>100</sup> Ibid, 249

<sup>101</sup> Ibid, 249

<sup>102</sup> Ibid, 248

<sup>103</sup> Ibid, 249



The institutional arrangement for waste management is straightforward given the size of Singapore<sup>104</sup> and the government structure. As there is no “local” government, the national government is responsible for waste collection and disposal. In July 2002, the National Environment Agency (NEA) was established under the Ministry of the Environment and Water Resources (MEWR). The NEA is tasked to develop and implement environmental policies<sup>105</sup>.

The NEA is also responsible for providing licences for waste collection to waste collectors, and enforcing regulations regarding illegal dumping in Singapore. Four licensed Public Waste Collectors (PWCs) are contracted to manage and collect public waste in Singapore<sup>106</sup>.

In addition, the Waste and Resource Management Department (WRMD) within the Environmental Protection Division of the NEA operates and maintains WTE incineration plants, the Semakau landfill and the waste transfer station<sup>107</sup>.

### 6.1.5 Policies and programs for waste management

To effectively manage waste in the land-scarce nation, the government of Singapore has designed and implemented sound regulations, policies and programs. The regulations include<sup>108</sup>:

- Environmental Public Health (Toxic Industrial Waste) Regulations, Reg 11;
- Environmental Public Health (General Waste Collection) Regulations, Reg 12;
- Environmental Public Health (Public Cleansing) Regulations, Reg 6; and
- Hazardous Waste (Control of Export, Import and Transit) Act, (Cap 122 A).

There are also policies and programs:

- Clean Land Policy focuses on: (i) reducing and recycling waste; (ii) minimizing the volume of waste disposed; and (iii) disposing of hazardous waste safely<sup>109</sup>;
- The Keep Singapore Clean Movement (KSCM) aims to raise public awareness about cleanliness in Singapore, and focuses on advancing Singapore from being a “clean city to a truly clean city”<sup>110</sup>; and

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<sup>104</sup> Torsten Kleiss, “Institutional Arrangements for Municipal Solid Waste Combustion Projects” (PhD diss., Verlag der Bauhaus-Universität Weimar, 2008), accessed on 8 April 2015, URL:

[http://scholar.google.com/scholar?cluster=14904093591811430685&hl=en&as\\_sdt=0,5&as\\_vis=1](http://scholar.google.com/scholar?cluster=14904093591811430685&hl=en&as_sdt=0,5&as_vis=1)

<sup>105</sup> Ibid

<sup>106</sup> The National Environment Agency, “Overview.”

<sup>107</sup> The National Environment Agency, “Divisions/Departments,” last modified 2013, accessed on 8 April 2015, URL: <http://www.nea.gov.sg/corporate-functions/about-nea/divisions-departments>

<sup>108</sup> The National Environment Agency, “Legislation,” last modified 2013, accessed on 10 April 2015, URL: <http://www.nea.gov.sg/corporate-functions/about-nea/legislation>

<sup>109</sup> Ministry of the Environment and Water Resources, “Managing Our Waste: Clean Land Policy,” last modified on March 16, 2015, accessed on 10 April 2015, URL: <http://app.mewr.gov.sg/web/Contents/Contents.aspx?id=198>

<sup>110</sup> The National Environment Agency, “Keep Singapore Clean Movement,” last modified 2013, accessed on 10 April 2015, URL: <http://www.nea.gov.sg/events-programmes/campaigns/keep-singapore-clean-movement>

- The Clean and Green Singapore (CGS) campaign nationwide initiative aims to engage and inspire Singaporeans to protect and care for the environment by adopting a clean and green lifestyle<sup>111</sup>.

## 6.2 Thailand

### 6.2.1 The current situation regarding waste management

In the past few decades, economic development and population growth, have led to an increase in waste throughout Thailand<sup>112</sup>. For example, in 2001, 62 million people generated about 37,000 tonnes of municipal waste per day, while in 2010, approximately 64 million people produced approximately 41,000 tonnes of municipal waste per day<sup>113</sup>.

Although there is limited information about infectious waste, industrial hazardous, industrial non-hazardous waste and community hazardous waste, data shows that municipal solid waste increased from 14,400, 000 tonnes in 2002 to 24,730,000 tonnes in 2012<sup>114</sup>. The 2003 World Bank report about the composition of waste in Thailand appears in Table 4 below<sup>115</sup>:

**Table 4: Composition of waste in Thailand**

Types of waste	Major sources	Main waste compositions
Municipal solid waste	Residential households Commercial/tourism Agriculture	Kitchen waste (51%) Plastic and foam (22%) Paper (13%) and glass (3%)
Infectious waste	Hospital (93%) Education & labs (7%)	Tissue samples, Blood and other liquids Surgical wastes and syringes
Industrial Hazardous waste	Metals industries (33%) Electronic industries (28%) Plastic industries (8%) Chemicals and petroleum industries (7%).	Filter materials, waste sludge (35%) Fuel, oil and grease (28%) Liquid organic compounds (8%)
Industrial Non-Hazardous waste	Metals industries (36%) Food industries (13%) Furniture (7%)	Metals and metal alloys (30%) Parts of wood (16%) Animal parts (13%)
Community Hazardous Waste	Automotive stations (54%) Residential (19%)	Recyclable waste oils (27%) Lead acid batteries (21%)

<sup>111</sup> The National Environment Agency, "Clean & Green Singapore," last modified 2013, accessed on 10 April 2015, URL: <http://www.nea.gov.sg/events-programmes/campaigns/clean-green-singapore>

<sup>112</sup> Wiratchapan Suthapanich, "Characterization and Assessment of Municipal Solid Waste for Energy Recovery Options in Phetchaburi, Thailand," (Master thesis, Asian Institute of Technology, 2014), accessed on 13 April 2015, URL: <http://www.faculty.ait.ac.th/visu/images/pdf/2014/wiratchapan.pdf>

<sup>113</sup> Cherdasirku Chak, "Generation and disposition of municipal solid waste (MSW) management in Thailand," Earth Engineering Center, Columbia University, 2012, accessed on 13 April 2015, URL: [http://www.seas.columbia.edu/earth/wtert/sofos/Thailand\\_MSW\\_Chak\\_essay.pdf](http://www.seas.columbia.edu/earth/wtert/sofos/Thailand_MSW_Chak_essay.pdf)

<sup>114</sup> Wiratchapan Suthapanich, "Characterization and Assessment," 1

<sup>115</sup> The World Bank, "Thailand Environment," 8

Agricultural (10%)  
Gas stations (10%)

Other toxic chemicals (8%)  
Other waste oils (6%)

Source: The World Bank, "Thailand Environment Monitor 2003", p.8

World Bank data about the sources of solid waste generation in Thailand in 2002 appears in Table 5 below<sup>116</sup>:

**Table 5: Sources of solid waste generation in Thailand (2002)**

Types of waste		Total waste generation (1000 tons/year)	Total minus reuse & recycling (1000 tons/year)	Largest- waste generating province (& of total)
Municipal waste	solid	14,400	12,800	Bangkok (27%) Nakhon Ratchasima (3.3%) Samut Prakan (2.3%) Khon Kaen (2.1%)
Infectious waste		21.3	21.3	Bangkok (21%) Chiang Mai (3.9%) Nonthaburi (3.4%) Nakhon Rachasijma (3.0%)
Industrial Hazardous waste		963	788	Samut Prakan (19%) Bangkok (18%) Pathumthani (11%) Samut Sakhon (7%)
Industrial Non-Hazardous waste		5,890	1,271	Samut Prakan (13%) Bangkok (11%) Samut Sakorn (8.5%) Patumthani (5.2%)
Community Hazardous Waste		372	182	Bangkok (34%) Nakhon Pathom (2.6%) Nonthaburi (1.4%) Pathum Thani (0.8%)

Source: The World Bank, "Thailand Environment Monitor 2003", 8

According to table 5, municipal solid waste accounted for 66.21 percent of the total waste generation, while industrial non-hazardous waste made up approximately 26.77 percent. Infectious waste, industrial hazardous waste and community hazardous waste accounted for approximately 0.96 percent, 4.37 percent, and 1.69 percent, respectively.

<sup>116</sup> The World Bank, "Thailand Environment Monitor 2003," 2004, 1, accessed on 13 April 2015, URL: [http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/10/21/000012009\\_20051021142543/Rendered/PDF/339510rev.pdf](http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/10/21/000012009_20051021142543/Rendered/PDF/339510rev.pdf)

## 6.2.2 Methods of waste management

Common methods of municipal solid waste (MSW) management in Thailand include sanitary landfill, composting, recycling, open dumping and incineration<sup>117</sup>. Of these, the top three methods are: (i) open dumping (78.2 percent of total MSW); (ii) recycling (11 percent of total MSW); and (iii) sanitary landfill (9.4 percent of total MSW)<sup>118</sup> (See table 6 below).

**Table 6: Methods of municipal solid waste management in Thailand in 2008**

Thailand MSW	Annual Country Waste (1000 tonnes)	% of total
Open dumps	11,751.95	78.2%
Recycling	1,650	11.0%
Sanitary landfill	1,420	9.4%
Incineration	142.35	0.9
Anaerobic digestion	29.2	0.2
Windrow composting	36.5	0.2
<b>Total</b>	<b>15,030</b>	<b>100.0%</b>

Source: Chak Cherdstirkul, "Generation and disposition of municipal solid waste (MSW) management in Thailand," 2012

### ▪ Sanitary Landfill

There are approximately 97 sanitary landfill sites operating in Thailand with 16 under construction<sup>119</sup>, and 11 that have stopped operating due to the overloading of solid waste and complaints from the public<sup>120</sup>. Also, seven landfill sites did not become operational because Local Administrative Organizations are not ready to operate them or because local communities are opposed to them<sup>121</sup>. This method of waste management tends to use a large land area, and has a negative impact on the environment<sup>122</sup>.

### ▪ Open dumping

This method of waste disposal at open dump sites has been widely used in Thailand<sup>123</sup>. Table 6 shows that 78.2 percent of total MSW generation in 2008 was directly disposed of at open dumps<sup>124</sup>. However, the capacity of open dump sites in ASEAN countries, including Thailand, tends to be exceeded due

<sup>117</sup> Wiratchapan Suthapanich, "Characterization and Assessment," 10

<sup>118</sup> Cherdstirkul Chak, "Generation and disposition," 9

<sup>119</sup> Sirintornthep Towprayoon and Komsilp Wangyao, "MSW policy and WTE in Thailand," (Center of Excellence on Energy Technology and Environment, 20 October 2012), accessed on 13 April 2015, URL: <http://www.iitk.ac.in/ime/anoops/for12/11%20-%20Dr.%20Sirintornthep%20Towprayoon%20-%20MSW%20Policy%20and%20WTE%20in%20Thailand%20over%203.pdf>

<sup>120</sup> Wiratchapan Suthapanich, "Characterization and Assessment," 10

<sup>121</sup> Ibid, 10

<sup>122</sup> Ibid, 10

<sup>123</sup> Ibid, 10

<sup>124</sup> Cherdstirkul Chak, "Generation and disposition," 9

to a lack of sound waste management planning. Consequently, open-dump site practices tend to lead to environmental pollution including leachate, gas, odors, flies, vermin, and pathogens<sup>125</sup>.

### ▪ **Composting**

Although composting appears to be a promising method of waste management in terms of generating valuable fertilizer for agricultural and horticultural uses<sup>126</sup>, Table 6 shows that only 0.2 percent of MSW was composted in 2008<sup>127</sup>. This appears to result from a lack of knowledge of this procedure and the high costs involved in its operation<sup>128</sup>.

### ▪ **Recycling**

Table 6 shows that approximately 11 percent of total MSW (i.e., 1,650,000 tonnes), was recycled in 2008<sup>129</sup>. The recycling rate was increased to 22 percent of the total waste generated (accounting for 15.1 million tonnes) across the country in 2009. This increase is due to the fact that the Thai government has been urging collaboration among key stakeholders to promote the 3Rs (reduce, re-use, and recycle) concept across the country. The main composition of collected and recycled waste includes: paper, plastics, glass, aluminium and steel<sup>130</sup>.

### ▪ **Incineration**

There are currently three incineration plants for waste disposal: Phuket province (250 tonnes/day), Samui Island (75 tonnes/day) and Lamphun province (10 tonnes/day)<sup>131</sup>. However, Table 6 shows that only a low percentage of municipal waste was incinerated, accounting for just 0.9 percent of total municipal waste in 2008.

### ▪ **Anaerobic digestion**

The anaerobic digestion (AD) method is used to transform organic waste into liquid fertilizers and solid products and the methane produced during this process can be used to produce energy<sup>132</sup>. Figure 1 indicates that an AD system uses a digester as an airtight chamber where biosolids, food waste, other organic waste, or combinations of these feedstocks decompose. The

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<sup>125</sup> Uyen Nguyen Ngoc and Hans Schnitzer, "Sustainable Solutions for Solid Waste Management in Southeast Asian Countries," *Waste Management* 29 (2009), accessed on 10 April 2015, URL: <http://ekh.unep.org/files/1-s2.0-S0956053X0800442X-main.pdf>

<sup>126</sup> Thaniya Kaosol, "Sustainable Solutions for Municipal Solid Waste Management in Thailand," *World Academy of Science, Engineering and Technology* (2009):665-670, accessed on 13 April 2015, URL: <http://waset.org/publications/6576/sustainable-solutions-for-municipal-solid-waste-management-in-thailand>

<sup>127</sup> Cherdasirkku Chak, "Generation and disposition," 9

<sup>128</sup> Thaniya Kaosol, "Sustainable Solutions," 668

<sup>129</sup> Cherdasirkku Chak, "Generation and disposition," 9

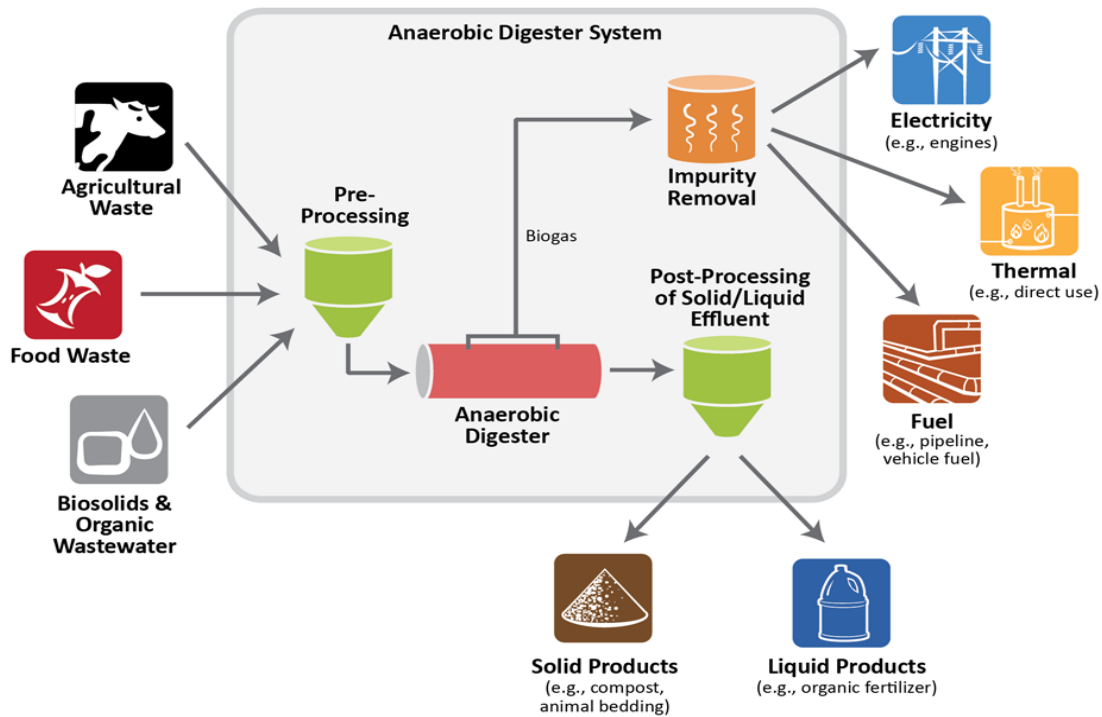
<sup>130</sup> Waste Management World, "Thai Style Recycling," last modified 2015, accessed 13 April 2015, URL: <http://www.waste-management-world.com/articles/print/volume-12/issue-5/features/thai-style-recycling.html>

<sup>131</sup> Wiratchapan Suthapanich, "Characterization and Assessment," 11

<sup>132</sup> Thaniya Kaosol, "Sustainable Solutions"

process generates biogas (a blend of methane and carbon dioxide) and digestate (the nutrient-rich material remaining after the anaerobic process that can be used as fertilizer)<sup>133</sup>. It should be noted the design of AD systems depends on the facility's location, feedstock, and expected outcomes<sup>134</sup>.

**Figure 1: The process of how the anaerobic digestion works**



Source: Global Methane Initiative, "Successful Applications of Anaerobic Digestion from across the world"

Table 6 indicates that in Thailand, only 0.2 percent of waste is transformed through anaerobic digestion. This is probably due to fact that it is a newly introduced technology for waste management in Thailand.

### 6.2.3 Impacts of waste management

The dominant practice of open dumping and the use of landfill sites has had negative effects on the environment and is a social burden in Thailand<sup>135</sup>. This is

<sup>133</sup> Global Methane Initiative, "Successful Applications of Anaerobic Digestion from across the world," 2013, accessed on 3 May 2015, URL: <https://www.globalmethane.org/documents/GMI%20Benefits%20Report.pdf>

<sup>134</sup> Ibid, 4

<sup>135</sup> SNM Menikpura, Shabbir H Gheewala, and Bebastien Bonnet, "Framework for Life Cycle Sustainability Assessment of Municipal Solid Waste Management Systems with an application to a case study in Thailand," *Waste Management & Research* 708-719 (2012): 708, accessed on 26 April 2015, URL: <http://scholar.google.com/scholar?hl=en&q=Framework+for+Life+Cycle+Sustainability+Assessment+of+Municipal>

because the large amount of waste generated has been disposed of in landfills without a gas recovery system (i.e. in Nonthaburi Municipality)<sup>136</sup>. To reduce the negative impacts, an integrated waste management method (incorporating recycling, anaerobic digestion, incineration and new landfill technologies [see the figure of this integrated method in the Appendix 2]), has been introduced<sup>137</sup>.

An assessment study on the proposed integrated waste management system in Nonthaburi Municipality shows that:

- While the damage to the ecosystem (e.g., potential loss of species) from the integrated waste management still occurs, consolidated waste management technologies contribute to saving \$81.4 per tonne of municipal solid waste, which results from avoiding a marginal cost increase for fossil fuel and mineral extraction<sup>138</sup>;
- 24 percent of waste recycling contributes to mitigating the negative effects on health. Moreover, this system contributes to increased employment opportunities and income generation for the community through selling recyclable waste at 17,440 baht/tonne<sup>139</sup>;
- The incineration plants in Thailand (due to low efficiency) tend to emit large amounts of fossil-based CO<sub>2</sub> emissions<sup>140</sup>. For example, approximately 90 percent of health problems related to incineration and increases to global warming, results from the large fossil-based CO<sub>2</sub> emissions released during the combustion of plastic, textiles and rubber/leather waste. The remaining 10 percent of health problems results from direct and indirect exposure to human toxic compounds, including NO<sub>x</sub>, SO<sub>x</sub><sup>141</sup> and others<sup>142</sup>; and

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[+Solid+Waste+Management+Systems+with+an+application+to+a+case+study+in+Thailand%2C%E2%80%9D+Waste+Management+%26+Research+708-719+%282012%29%3A+708%2C+accessed+on+April+26%2C+2015&btnG=&as\\_sdt=1%2C5&as\\_sdtp](#)

<sup>136</sup> Ibid, 708

<sup>137</sup> Ibid, 708; it seems that there is a lack of information available on the internet about the impacts of waste management practices in Thailand as a whole.

<sup>138</sup> Ibid, 716

<sup>139</sup> Ibid, 718

<sup>140</sup> Carbon dioxide (CO<sub>2</sub>) is the primary greenhouse gas emitted through human activity and a variety of natural sources, according to <http://www.epa.gov/climatechange/ghgemissions/gases/co2.html>, accessed on 5 May 2015. CO<sub>2</sub> emissions through human activity (such as the burning of fossil fuel) contribute to climate change as these CO<sub>2</sub> emissions raise global temperatures by trapping solar energy in the atmosphere, according to <http://education.seattlepi.com/consequences-carbon-emissions-humans-4138.html> accessed on 5 May 2015.

<sup>141</sup> Nitrogen Oxide (NO<sub>x</sub>) is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts, according to [http://www.oilgae.com/ref/glos/nox\\_emissions.html](http://www.oilgae.com/ref/glos/nox_emissions.html). It may cause health problem to the human including emphysema, artillery and heart disease.

Sulphur Oxide (SO<sub>x</sub>) is compounds of sulfur and oxygen molecules. It may cause human health problems including respiratory problems, heart disease and blurry sight, according to Mochamad Arief Budihardjo, "Risk Analysis Study of NO<sub>x</sub>, and SO<sub>x</sub> from Transportation (Case Study: Main Streets of D.I.JOGJAKARTA)," p. 43

<sup>142</sup> Ibid, 717



- Residual waste in landfills also causes minor human health effects as a result of low emissions of toxic gases such as CH<sub>4</sub> and NH<sub>3</sub>.<sup>143</sup>

However, the same assessment study concludes that the integrated waste management system has the capacity to avoid damage to health as damaging to health accounts for 24 percent of waste recycling.<sup>144</sup> This suggests that the integrated waste management system is an effective waste management option.

## 6.2.4 Responsibilities of the national and local governments

### 6.2.4.1 National government level

A number of key ministries are responsible for municipal solid waste (MSW) management in Thailand. These include<sup>145</sup>:

- The Ministry of Natural Resources and Environment (MONRE) through the division of the National Environmental Board is responsible for formulating policy and plans<sup>146</sup> for environmental conservation and administrative management. Moreover, the Pollution Control Department of MONRE is in charge of monitoring MSW operations managed by the municipalities;
- The Ministry of Public Health is tasked to issue MSW management standards and monitor waste management operations of municipalities;
- The Ministry of Industry is in charge of providing licenses for MSW treatment companies/new factories;
- The Ministry of Interior through the Department of Local Administration supervises the Bangkok Metropolitan Administration as well as other local municipalities;

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<sup>143</sup> Ibid, 717; Methane (CH<sub>4</sub>) is one of the greenhouse gases emitted from human activities and number of natural resources, according to <http://epa.gov/climatechange/ghgemissions/gases/ch4.html>. If methane is allowed to leak into the air before being used (e.g from a leaky pipe), it absorbs the sun's heat, thus warming the atmosphere, according to <http://www.edf.org/climate/methane>

Ammonia (NH<sub>3</sub>) is a nutrient that contains nitrogen and hydrogen. However, NH<sub>3</sub> is one of the pollutants that cause lower reproduction and growth or death, according to [http://www.waterboards.ca.gov/water\\_issues/programs/swamp/docs/cwt/guidance/3310en.pdf](http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/cwt/guidance/3310en.pdf), accessed on 5 May 2013.

<sup>144</sup> Ibid, 718

<sup>145</sup> Cherdasitirku Chak, "Generation and disposition," 12

<sup>146</sup> The Policy and Prospective Plan for Enhancement and Conservation of National Environment Quality B.E. 2540-2559 (1997-2016), see also in Poonsak Chanchampee, "Methods for Evaluation of Waste Management in Thailand in Consideration of Policy, Environmental Impact and Economics" (PhD diss., Technischen Universitat Berlin, 2010),



- The Bangkok Metropolitan Administration through the Department of Public Cleansing is in charge of providing legal advice on waste disposal projects; and
- The Ministry of Energy through the Department of Alternative Energy Development and Efficiency is tasked to provide subsidies for waste to energy projects.

#### 6.2.4.2 Local government level

As in Cambodia, Thailand's local government is responsible for disposing of MSW and for contracting private companies to operate waste collection, transportation, treatment and disposal<sup>147</sup>. In Thailand, there are four categories of local administrative organizations<sup>148</sup>:

- Municipal;
- Sub-district Administrative Organization (SAO);
- Provincial Administrative Organization (PAO); and
- Special Administrative Areas (Bangkok and Pattaya City).

#### 6.2.5 Policies and programs for waste management

Regulations for managing waste in Thailand include<sup>149</sup>:

- The Enhancement and Conservation of National Environmental Quality Act, 1992 and its requirements regarding the procedures for collection and transportation of community hazardous waste;
- The Public Health Act, 1992;
- The Town Planning Act, 1975, regarding mandatory requirements for areas used as sites for integrated waste disposal;
- Rules on waste separation at source; and
- Criteria, standards and procedures for managing infected waste.

Key policies and programs for implementing waste management in Thailand, include:

- A National Integrated Waste Management Plan<sup>150</sup>;
- A National Master Plan on Cleaner Production Technology<sup>151</sup>;

<sup>147</sup> Cherdsatirku Chak, "Generation and disposition," 12

<sup>148</sup> Taweechai Jiaranaikhajorn, "Overview on Waste Management in Thailand" (Slide Presentation by Pollution Control Department), accessed on 14 April 2015, URL: [http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCEQFjAB&url=http%3A%2F%2Fwww.pcd.go.th%2Fcount%2Fmgtdl.cfm%3FFileName%3DOverview\\_waste.pdf%26BookName%3DOverviewWaste&ei=SscwVai6OlbCmAX4xYHYAQ&usg=AFQjCNEhanvOSjJTURQcHJQLBCCcvFCjgA&sig2=b9Wf67GXmGOnKP85m7zPrA](http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CCEQFjAB&url=http%3A%2F%2Fwww.pcd.go.th%2Fcount%2Fmgtdl.cfm%3FFileName%3DOverview_waste.pdf%26BookName%3DOverviewWaste&ei=SscwVai6OlbCmAX4xYHYAQ&usg=AFQjCNEhanvOSjJTURQcHJQLBCCcvFCjgA&sig2=b9Wf67GXmGOnKP85m7zPrA)

<sup>149</sup> AIT & UNEP, *Municipal Waste*, 13

<sup>150</sup> AIT, *3R in Asia: A Gap Analysis in Selected Asian Countries*, (Pathumthani: 3R Knowledge Hub Secretariat, 2008),3, accessed on 14 April 2015, URL: [http://www.3rkh.net/index.php?option=com\\_phocadownload&view=file&id=646&Itemid=238](http://www.3rkh.net/index.php?option=com_phocadownload&view=file&id=646&Itemid=238)

- The 3R (Reduce, Reuse and Recycle) program which has been implemented progressively among industries, and civil society organizations. Sound practices related to the program include, Take-Back Schemes for End-of-Life Products, Waste Exchange Programs and a Green Purchasing Network<sup>152</sup>;
- Plans for Packaging Waste Management<sup>153</sup> ; and
- A Pilot Program on Plastic and Foam Waste Recycling<sup>154</sup>

## 6.3 Vietnam

### 6.3.1 The current situation regarding waste management

Solid waste is an increasing problem for Vietnam. In 2011, when Vietnam’s population numbered around 87.84 million<sup>155</sup>, approximately 28 million tonnes of solid waste was generated annually. This amount of waste is predicted to increase by 10 per cent a year<sup>156</sup>. Although in 2011 there was updated information on the total waste generation in Vietnam, there seems to be a lack of more detailed updates. Therefore, this paper uses the 2004 World Bank report “Solid Waste” as reference material. This report showed that over 15 million tonnes of waste was generated in 2004, about 80 percent (12.8 million tons/year) of which was generated from municipal sources including households, restaurants, markets, and businesses<sup>157</sup>. Approximately 16 percent (2.5 million tonnes/ year) was non-hazardous waste generated from industries. In addition, approximately 160,000 tonnes/year of total waste generated was hazardous including healthcare waste from hospitals, toxic or flammable waste from industrial processes, and pesticides and pesticide containers from agriculture<sup>158</sup>. Table 7 illustrates these sources.

**Table 7: Sources of Solid Waste Generation in Vietnam**

Sources of waste Generation	Amount of waste (1000 tonnes/year)	% of total waste generation
Municipal solid waste:		
• National	12,800	80.83
• Urban areas	6,400	

<sup>151</sup> AIT, *3R in Asia: A Gap Analysis*, 119

<sup>152</sup> Ibid, 3

<sup>153</sup> Ibid, 119

<sup>154</sup> Ibid, 119

<sup>155</sup> “Vietnam Population 2013,” World Population Statistics, accessed on 10 June 2015, URL:

<http://www.worldpopulationstatistics.com/vietnam-population-2013/>

<sup>156</sup> Vietnamnews, “Nation Faces Solid Waste Problem,” Viet Nam News, 8 August 2012, accessed on 20 April 2015,

URL: <http://vietnamnews.vn/Environment/228473/nation-faces-solid-waste-problem.html>

<sup>157</sup> The World Bank, “Vietnam Environment Monitor 2004: Solid Waste,” 2004, accessed on 20 April 2015, URL:

<http://www->

[wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/07/28/000012009\\_20050728112421/Rendered/PDF/331510rev0PAPER0VN0Env0Monitor02004.pdf](http://wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2005/07/28/000012009_20050728112421/Rendered/PDF/331510rev0PAPER0VN0Env0Monitor02004.pdf)

<sup>158</sup> World Bank, “Vietnam Environment,” 6

• Rural areas	6,400	
Hazardous waste by industries	128.4	0.81
Non-hazardous waste by industries	2,510	15.85
Hazardous healthcare waste	21	0.14
Hazardous waste from agriculture	8.6	0.05
Amount of stockpiled agriculture chemicals	367	2.32
<b>Total</b>	<b>15,835</b>	<b>100</b>

Source: World Bank "Vietnam Environment Monitor 2004: Solid Waste," 6

Although there is limited information on the composition of waste in Vietnam as a whole, Table 8 does provide data on waste composition in Hanoi. As can be seen, in 2003, organic waste comprised the largest proportion (49 percent) of total waste composition followed by inert matter (18.4 percent) (such as construction waste, sand and stone) and plastic (16.6 percent).

**Table 8: Waste Composition in Hanoi in 2003**

<b>Waste composition</b>	<b>Per cent of total waste</b>
Organic	49.1
Inert matter	18.4
Plastic, rubber, leather, wood, hair, eathers	16.5 (Plastic 15.6)
Glass	7.2
Metal	6.0
Paper and textiles	1.9
Others	0.9

Source: World Bank "Vietnam Environment Monitor 2004: Solid Waste," 16

### 6.3.2 Methods of waste management

In Vietnam, the municipalities are in charge of the transportation of waste to the final disposal facilities<sup>159</sup> and waste collection in cities tends to be better than it is in rural areas. Also, larger cities in Vietnam collect a larger percentage of their waste (about 76 percent) than smaller cities (70 percent). Rural areas tend to have the lowest collection rates accounting for less than 20 percent<sup>160</sup> which is due to their remoteness and the lack of access to transportation<sup>161</sup>.

Methods of waste disposal in Vietnam include:

- **Composting**

Composting is used to decompose organic waste in order to produce soil conditioners (to improve the nutrients in soil), compost, or organic

<sup>159</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste Management in Vietnam: Status and the Strategic Actions," *International Journal of Environmental Resources*, 285-296, 2011, accessed on 17 April 2015, URL: [http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CC4QFjAD&url=http%3A%2F%2Fwww.sid.ir%2Fen%2FVEWSSID%2FJ\\_pdf%2F108220110204.pdf&ei=8hUxVZrhEaPFmAWa4ICQCA&usg=AFQjCNFgi digfqL9JiFgXzLdGiDu8CWJw&sig2=hir42IsT\\_8xdP5WZVIZXZg&bvm=bv.91071109,d.dGY&cad=rja](http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CC4QFjAD&url=http%3A%2F%2Fwww.sid.ir%2Fen%2FVEWSSID%2FJ_pdf%2F108220110204.pdf&ei=8hUxVZrhEaPFmAWa4ICQCA&usg=AFQjCNFgi digfqL9JiFgXzLdGiDu8CWJw&sig2=hir42IsT_8xdP5WZVIZXZg&bvm=bv.91071109,d.dGY&cad=rja)

<sup>160</sup> World Bank, "Vietnam Environment," 8

<sup>161</sup> Ibid, 21

fertilizers<sup>162</sup>. Although it tends to play an important role in recycling organic waste, it is not widely used in Vietnam because of: (i) inadequate attention to the biological requirements needed for this process; (ii) poor feed stock and poor quality of fertilizers; and (iii) poor marketing expertise<sup>163</sup>.

To cope with these problems, several private companies have signed contracts with municipalities to treat compostable wastes. The companies charge a treatment fee based on the amount of waste treated from municipalities (USD 10-15/tonne of waste)<sup>164</sup>. These companies have introduced new technology<sup>165</sup> for organic solid waste composting which produces good quality fertilizer that can be sold at a price of USD 30/ton<sup>166</sup> (See also Appendix 1 for selected composting facilities in Vietnam).

### ▪ **Recycling**

The informal sector encompasses waste pickers or scavengers, collectors, garbage truck helpers, etc. These people play an important role in recycling waste in Vietnam<sup>167</sup>. Vietnamese households tend to commonly reuse and recycle waste, while junk-buyers, waste pickers, and scavengers also collect a variety of materials including cardboard, plastics, glass bottles, scrap paper and scrap metals<sup>168</sup>.

Recyclable wastes are normally sold to distributors, who then clean, sort, package, and initially process them at recycling factories and enterprises before reselling<sup>169</sup>. In 2003, the waste recycling rate accounted for 20 percent of municipal solid waste in Hanoi. In addition, in 2003, approximately 52, 000 tonnes of paper, 25,000 tonnes of plastic and 735,000 tonnes of waste metal were recycled by craft villages in northern Vietnam<sup>170</sup>. However, there is a lack of information about the national amount of waste recycled in Vietnam each year<sup>171</sup>.

### ▪ **Incineration and burning**

As in Cambodia, incineration is not commonly practised in Vietnam and is only used in a few hospitals at the city level<sup>172</sup>. Although Vietnam has built 43 modern medical waste incinerators since 1997 for the

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<sup>162</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>163</sup> Ibid, 291

<sup>164</sup> Ibid, 291

<sup>165</sup> The technology can be found in Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 292

<sup>166</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>167</sup> Ibid, 292

<sup>168</sup> Ibid, 292

<sup>169</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 292

<sup>170</sup> World Bank, "Vietnam Environment," 28-29

<sup>171</sup> World Bank, "Vietnam Environment," 28

<sup>172</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

incineration of hazardous healthcare waste<sup>173</sup>, the existing incinerators have a small capacity of 5-20 tonnes/day<sup>174</sup>. In addition, these incinerators are problematic because they do not meet the required standards in terms of the proper temperature for burning and the control of the emission of gases during the combustion process<sup>175</sup>.

As waste is not generally incinerated, open burning at landfill sites is commonly practised to reduce the amount of waste at sites, and to increase the capacity of the landfills<sup>176</sup>. In addition, Vietnamese citizens in urban and rural areas tend to burn household waste at home<sup>177</sup>. There is a lack of information available on the amount or percentage of waste that is burned.

#### ▪ **Landfill**

Landfill is a commonly used disposal method for municipal solid waste in Vietnam, as well as for some industrial and healthcare waste<sup>178</sup>. There are approximately 91 landfill sites (including open dumps and controlled dump sites) in Vietnam of which only 17 of the 91 are sanitary sites<sup>179</sup>. Although the Vietnamese government introduced a requirement for all landfills to be made sanitary by 2007, lack of financial resources has prevented this, and funding from Official Development Assistance is required<sup>180</sup>.

### 6.3.3 Impacts of Waste Management

#### ▪ **Recycling**

Although the recycling factories, enterprises and craft villages play a key role in reducing waste, they are also a probable cause of some environmental damage<sup>181</sup>. This is because the small and medium recycling facilities in the craft villages use old technologies and thus contribute to environmental pollution and the degradation of human health<sup>182</sup>. However, a lack of data makes the impacts difficult to quantify.

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<sup>173</sup> World Bank, "Vietnam Environment," 25

<sup>174</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>175</sup> The prime reasons are: (i) the low calorific value of the healthcare waste caused start-up problems, and (ii) fuel had to be added constantly to maintain the combustion process, see also in Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>176</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>177</sup> Ibid, 291

<sup>178</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 291

<sup>179</sup> World Bank, "Vietnam Environment," 23

<sup>180</sup> Ibid, 23

<sup>181</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 292

<sup>182</sup> WENID and VEA, "Country Analysis Paper" (paper prepared by WENID and VEA for the Fourth Regional 3R Forum in Asia "3Rs in the Context of Rio+20 Outcomes- The Future We Want", Hanoi, Vietnam, 18-20 March 2013,)

## ▪ **Incineration and burning**

Even though the operation of incinerators is evaluated by the government in terms of technical standards and gas emissions, Vietnam does not have the technology to analyse the dioxin concentrations they emit<sup>183</sup>. A recent study conducted by Steering Committee 33<sup>184</sup> found that many incinerators that burn industrial and medical wastes are discharging dangerous amounts of dioxin<sup>185</sup>. Emission samples from all 18 medical and industrial incinerators contained dioxin, while seven out of the 18 exceeded the permitted level<sup>186</sup> and could cause human health problems including cancer<sup>187</sup>.

## ▪ **Landfill**

As mentioned above, most of the landfill sites lack sanitary design techniques. These poorly operated landfills tend to exert negative impacts on the environment including<sup>188</sup>:

- Contamination of ground and surface water by untreated leachate;
- Emissions of airborne pollutants; and
- The spread of odors, flies, mosquitoes, rodents, dust and noise.

Moreover, unsanitary landfills have negative affects on local communities. Taking the Dong Thanh landfill in Ho Chi Mich City as an example, impacts show that<sup>189</sup>:

- Approximately 400 households in the vicinity of the landfill lose agricultural income and have health problems;
- The average incidence rate of skin, digestive, and respiratory disease was 58 percent; and
- 16 percent of wells in the vicinity of the landfill did not meet the national standards for microbiological parameters, while 100 per cent of wells did not meet physico-chemical standards.

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accessed on 21 April 2015, URL:

[http://www.uncrd.or.jp/content/documents/Country%20Analysis%20Paper\\_Vietnam.pdf](http://www.uncrd.or.jp/content/documents/Country%20Analysis%20Paper_Vietnam.pdf)

<sup>183</sup> Ibid, 291

<sup>184</sup> A national committee has been established to mitigate the effects of toxic chemicals used by the US during the Vietnam War, and the Ministry of Natural Resources and Environment. See also in Thanh Nien News, "Study Finds Large Dioxin Emissions from Vietnam's Waste Treatment Plants," Thanh Nien News, 9 April 2015, accessed on 21 April 2015, URL: <http://www.thanhniennews.com/health/study-finds-large-dioxin-emissions-from-vietnams-waste-treatment-plants-40949.html>

<sup>185</sup> Dioxin is one of the most toxic and persistent compounds which can leave impacts including cancer through generations. See also Thanh Nien News, "Study Finds Large"

<sup>186</sup> Vietnam's environment ministry allows waste treatment plants to emit dioxin at the toxicity equivalence (TEQ) of 600 picograms per normal cubic meter. See also in Thanh Nien News, "Study Finds Large"

<sup>187</sup> Ibid

<sup>188</sup> World Bank, "Vietnam Environment," 23

<sup>189</sup> Ibid, 23

## 6.3.4 Responsibilities of the national and local governments

### 6.3.4.1 National government level

In Vietnam, key government institutions involved with waste management include<sup>190</sup>:

- The Ministry of Natural Resources and Environment (MoNRE) is responsible for implementing state management of environmental protection and nationwide coordination of all environmental protection activities in Vietnam;
- The Ministry of Construction (MoC) is in charge of municipal solid waste management and the location of landfills. Their key responsibilities include: (i) designing policy and legislation, and planning and construction of solid waste facilities; and (ii) developing and managing plans for the construction of waste-related infrastructure at national and provincial levels;
- The Ministry of Industry is mainly responsible for managing industrial waste including inspecting, supervising, and taking measures to encourage businesses to comply with regulations on industrial waste management;
- The Ministry of Health deals mainly with hospital waste management by evaluating the impacts of solid waste on human health, inspecting and supervising hospital waste treatment activities;
- The Ministry of Planning and Investment cooperates with the Ministry of Finance to provide financial resources for other ministries/agencies and localities to carry out waste management plans based upon their annual and long-term waste management plans;
- The Ministry of Culture and Information is in charge of promoting legal documents on waste management to raise awareness among the public and to outline their responsibilities in respect of environmental protection; and
- The Ministry of Transportation is tasked with planning and managing infrastructure at the national and provincial levels, and with monitoring the Urban Environment Company (URENCO).

### 6.3.4.2 Local government level

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<sup>190</sup> Le Hoang Viet, Nguyen Vo Chau Ngan, Nguyen Xuan Hoang, Do Ngoc Quynh, Warinthorn Songkasiri, Catalin Stefan and Terry Commins, "Legal and Institutional Framework for Solid Waste Management in Vietnam," *Asian Journal on Energy and Environment*, 261-272, (2009), accessed on 17 April 2015, URL: [http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CBwQFjAA&url=http%3A%2F%2Fwww.asian-energy-journal.info%2FAbstract%2FLegal%2520and%2520institutional%2520framework%2520for%2520solid%2520waste%2520management%2520in%2520vietnam..pdf&ei=mnl1VeOSElf28QWK4oHQDg&usg=AFQjCNEEaink3KqHYKDKN T\\_mNO6wNtQyeg&sig2=V2tZTY0By5KQ8VIEYhhqMA&bvm=bv.91071109,d.dGc](http://www.google.com.kh/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CBwQFjAA&url=http%3A%2F%2Fwww.asian-energy-journal.info%2FAbstract%2FLegal%2520and%2520institutional%2520framework%2520for%2520solid%2520waste%2520management%2520in%2520vietnam..pdf&ei=mnl1VeOSElf28QWK4oHQDg&usg=AFQjCNEEaink3KqHYKDKN T_mNO6wNtQyeg&sig2=V2tZTY0By5KQ8VIEYhhqMA&bvm=bv.91071109,d.dGc)

Similar to Cambodia and Thailand, Vietnam's provincial and municipal governments and agencies play significant roles in providing services for solid waste management. These include<sup>191</sup>:

- The People's Committee (PC) which is in charge of state administration at the local level<sup>192</sup>;
- The Department of Natural Resources and Environment (DoNRE), which is an agency of MoNRE that monitors environmental quality, and manages and implements waste management policies and regulations issued by MoNRE and the PC<sup>193</sup>;
- The Urban Environment Company (URENCO)<sup>194</sup>, which is an agency of DoNRE and the PC, and is responsible for waste collection, transportation, and treatment in the provinces and cities;
- The Chief Architect's Office (CAO) is responsible for spatial planning in Hanoi and Ho Chi Minh City. It endeavours to develop an urban master plan to avoid or reduce urban environmental problems by specifying locations for waste treatment projects<sup>195</sup>; and
- The Department of Construction, which is the agency of the MoC at the provincial level that is responsible for waste management construction and landfill locations including organizing the design and construction of landfill projects based on sound environmental and construction standards<sup>196</sup>.

### 6.3.5 Policies and programs for waste management

Several regulations have been put in place to govern the implementation of waste management including<sup>197</sup>:

- Environmental Protection Legislation ;
- Solid and Hazardous Waste Legislation;
- Toxic Substances Legislation;
- Medical Waste Legislation;
- Legislation on Recycling;
- Legislation on Waste Management Infrastructure Facilities; and
- Standards for: hazardous waste landfill design; health care solid waste incinerators; landfill design; prevention and warning signs for

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<sup>191</sup> Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 286

<sup>192</sup> The key responsibilities of PC are: (i) implementation of state management regulations on environmental protection in their localities, providing direction to functional agencies at local level to coordinate with the agencies of the central level, (ii) providing direction and consultancy for proper waste management facilities, waste treatment projects in areas of design, construction, monitoring, etc; (iii) investment and subsidization for solid waste management and treatment facilities, see also Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 286

<sup>193</sup> DoNRE's work is influenced by PC in terms of administrative and political relations and by MoNRE in terms of collaboration, support, and technical guidance, see also Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 286

<sup>194</sup> URENCO is also tasked to collect solid waste, maintain hygiene for public areas, public lighting and to plant and take care of trees along the street, see also Thanh, N.P. and Mastsui, Y., "Municipal Solid Waste," 286

<sup>195</sup> Le Hoang Viet et al, "Legal and Institutional," 269

<sup>196</sup> Ibid, 269

<sup>197</sup> See more detail of these regulations in Le Hoang Viet et al, "Legal and Institutional," 263-267



hazardous waste; and environmental protection for sanitary landfills.

There are also a number of policies and programs that have been developed to strengthen the implementation of waste management in Vietnam, including:

- The National Strategy for Solid Waste Management in industrial and urban areas up to 2020. This strategy was approved by the Prime Minister in 1999<sup>198</sup>;
- The National Strategy on Environmental Protection up to year 2010 and Vision to 2020 which was approved by the Prime Minister in 2003<sup>199</sup>;
- The policy that sets targets to reduce the use of plastic bags at shopping centres and supermarkets by 65 percent. It also calls for a reduction in the number of plastic bags used at traditional markets by 40 percent, and 35 percent for non-biodegradable plastic bags used in daily life which will be recovered and recycled into environmental-friendly products<sup>200</sup>; and
- The National Strategy on Reducing, Reusing and Recycling (3R) which promotes community participation, enhancing 3R infrastructure development, extending producer responsibility, establishment of environmentally-friendly industrial facilities, reduction of production and service wastes, reuse of household products, development of waste markets, recycling industries, and establishment of recycling funds<sup>201</sup>.

## 6.4 The United Kingdom

### 6.4.1 The current situation regarding waste management

The United Kingdom (UK) which consists of England, Wales, Scotland and Northern Ireland will be examined as a whole. In the UK, waste is defined as “any substance or object which the holder discards, intends to discard or is required to discard<sup>202</sup>.” Based on this definition, the main types of waste are categorized as follows<sup>203</sup>:

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<sup>198</sup> Ibid, 264

<sup>199</sup> Le Hoang Viet et al, “Legal and Institutional,” 263

<sup>200</sup> 3R Knowledge Hub, “Regulation/Policy Factsheet: Environmental Protection Tax Law, Vietnam, 2010,” accessed on 16 April 2015, URL: [http://www.3rkh.net/index.php?option=com\\_phocadownload&view=file&id=549:plastic-policy-fact-sheet-vietnam&start=70&order\\_by=ordering&Itemid=238](http://www.3rkh.net/index.php?option=com_phocadownload&view=file&id=549:plastic-policy-fact-sheet-vietnam&start=70&order_by=ordering&Itemid=238)

<sup>201</sup> As of January 2009, this strategy was still in the 3<sup>rd</sup> draft, presently as of 21 April 2015, there seems to be lack of updated information available on the internet about whether or not this strategy has been completely finalized.

See also in UNCRD, AIT/UNEP, IGES, “National 3R Strategy Development: A Progress Report on Seven Countries in Asia,” 2009, 10, accessed on 21 April 2015, URL: <http://pub.iges.or.jp/modules/envirolib/view.php?docid=2637>

<sup>202</sup> Department for Environment, Food & Rural Affairs, Waste Management Plan for England, (London, 2013), 7, accessed on 22 April 2015, URL: <https://www.gov.uk/government/publications/waste-management-plan-for-england>

<sup>203</sup> Ibid, 7

- Municipal waste – household waste and commercial waste similar to household waste;
- Industrial (including agricultural) and commercial waste;
- Construction and demolition waste; and
- Hazardous waste.

In 2012, when the population of the UK was estimated to be around 63.7 million people<sup>204</sup>, it generated approximately 200 million tonnes of waste. Of this: 50 percent was generated by construction; industrial and commercial (I&C) accounted for about 24 percent; while municipal waste accounted for approximately 14 percent<sup>205</sup>. Of the 200 million tonnes of waste, hazardous waste accounted for approximately 5,931, 000 tonnes in 2012<sup>206</sup>.

Table 9 indicates the composition of waste generation in the UK in 2012. It shows that of the total waste, mineral waste made up the largest proportion, accounting for 34.6 per cent, followed by soils waste (20.8 percent) and household and similar wastes (13.2 percent)<sup>207</sup>.

**Table 9: Waste listed by material in the UK in 2012**

<b>Waste composition</b>	<b>Tonnes (thousand)</b>	<b>Proportion of total</b>
Mineral waste	69,205	34.6%
Soils	41,625	20.8%
Household & similar waste	26,446	13.2%
Other waste	23,948	12.0%
Dredging spoils	14,721	7.4%
Vegetal waste	6,602	3.3%
Metallic waste	6,060	3.0%
Paper & cardboard waste	3,659	1.8%
Plastic waste	3,199	1.6%
Wood waste	2,306	1.2%
Glass waste	2,250	1.1%
<b>All wastes</b>	<b>200,020</b>	<b>100.0%</b>

Source: Department for Environment, Food & Rural Affairs, UK Statistics on Waste- 2010 to 2012, 10

<sup>204</sup> "Analysis of annual mid-year population estimates for 2011 and 2012," Office for National Statistics, accessed on 12 June 2015, URL: <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2011-and-mid-2012/sty---uk-population-estimates.html>

<sup>205</sup> Department for Environment, Food & Rural Affairs, UK Statistics on Waste- 2010 to 2012, by Robin Karfoot, (York: Government Statistic Service, 2015), 1, accessed on 22 April 2015, URL: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/416471/UK\\_Statistical\\_release\\_UPDATEv6\\_19\\_03\\_2015.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416471/UK_Statistical_release_UPDATEv6_19_03_2015.pdf)

<sup>206</sup> Hazardous waste is found in Commercial and Industrial (3,173, 000 tonnes), Construction (1, 057,000 tonnes), Household (1,306,000 tonnes) and other waste (395,000 tonnes). See also Department for Environment, Food & Rural Affairs, UK Statistics, 9

<sup>207</sup> Department for Environment, Food & Rural Affairs, UK Statistics, 10

## 6.4.2 Methods of waste management

Given that the UK aims to meet its obligations under the European Union (EU) Waste Framework Directive and EU Landfill Directive<sup>208</sup>, a number of alternative disposal options have been introduced. These options consist of: increased recycling; composting; anaerobic digestion and the use of thermal treatment facilities to generate energy from waste<sup>209</sup>.

### ▪ Recovery, recycling and composting

Recycling and composting have been increasingly used as methods for waste management in the UK over recent years<sup>210</sup>. For instance, the recycling rate of household waste increased from 40.3 percent in 2010 to 43.9 percent in 2012. This increasing rate of waste recycling appears to result from the government's efforts to achieve the EU target, which for the UK is to achieve a recycle rate of at least 50 percent by 2020<sup>211</sup>.

In 2012, 2341 recycling facilities were operating in the UK. 749 of these were recycling end-of-life vehicles, 761 were vehicle dismantling facilities, 60 were vehicle de-pollution sites and 771 were metal recycling plants<sup>212</sup>. Moreover, 203 composting sites were also operating in the UK. Of the total composting sites, 149 were open windrow<sup>213</sup>, 41 in-vessels<sup>214</sup> and 13 combined open windrow and in-vessel technology<sup>215</sup>.

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<sup>208</sup> The EU Waste Framework Directive requires "all member states to take the necessary measures to ensure waste is recovered or disposed of without having harmful effects on human health or causing harm to the environment. The Directive also requires member states to take appropriate actions to motivate: firstly, the prevention or reduction of waste production and its harmfulness; secondly, the recovery of waste through means of recycling, reuse, or any other process to transfer waste to energy".

Meanwhile, the EU Landfill directive aims "to prevent or reduce as much as possible negative effects on the environment from the landfilling of waste, by introducing strict technical requirements for waste and landfills and setting targets for the reduction of biodegradable municipal waste going to landfill". See also in Department for Environment, Food & Rural Affairs, "Waste Legislation and Regulations," last modified on 9 May 2014, accessed on 22 April 2015, URL: <https://www.gov.uk/waste-legislation-and-regulations>

<sup>209</sup> Nickolas Themelis and Athanasios Bourtsalas, "UK Waste Management: Growing Old or Growing Clean?," last modified 2015, accessed on 22 April 2015, URL: <http://www.waste-management-world.com/articles/print/volume-14/issue-3/features/uk-waste-management-growing-old-or-growing-clean.html>

<sup>210</sup> Nickolas Themelis and Athanasios Bourtsalas, "UK Waste Management"

<sup>211</sup> Department for Environment, Food & Rural Affairs, UK Statistics on Waste, 1

<sup>212</sup> Nickolas Themelis and Athanasios Bourtsalas, "UK Waste Management"

<sup>213</sup> Windrow composting is used for processing garden waste, such as grass cuttings, pruning and leaves in either an open air environment or within large covered areas where the material can break down in the presence of oxygen, according to "Open Windrow Composting," last modified 13 March 2012, accessed on 22 April 2015, URL: <http://www.wrap.org.uk/content/open-windrow-composting>

<sup>214</sup> In-vessel composting is used to treat food and garden waste mixtures. These systems ensure that composting takes place in an enclosed environment, with accurate temperature control and monitoring, according to "In vessel composting," last modified 13 March 2012, accessed on 22 April 2015, URL: <http://www.wrap.org.uk/content/vessel-composting-ivc>

<sup>215</sup> Nickolas Themelis and Athanasios Bourtsalas, "UK Waste Management"

Waste recovery<sup>216</sup> is also one of the waste management methods used in the UK. Approximately 49 percent of the 186.2 million tonnes of waste moved into final treatment was recovered in 2012<sup>217</sup>. Specifically, the recovery rate of non-hazardous construction and demolition waste was 86.5 percent in 2012, rising from 86.2 percent in 2010<sup>218</sup>. This increasing recovery rate exceeds the target set by the EU for the UK to recover non-hazardous construction and demolition waste by at least 70 percent by 2020<sup>219</sup>.

#### ▪ **Landfill**

Over the last several years, landfill has been used as the last waste management option in the UK<sup>220</sup> due to the fact that disposing of waste in a landfill is causing negative effects on the environment (i.e. waste disposed in landfills produces methane, a greenhouse gas)<sup>221</sup>. More than 80 percent of biodegradable municipal waste has been disposed of at landfill sites since 1995<sup>222</sup>. However, the EU Landfill Directive sets the target for the UK to minimize biodegradable municipal waste (BMW) disposed of at landfills to 35 percent of the 1995 level by 2020<sup>223</sup>. As a result, approximately 130 landfills have been closed<sup>224</sup>. Furthermore, the UK Statistics on Waste show that in 2012 there was a decreasing amount (i.e., 10.3 million tonnes) of biodegradable waste disposed of in landfills. This amount represents 29 percent of the 1995 baseline amount<sup>225</sup> which appears to indicate that the UK will meet the 2020 target<sup>226</sup>.

#### ▪ **Waste to Energy**

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<sup>216</sup> Recovery is divided into three sub-categories: preparing for re-use, recycling, and other recovery, according to Eurostat, “Guidance on the Interpretation of the term backfilling,” accessed on 22 April 2015, URL: <http://ec.europa.eu/eurostat/documents/342366/4953052/Guidance-on-Backfilling.pdf/c18d330c-97f2-4f8c-badd-ba446491b47e>

<sup>217</sup> Department for Environment, Food & Rural Affairs, UK Statistics on Waste, 12

<sup>218</sup> Department for Environment, Food & Rural Affairs, UK Statistics on Waste, 6

<sup>219</sup> Ibid, 1

<sup>220</sup> Department for Environment, Food & Rural Affairs, “Waste and Recycling,” last modified on 27 March 2015, accessed on 23 April 2015, URL: <https://www.gov.uk/government/policies/reducing-and-managing-waste>

<sup>221</sup> Ibid

<sup>222</sup> CIWM, “Landfill Directive (1999/31/EC)”

<sup>223</sup> House of Commons, Environment, Food and Rural Affairs Committee, Waste Management in England, (London: 2015), 7, accessed on 23 April 2015, URL:

<http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenvfru/241/241.pdf>. See also The main reason that EU introduced the Landfill Directive across the EU member states is that it aims to reduce reliance on landfill as a disposal option, and tries to minimize the negative impacts of landfills on the environment and human health, according to CIWM, “Landfill Directive (1999/31/EC),” accessed on 24 April 2015, URL: <http://www.ciwm.co.uk/CIWM/InformationCentre/AtoZ/LPages/LandfillDirective.aspx>

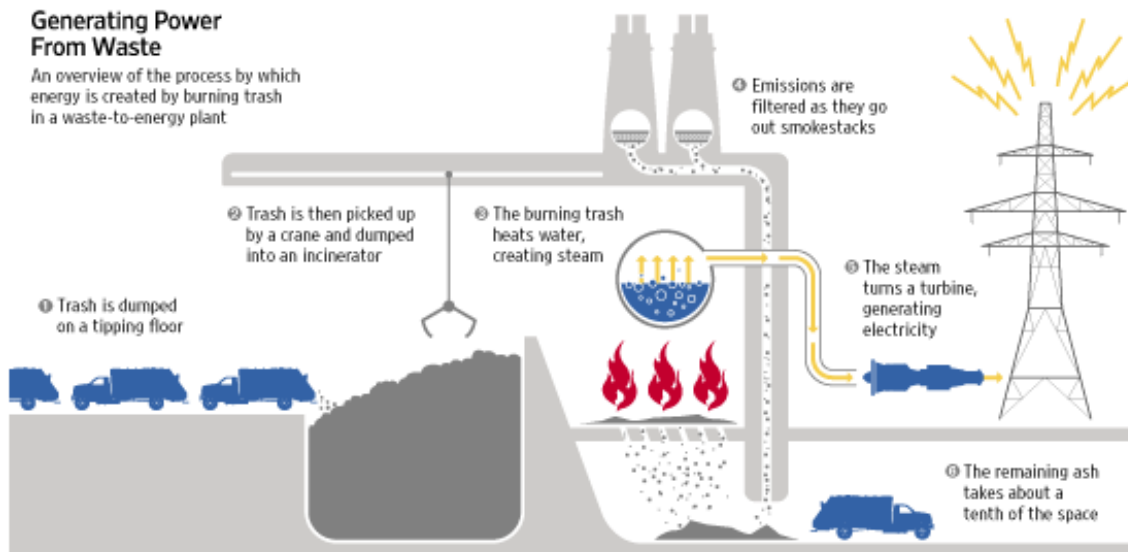
<sup>224</sup> House of Commons, Environment, Food and Rural Affairs Committee, Waste Management in England, 8

<sup>225</sup> Department for Environment, Food & Rural Affairs, UK Statistics on Waste, 12

<sup>226</sup> House of Commons, Environment, Food and Rural Affairs Committee, Waste Management in England, 8

In order to divert waste from landfills, alternative waste management facilities such as waste-to-energy plants (WEPs) have been developed<sup>227</sup>. In 2012, 16.1 percent of municipal solid waste was processed in WEPs<sup>228</sup>. This proportion accounted for about 5 percent (an increase of about 300 percent compared with 1996) of the country's total renewable energy sources (RES)<sup>229</sup>. Figure 2 shows the WEP process of producing energy from waste.

**Figure 2: The process of WEP to produce energy**



Source: Google Image, accessed on 23 April 2015

- **Anaerobic digestion**

In the UK, anaerobic digestion (AD)<sup>230</sup> is not a new technology. It has been employed since the late 1800s. Recently, this method has been increasingly used to produce clean renewable energy<sup>231</sup>. Also, it is used to treat waste generated in homes, farms, supermarkets and industries

<sup>227</sup> House of Commons, Environment, Food and Rural Affairs Committee, Waste Management in England, 8

<sup>228</sup> Nickolas Themelis and Athanasios Bourtsalas, "UK Waste Management"

<sup>229</sup> Ibid

<sup>230</sup> Anaerobic Digestion is a natural process in which micro-organisms break down organic matter, in the absence of oxygen, into biogas (a mixture of carbon dioxide "CO<sub>2</sub>" and methane) and digestate (a nitrogen-rich fertilizer), see detail in Defra and Department of Energy and Climate Change, Anaerobic Digestion Strategy and Action Plan, (London: Defra, 2011), 5, accessed on 24 April 2015, URL:

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/69400/anaerobic-digestion-strat-action-plan.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69400/anaerobic-digestion-strat-action-plan.pdf)

<sup>231</sup> "What is AD?" accessed on 24 April 2015, URL: <http://www.biogas-info.co.uk/what-is-anaerobic-digestion.html>

across the UK. Ultimately, it contributes to diverting waste from landfills<sup>232</sup>.

In 2011, there were 54 AD plants in operation (32 on-farms and 22 off-farms)<sup>233</sup>. These plants treated approximately 534,200 tonnes of commercial waste, 382,000 tonnes from the food and drink sector and 136,156 tonnes from farm-based operations. As a result, these plants produced 35 megawatts of electricity (MWe) in 2011<sup>234</sup>. The UK government plans to build an additional 50 AD plants, which are expected to generate approximately 70 MWe<sup>235</sup>.

### 6.4.3 Impacts of waste management

#### ▪ Impact of Landfills

It is commonly perceived that the disposal of waste at landfill sites can pose health risks to people. However, it is argued that improving landfill design and management along with restrictions on the types of wastes disposed of in landfills as well as well-enforced environmental regulations should ensure that there is no significant harmful risks to human health<sup>236</sup>.

A study conducted by the UK's Health Protection Agency (HPA) concluded that living close to a well-managed landfill site does not cause a significant risk to human health<sup>237</sup>. However, only modern landfill sites were selected for this study. The HPA will conduct further assessments of the risks of exposure to landfill sites as emissions from individual sites may vary<sup>238</sup>.

To date, it should be noted, that there is no information available on the impact of the closing of 130 landfills (as noted above).

#### ▪ Impact of Waste-to-Energy

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<sup>232</sup> Ibid

<sup>233</sup> Defra and Department of Energy and Climate Change, Anaerobic Digestion Strategy and Action Plan, (London: Defra, 2011), 17

<sup>234</sup> Ibid, 17

<sup>235</sup> Ibid, 17

<sup>236</sup> Health Protection Agency, Impact on Health of Emissions from Landfill Sites, by Y Macklin, A Kibble and F Pollitt, (2011), accessed on 24 April 2015, URL:

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/334356/RCE-18\\_for\\_website\\_with\\_security.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/334356/RCE-18_for_website_with_security.pdf)

<sup>237</sup> Health Protection Agency, Impact on Health of Emissions from Landfill Sites, 24

<sup>238</sup> Ibid

The opponents of the waste-to-energy plants (WEPs) believe that WEPs can be dangerous to human health and the environment from the effects of burning waste at these facilities<sup>239</sup>.

Nevertheless, in recent years, the UK has been committed to this process<sup>240</sup>. WEP appears to be an effective waste management option as it avoids methane emissions at landfills, and uses waste as fuel to replace fossil fuels such as oil, coal or gas<sup>241</sup>. These factors may minimize the effects of waste management practices (i.e. WEPs) on climate change<sup>242</sup>. However, the growing traffic congestion and increasing noise in the vicinity of the plants contribute to some local negative impacts<sup>243</sup>.

Using anaerobic digestion (AD) is also beneficial for waste management. It contributes to decreasing greenhouse gas emissions, produces renewable energy for heat, power and transport fuel, recycles nutrients back to the land, and reduces air pollution<sup>244</sup>.

It should be noted that the UK Environment Agency is committed to enforcing environmental regulations. For example, it only permits a WEP to operate if it is "sure that the plant will be designed, constructed and operated in a way that will not significantly pollute the environment or harm human health<sup>245</sup>." The commitment in law of the enforcement of regulations by the UK government tends to ensure that proper waste management practices are adhered to in order to reduce negative impacts.

## 6.4.4 Responsibilities of the national and local governments

### 6.4.4.1 National government level

At the country level, the Environment Agency plays an oversight role on waste and environmental regulations in England and Wales. The Scottish Environmental Protection Agency and the Northern Ireland Environment Agency are in charge of overseeing the waste and environmental regulations in Scotland and Northern

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<sup>239</sup> House of Commons, Energy from Waste and Incineration, by Oliver Bennett, (2011), 1, accessed on 22 April 2015, URL:

<http://www.google.com/url?sa=t&rct=j&q=&escr=s&source=web&cd=5&ved=0CEoQFjAE&url=http%3A%2F%2Fwww.parliament.uk%2Fbriefing-papers%2FNS05958.pdf&ei=Z7Y9VeC6NeHDmwX4yICYBw&usg=AFQjCNEEEMEogCkSASThfe94uWNjbFwRyQ&sig2=l1cmBJg930h7sZX6u3Fguw&bvm=bv.91665533.d.dGY>

<sup>240</sup> Ibid, 8

<sup>241</sup> Ibid, 8

<sup>242</sup> Ibid, 8

<sup>243</sup> Ibid, 5

<sup>244</sup> Ibid, 8

<sup>245</sup> Ibid, 3



Ireland, respectively<sup>246</sup>. These agencies are under the authority of the UK Department for Environment, Food and Rural Affairs (Defra). Defra is responsible for policy and regulations on the environment, food and rural issues<sup>247</sup>.

UK government departments involved with waste management include:

- The Department for Communities and Local Government (DCLG) is responsible for creating suitable places to live and work, and for giving more power to local people to shape what happens in their area<sup>248</sup>;
- The Department for Energy and Climate Change (DECC) is responsible for managing the use of radioactive and nuclear substances and for disposal of radioactive waste<sup>249</sup>; and
- Her Majesty's Treasury is the government's economic and finance ministry, maintaining control over public spending, setting the direction of the UK's economic policy and working to achieve strong and sustainable economic growth<sup>250</sup>.

However, it has been observed by the UK House of Commons Environment, Food and Rural Affairs Committee, that there is a lack of coordination and cooperation as well as a lack of clear government leadership in waste management among these government departments<sup>251</sup>.

#### 6.4.4.2 Local government level

The UK has defined its local government as councils. Most parts of England have two tiers of local government: county councils and district, borough or city councils. Some parts of the country have just one tier of local government, which is known as a "unitary authority" (i.e. in Scotland)<sup>252</sup>. Local governments in the UK are in charge of waste collection and disposal including<sup>253</sup>:

- Waste collection and disposal;
- Recycling collection;
- Street cleaning and litter collection;
- Developing a waste strategy and planning; and

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<sup>246</sup> UK Trade & Investment, "Waste Management in the UK: Investment Opportunities," last modified 19 February 2014, accessed on 22 April 2015, URL: <https://www.gov.uk/government/publications/waste-management-in-the-uk-investment-opportunities/waste-management-in-the-uk-investment-opportunities>

<sup>247</sup> Department for Environment, Food & Rural Affairs, "What We Do," accessed on 23 April 2015, URL: <https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs>

<sup>248</sup> Department for Communities and Local Government, "What We Do," accessed on 23 April 2015, URL: <https://www.gov.uk/government/organisations/department-for-communities-and-local-government>

<sup>249</sup> Department for Energy and Climate Change, "Radioactive and nuclear substances and waste," last modified on July 24, 2014, accessed on 23 April 2015, URL: <https://www.gov.uk/government/policies/managing-the-use-and-disposal-of-radioactive-and-nuclear-substances-and-waste>

<sup>250</sup> HM Treasury, "What We Do," accessed on 23 April 2015, URL: <https://www.gov.uk/government/organisations/hm-treasury>

<sup>251</sup> House of Commons, Environment, Food and Rural Affairs Committee, Waste Management in England, 9

<sup>252</sup> "Understand how your council works," last modified on November 12, 2014, accessed on April 23, 2015, URL: <https://www.gov.uk/understand-how-your-council-works/types-of-council>

<sup>253</sup> UK Trade & Investment, "Waste Management"



- Encouraging good waste management (i.e. recycling) in their areas.

The UK government also provides funding for the Waste and Resources Action Programme (WRAP), a not-for-profit Company, to promote sustainable waste management through working with businesses, local authorities, communities and households<sup>254</sup>.

#### 6.4.5 Policies and programs for waste management

Regulations have been developed and implemented to ensure proper waste management in the UK. These include<sup>255</sup>:

- Waste (England and Wales) regulations 2012. These give additional tasks to Waste Collection Authorities to separately collect waste paper, metal, plastic and glass;
- Hazardous waste regulations to apply strict controls in respect of the production of hazardous waste and to their movement, management, recovery and disposal;
- Waste shipment regulations containing EU regulations, a UK statutory instrument and a UK Plan, which control movements of waste between the UK and other countries;
- Packaging and packaging waste regulations to ensure the consistency of national measures concerning the management of packaging and packaging waste to provide environmental protection and to ensure the functioning of the internal market;
- Landfill directives to prevent, or reduce as much as possible, negative effects on the environment from landfills, by introducing strict technical requirements for waste and landfills and setting targets for the reduction of biodegradable municipal waste going to landfills;
- End-of-life vehicles regulation 2003 to prevent waste from end-of-life vehicles and to promote the collection, re-use and recycling of their components to protect the environment; and
- Batteries directives to increase the environmental performance of batteries and reduce the negative effect of waste batteries on the environment.

The development of policies on waste management in the UK has been based on the concept of the waste hierarchy stated in the EU Waste Framework Directive<sup>256</sup>. This hierarchy consists of: (i) prevention; (ii) preparing for re-use; (iii) recycling;

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<sup>254</sup> Department for Environment, Food & Rural Affairs, "Waste and Recycling," last modified on 27 March 2015, accessed on 23 April 2015, URL: <https://www.gov.uk/government/policies/reducing-and-managing-waste>; see also in URL: <http://www.environmental-expert.com/companies/wrap-the-waste-resources-action-programme-8818>

<sup>255</sup> Department for Environment, Food & Rural Affairs, "Waste Legislation and Regulations," last modified on 9 May 2014, accessed on 22 April 2015, URL: <https://www.gov.uk/waste-legislation-and-regulations>

<sup>256</sup> This concept has been brought into the UK through the Waste (England and Wales) Regulations 2011. See also in Department for Environment, Food & Rural Affairs, "Waste Legislation"

(iv) other recovery; and (v) disposal<sup>257</sup> (See also Appendix 3 on Waste Hierarchy explanation). There are also a number of related waste management plans and strategies including the waste hierarchy that are being implemented for strengthening waste management in the UK<sup>258</sup>, including:

- Waste Management Plan for England 2013 which aims to manage waste towards a zero waste economy by using the waste hierarchy as a guide to sustainable waste management<sup>259</sup>;
- Waste Strategy Document for Wales 2010 provides key actions for implementation in order to achieve the status of a zero waste nation by 2050<sup>260</sup>;
- Scotland's Zero Waste Plan 2010, which aims to make the most efficient use of resources by minimizing Scotland's demand on primary resources, and maximizing the reuse, recycling and recovery of resources instead of treating them as waste<sup>261</sup>; and
- Northern Ireland Waste Management Strategy 2006-2020 which aims to manage waste and resources effectively through reducing the amount of waste generated, and minimize the impacts of waste on the environment and public health<sup>262</sup>.

## 6.5 Germany

### 6.5.1 The current situation of waste management

Germany's waste recovery rates are the highest in the world and show how the waste management industry contributes to sustainable economic production in the country by saving raw materials and primary energy. Almost 57 percent of municipal waste and 58 percent of production waste is recycled. Other types of waste have even higher recycling rates, for example, 86 percent for construction waste, around 80 percent for packaging, 82 percent for batteries and around 80 percent for graphic paper.<sup>263</sup> The following chart shows the municipal waste disposal rate target to 2020.

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<sup>257</sup> See the detail of this concept in Department for Environment, Food & Rural Affairs, "Waste Legislation"

<sup>258</sup> It should be noted the devolved administrations including Scotland, Wales, the Northern Ireland are responsible for developing waste management plans in their areas. See also in Department for Environment Food and Rural Affairs, "Waste Management Plan for England," 6

<sup>259</sup> Department for Environment Food and Rural Affairs, "Waste Management Plan for England," 1

<sup>260</sup> Welsh Assembly Government, Towards Zero Waste: The Overarching Waste Strategy Document for Wales, (2010), accessed on 23 April 2015, URL:

[http://gov.wales/topics/environmentcountryside/epq/waste\\_recycling/publication/towardszero/?lang=en](http://gov.wales/topics/environmentcountryside/epq/waste_recycling/publication/towardszero/?lang=en)

<sup>261</sup> The Scottish Government, Scotland's Zero Waste Plan, (Edinburgh: the Scottish Government, 2010), accessed on 23 April 2015, URL:

<http://www.zerowastescotland.org.uk/sites/files/zws/zero%20waste%20plan%2009062010%20document%2001.pdf>

<sup>262</sup> Department of the Environment, Towards Resource Management: The Northern Ireland Waste Management Strategy 2006-2020, accessed on 23 April 2015, URL: <http://www.doeni.gov.uk/niea/wms.17.pdf>

<sup>263</sup> Federal Ministry for the Environment, at < <http://www.bmub.bund.de/en/topics/water-waste-soil/waste-management/waste-policy/>>

**Figure 3: Municipal Waste: Target 2020**

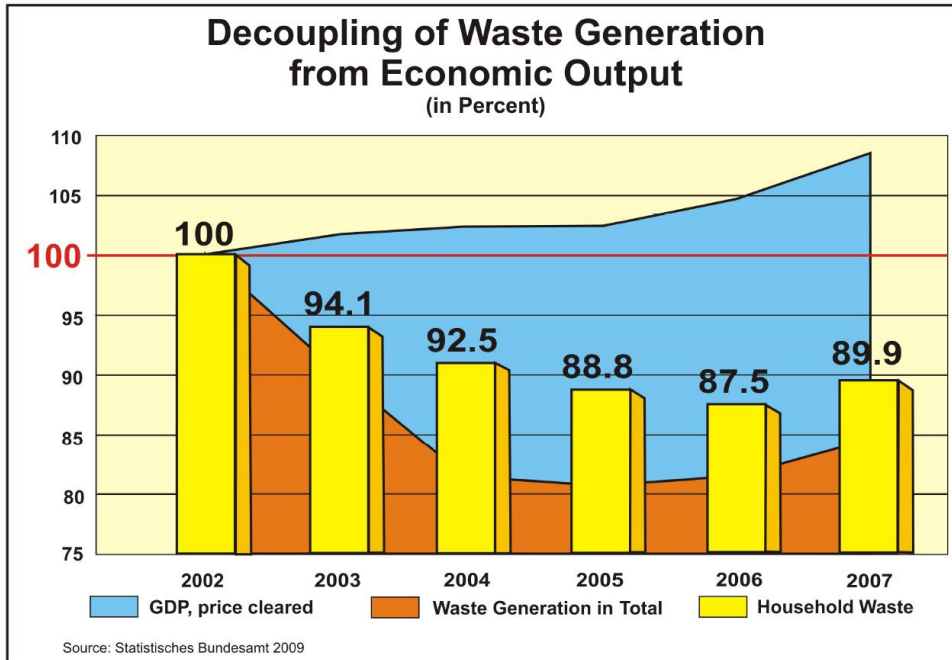


In 2013, the amount of household waste generated per head of population in Germany declined slightly year on year. While the total population of Germany was estimated to number around 82 million in 2013<sup>264</sup>, on the basis of provisional data, a total of 36.6 million tonnes of waste were collected from households. This was an average of 453 kilograms per inhabitant. In 2012, the total amounted to 36.7 million tonnes or 456 kilograms per head of the population.<sup>265</sup>

**Figure 4: Decoupling of Waste Generation from Economic Output**

<sup>264</sup> "Population of Germany 2014," World Population Statistics, accessed on 12 June 2015, URL: <http://www.worldpopulationstatistics.com/germany-population/>

<sup>265</sup> Statistisches Bundesamt, at [https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/Environment/EnvironmentalSurveys/WasteManagement/Current\\_new.html;sessionid=5FFD3A42226D1678D5233E27DD6482CB.cae1](https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/Environment/EnvironmentalSurveys/WasteManagement/Current_new.html;sessionid=5FFD3A42226D1678D5233E27DD6482CB.cae1)



As can be seen from Figure 4, while the German GDP is growing, in total, the waste generation is stagnant or has even been reduced.

### 6.5.2 Methods of waste management

Municipal solid waste (MSW) is managed by the public waste management system, which is operated by public bodies, by private companies, or through private-public partnerships. The disposal process includes the collection and transportation of waste, the recycling process for the recovery of secondary raw materials, combustion in waste incineration plants to produce energy or, ultimately, decomposition in landfills.

For different sorts of waste, different collection schemes exist, e.g. for recyclable waste, preferential packaging waste, biological waste (in particular kitchen waste) and residual waste. Glass and textiles are often collected in containers distributed across cities and villages; yard and garden waste is either collected on demand or is brought to special municipal facilities. This approach aims to minimize waste and to conserve reserves of raw materials. Municipal waste management services perform the removal of residual and organic waste from waste bins. Each household has various (different colored) waste bins for different sorts of waste:

- Organic waste bin: kitchen and food waste, e.g. eggshells, coffee filter papers, fruit and vegetables, flowers, leaves and grass cuttings;
- Paper bin: cardboard files, writing paper and envelopes, books, magazines, cardboard boxes, paper and cardboard packaging, newspapers;
- "Yellow bag": metal packaging (cans, crown caps), synthetic packaging (foam packaging, yoghurt pots, polystyrene) and composites (milk and fruit juice cartons or tetra packs, frozen food packaging); and

- Recyclable glass: separated at home by color and then placed in bottle banks.

**Figure 5: Waste bins**



Additionally, old clothes, compost and bio-waste, packaging, electrical and electronic waste, batteries, metal, and hazardous waste from private households are collected separately before they are recycled.

#### ▪ **Recovery and Reuse of Waste**

A number of laws and regulations contain provisions on recovery, reuse and recycling for the following wastes: packaging, batteries, waste electrical and electronic equipment, end-of-life vehicles, waste oil, biodegradable waste, waste wood, sewage sludge, commercial municipal waste, waste going for incineration, waste recovered at surface landfills and waste going to underground storage.

Because of the high standards imposed on recovery, waste that has been separately collected still needs to be further sorted. This sorting is mainly performed automatically using, for example, a refined detector system based on near infrared spectrography in order to separate different types of plastic with a high degree of accuracy. For example, the Ordinance on Bio-waste ensures that only biodegradable waste with a low pollutant content is used as a source material for fertilizers or soil improvers. The aim is to recycle organic material and to avoid the accumulation of pollutants in the soil. An average of about 50 percent of the population in Germany collects bio-waste by using bio-bins. Around 30 percent of sewage sludge is currently used as a source material for fertilizers, because sewage



sludge from local authority sewage treatment plants contains high levels of phosphorous.

The German government is also promoting techniques for extracting low-pollutant phosphate from sewage sludge and domestic sewage to increase the ratio of recycled phosphor. The Waste Wood Ordinance sets out concrete requirements governing the recycling, energy recovery and disposal of waste wood. It ensures that pollutants are not recycled or do not accumulate during recovery. In addition, there are voluntary commitments by the industry for construction and demolition waste and for graphic paper.

- **Landfill**

Waste disposal through landfill is a central component of waste management. The Landfill Ordinance sets high standards for landfill sites. It also requires extremely hazardous waste to be disposed of below ground in deep salt mines. Only about 160 landfill sites for municipal waste exist in Germany today compared with about 2,000 landfill sites in the 1980s (see the following chart). The provisions on landfills in Germany are much stricter than is required by the EU Landfill Directive. Since 2005, residual waste from households and industry must be treated in such a way as to prevent biological conversion processes from occurring in landfills. This has led to a reduction of more than 30 million tonnes of carbon dioxide equivalents per year.

The substitution of fossil fuels through the non-recyclable biogenic (i.e., produced by a biological process) part of residual waste in waste-to-energy plants leads to a yearly reduction of approximately 4 million tonnes of carbon dioxide equivalents. Thus, sustainable residual waste management makes an important contribution to climate protection in Germany. The political goal is to recover municipal waste as much as possible and further reduce the number of above-ground landfills.

**Figure 6: Landfills for Household Waste**



## ▪ Incineration

The Waste Incineration Ordinance, based on the Federal Emission Control Act, contains standards for the incineration and co-incineration of waste. Germany has extended its waste incineration capacity significantly during recent years. In 2000, 56 waste incineration plants were in operation with a total throughput of MSW (Municipal Solid Waste) of approximately 11 million Mg.(i.e., metric tonne). These figures increased in 2010 to 69 plants with a MSW throughput of approx. 16.3 million Mg. The German decision to ban landfilling of untreated waste became a strong driver for improvement of energy recovery from waste. This increased not only the capacity of waste incineration plants, it also caused the development of improved energy efficiency of these plants. Currently, the amount of residual municipal solid waste can be easily handled by existing waste incineration plants and there is likely to be a capacity surplus in the near future. However, this can be absorbed by shutting down old plants.

### 6.5.3 Impacts of waste management

Waste management in Germany has undergone major changes since the 1990s. The Recycling Management and Waste Act (1994) and the related legal provisions are a significant step away from waste management based on disposal towards closed substance cycle management (i.e., manufacturers and sales companies have to design their products in such a way that the production of waste is reduced during their manufacture and subsequent use and that an environmentally compatible reutilization and disposal of the residual waste is possible). Due to the drastically stepped-up legal requirements, waste management has been contributing substantially to sustainable development in Germany over recent years.

The waste management sector in Germany has become an extensive and powerful economic sector in recent decades. Economical and responsible resource management is achieved through high rates of materials recovery and the consequent recovery of energy and secondary raw materials. Currently, more than 250,000 people are employed in waste management, an economic sector with annual revenues of around 50 billion euros.<sup>266</sup>

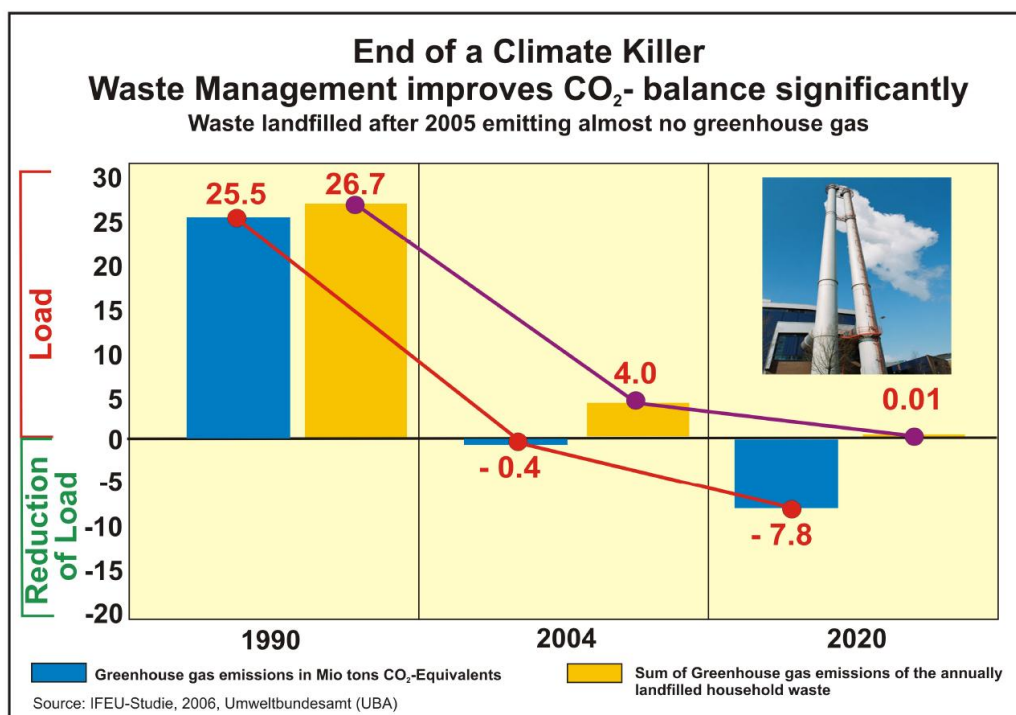
Germany has successfully established a modern waste and closed cycle management system with a significant and positive impact on the protection of soil, water and above all general health. Waste management is also making a significant contribution to climate action. Climate protection benefits from these waste management measures, for example through increased capacities in mechanical-biological pre-treatment of waste and the disposal ban for municipal waste without pre-treatment. The successes of modern waste management in the field of climate action have been remarkable. Over the last 15 years the emissions from

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<sup>266</sup> Federal Ministry of the Environment, at <http://www.bmub.bund.de/en/topics/water-waste-soil/waste-management/waste-policy/>

greenhouse gas pollutants from waste management have been reduced by 30 million tonnes of CO<sub>2</sub> equivalents per year (see Figure 7).

**Figure 7: End of a Climate Killer**



#### 6.5.4 Responsibilities of the national and local governments

In Germany, the responsibility for waste management and environmental protection is shared between the national government, the federal states and local authorities. The national Ministry of Environment sets priorities, participates in the enactment of laws, oversees strategic planning, information and public relations and defines requirements for waste facilities. Each federal state adopts its own waste management act containing supplementary regulations to the national law, e.g. concerning regional waste management concepts and rules on requirements for disposal. There is no national waste management planning in Germany. Instead, each federal state develops a waste management plan for its area.

For waste generated by households, the Recycling Management and Waste Act (*Kreislaufwirtschaftsgesetz*) assigns responsibility to the local public waste disposal authorities (in most federal states these are districts and towns). Their responsibility covers collecting and transporting waste, measures to promote waste prevention and recovery, planning, and constructing and operating waste disposal



facilities. Municipalities have practical tasks such as providing sites for waste collection.

Furthermore, German waste legislation is influenced by European law, either indirectly, when it shapes German legislation (for example through the Waste Framework Directive), or directly, when the EU sets binding laws (for example through the Waste Shipment Regulation). In fact, the main reason for the 2012 amendment to the Recycling Management and Waste Act was the entry into force of a new EU Waste Framework Directive (Directive 2008/98/EC). In implementing the Directive the text of the Recycling Management and Waste Act had to be revised. However, substantive law has not changed much and most amendments were caused by a new terminology that was introduced in the European Directive. European and German waste management regulations are not fully congruent. In general, Germany provides more stringent requirements because waste management is much more advanced in Germany than it is at the European level.

### 6.5.5 Policies and programs for waste management

In Germany, waste legislation is a field of environmental law and it is based on the precautionary principle (this means that there is a duty to prevent harm, even when all evidence has not yet been collected), the polluter-pays principle and the principle of co-operation. Waste management legislation includes all the legal rules governing the treatment, transportation and disposal and other matters dealing with waste. The key legislation for managing waste and disposal of waste in Germany is the Recycling Management and Waste Act (*Gesetz zur Neuregelung des Kreislaufwirtschafts- und Abfallrechts*), which regulates the waste management process. The act entered into force in 1994 and was amended in February 2012. It defines a five-step hierarchy for waste management:

- Avoidance;
- Pre-treatment for recycling;
- Recycling;
- Other – in particular energetic – use; and
- Disposal.<sup>267</sup>

These priorities are, however, handled flexibly with a view to optimal environmental protection. A deviation from this hierarchy may therefore be required for certain types of waste. For example, recovery measures must be technically and economically feasible. There is leeway concerning which instruments are used in a particular scenario in order to achieve the statutory goals.

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<sup>267</sup> Seifert/Vehlow, Country Report Germany, available at <  
<http://www.ieabioenergytask36.org/vbulletin/showthread.php?25-Country-reports-November-2012>>

According to article 1 of the Recycling Management and Waste Act, the goal of the Act is to conserve natural resources and to ensure the environmentally sound management of waste. Ultimately, the aim of the law is to reduce waste going to landfills. Waste should be avoided, for example, by doing without packaging or by using packaging materials multiple times (e.g. reusable packaging for soft drinks). For example, since food packaging in many cases is necessary to increase shelf life or to facilitate storage, it is necessary for the packaging to be recyclable. The goal is to manage materials sustainably and to thereby conserve resources and the environment. The Recycling Management and Waste Act aims to ensure the complete prevention, or at least the recovery of waste, including hazardous waste.

Germany was the first country in the EU to introduce producer responsibility with a packaging waste regulation in 1991. According to the principle of producer responsibility, which is a core tenet of German waste legislation, the producer of a product is generally responsible for the product when it becomes waste. However, this principle has been implemented only for some product types such as packaging, waste electric and electronic equipment, vehicles, solvents, waste oil and batteries.<sup>268</sup>

Thus, prevention takes precedence over recovery, which in turn comes before disposal. Waste prevention is implemented, *inter alia*, through extended producer responsibility, which on the one hand involves developing products and substances with the longest possible service life and, on the other, introduces production techniques that generate the minimum possible volume of waste through best available techniques. Under extended producer responsibility, producers of a commodity are required to consider the environmental impacts and possible risks of a product during its entire life-cycle. In collaboration with the other parties involved (for example, distributors, consumers, disposal and recycling companies, and government offices) the producer is required to create a system that minimizes the adverse environmental impacts and maximizes the recovery of resources.

Additionally, the Recycling Management and Waste Act is complemented by a series of regulations and ordinances that are issued on the basis of enabling provisions. They are usually used to specify the provisions of the Recycling Management and Waste Act for lists of waste, waste monitoring requirements, operational rules, product and production-related regulations and the treatment of sewage sludge and biowaste. Important ordinances are, for example: the Biowaste Ordinance (BioAbfV), the Landfill Ordinance (DepV), the Sewage Sludge Ordinance (AbfKlärV), and the Packaging Ordinance (the Ordinance).

The waste management policy aims to achieve a recycling-based economy that conserves resources and reduces adverse impacts on the environment. The aim is to increase and optimize the efficient use of raw materials, to maximize recovery quotas and to permanently remove from the environment any residual waste that

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<sup>268</sup> See also Fischer, Municipal Waste Management in Germany, available at [http://www.eea.europa.eu/publications#c14=&c12=&c7=en&c9=all&c11=5&b\\_start=0&c5=waste](http://www.eea.europa.eu/publications#c14=&c12=&c7=en&c9=all&c11=5&b_start=0&c5=waste) .

can no longer be used. This leads to substance management within closed substance cycles (*Kreislauf*). Consequently, the national policy on waste management focuses on the avoidance and recycling of waste.

## 7. Conclusion

In conclusion, waste management practices in Cambodia, other ASEAN member states (i.e. Vietnam, Thailand, and Singapore) and developed countries (i.e. Germany and the United Kingdom) vary. Cambodia, Thailand and Vietnam tend to employ conventional waste management methods with low-technology facilities. Singapore uses more modern technology for waste management (i.e. Waste-to-Energy facilities) with sound waste related laws and appropriate enforcement from government agencies. The United Kingdom and Germany use modern, technically advanced facilities for waste management (i.e. Waste-to-Energy plants and Anaerobic Digestion in the UK).

With regard to the impacts of waste management in Cambodia, although there seem to be no specific research studies on the impacts of littering, waste burning or landfilling, it is generally found that these waste management practices have negative impacts on the environment and on human health. In Thailand and Vietnam, disposing of waste in landfills also causes negative impacts on the environment and human health. However, disposing of waste in landfills in Singapore does not have such harmful effects because the landfill in Singapore has been technically designed to eliminate negative impacts. This is similar to the approach the UK and Germany have adopted in respect of the construction of landfills in recent years.

Nonetheless, the Waste-to-Energy incineration plants in Singapore appear to generate air pollution, which contributes to climate change, even though the plants have produced energy for the country. This indicates that incineration plants tend to contribute more or less to environmental pollution. However, in the UK and the Germany, the Waste-to-Energy incineration plants are permitted to operate only with highly technical design and with adherence to strict environmental regulations. The incineration plants contribute to a reduction in the effects of waste on climate change because they avoid the methane emissions of landfills.

With regard to the policies and programs on waste management, the governments of the countries studied have prepared and implemented various waste management policies and programs. Cambodia appears to have a number of waste regulations, policies and programs; however, the implementation of these policies and programs seems limited. It is worth noting that Singapore has implemented awareness-raising programs including the Keep Singapore Clean movement and the

Clean and Green Singapore campaign. Meanwhile, government agencies in the UK and Germany have a high commitment to enforcing regulations related to waste management, and implement the waste hierarchy concept in a progressive manner.

Cambodia can look to the experiences of these countries and adopt the most appropriate technologies and programs that can work and be adapted to the Cambodian context. For example, educational programs to inform youth and the general population about waste management issues may be a key component of developing a suitable waste management program for the country. In addition, Cambodia can learn from Singapore about how to construct and design sanitary landfill sites so that the negative impacts on the environment and human health of disposing waste in this way would be reduced.

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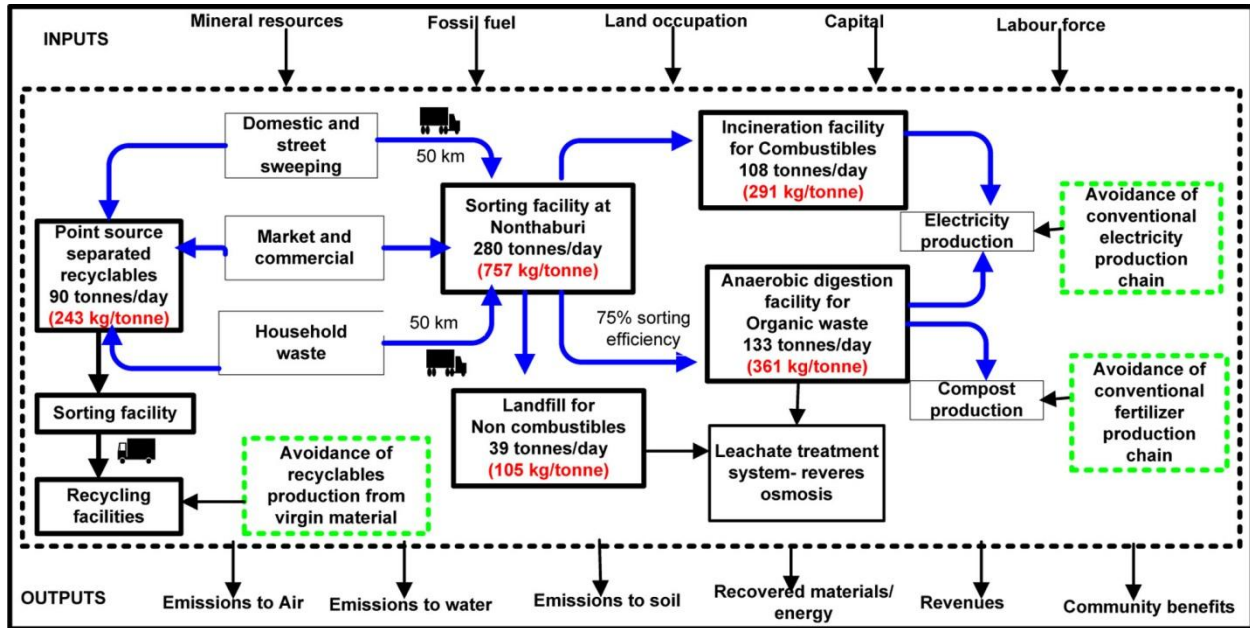
## Appendix:

### Appendix 1: Selected Composting Facilities in Vietnam

Location of Facility	Capacity (tonnes/day)	Opening Year	Sources of Organic waste	Status
Cau Dien, Hanoi	140	1992; expanded in 2002	Market and street waste	Operating. Sells three products of different quality for 800, 1200, and 2000 VND/kg.
Nam Dinh City	250	2003	Mixed municipal waste	Operating. Compost provided to farmers free of charge.
Phuc Khanh, Thai Binh	75	2001	N/A	Operating
Viet Tri City, Phu Tho Province	35.3	1998	N/A	Operating. Sells three products of different quality for 200, 250 and 900 VND/kg.
Hoc Mon, Ho Chi Minh City	240	1982; closed in 1991	Mixed municipal waste	Closed due to difficulties in selling compost
Phuc Hoa-Tan Thanh Baria-Vung Tau	30	N/A	N/A	Operating
Trang Cat, Hai Phong City	50	2004	Septage, sewers, mixed municipal waste	Trial period
Thi Phuong, Hue	159	2004	Mixed municipal waste	Operating. Sells compost for 1100 VND/kg to coffee and rubber farmers.

Source: World Bank "Vietnam Environment Monitor 2004: Solid Waste," 31

## Appendix 2: Integrated waste management method in Thailand



## Appendix 3: Figure of waste hierarchy

## The Waste Hierarchy

