

Categorization and Recycling of Solid Waste Generated by Health Care Entities in Rajshahi City Area

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Abstract

In view of the importance of energy saving as well as conservation of resources, efficient recycling of solid waste is now global concern requiring extensive research and development works towards exploring newer application and maximizing use of existing technologies for sustainable and environmentally sound management. The solid wastes can primarily be categorized based on the place of generation viz., urban, rural, and industrial solid wastes. The urban solid wastes are further classified under residential, commercial, industrial, construction activities, bio-medical treatment plant wastes based on the source of solid waste generation. The components and their percentage distribution in the solid waste stream vary in the urban and rural solid wastes. Definition of medical waste vary in different countries and institutes as well, based on different categories of waste. In general, medical waste are waste arising from, diagnosis monitoring and preventive, curative or palliative activities in field of the veterinary and human medicine (Akter 2000). According to the U.S Environmental Protection Agency (EPA) and World health Organization (WHO), definition of medical waste have a view to aid in regulating it. Given the fact that the medical waste stream is an extremely complex one including chemicals, which could be hazardous, as also normal kitchen or office waste akin to municipal solid waste. Usually, medical wastes produced by hospitals, clinics, pathological laboratories, diagnostic centers, doctors' offices, and other medical and research facilities. Recycling process is the best use of solid waste. If there have any opportunity of recycling of solid waste it should be done. Recycling helps saving water, energy and generates less contamination. It also reduces the amount of wastes to be collected, transported and disposed. Recycling can result in a more competitive economy and a cleaner environment and can contribute a more sustainable development. Recycling can provide social, economic and environmental benefits. So recycling must be needed for proper management.

Keywords

Solid waste, Recycling, Medical waste, Waste management, Medical waste Management.

1. Introduction

In view of the importance of energy saving as well as conservation of resources, efficient recycling of solid waste is now global concern requiring extensive research and development works towards exploring newer application and maximizing use of existing technologies for a sustainable and environmentally sound management (Demirbas,2010).

Solid waste is defined as any useless, unwanted, or discarded material that is not liquid or gas. Something can become waste when it is no longer useful to the landlord or it is used and fails to fulfill its purpose. Waste means unnecessary depletion of natural resources, redundant costs, environmental damage that could be avoided. The solid wastes can primarily be categorized based on the place of generation viz., urban, rural, and industrial solid wastes. The urban solid wastes are further classified under residential, commercial, industrial, construction activities, bio-medical treatment plant wastes based on the source of solid waste generation. The components and their percentage distribution in the solid waste stream vary in the urban and rural solid wastes.

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Recycling process is the best use of solid waste. If there is any opportunity of recycling of solid waste it should be done. Recycling helps save water and energy and generates less contamination. It also reduces the number of wastes to be collected, transported and disposed of. Recycling can result in a more competitive economy and a cleaner environment and can contribute to more sustainable development. Recycling can provide social, economic and environmental benefits. So recycling must be needed for proper management.

Sources of Solid Waste:

Municipal Waste:

Municipal solid waste (MSW) is the heterogeneous composition of wastes organic and inorganic, rapidly and slowly biodegradable, fresh and putrescible, hazardous and nonhazardous, generated in various sources in urban areas due to human activities. Wastes produced from different sources are the following.

Depending on the administrative boundaries, municipal waste may cover only residential and commercial non-hazardous waste, and may also include industrial and agricultural non-hazardous waste. This has to be defined based on the existing regulations and practices within the specified geographic location. Usually, the municipality - responsible for the collection and disposal of municipal waste - collects residential waste while other sectors (commercial, industrial, and agriculture), if they are allowed to dispose their waste at municipal facilities, make their own arrangements to transport their waste to the municipal disposal sites (landfill and incineration plants) and pay disposal charges. Different types of solid wastes are found from municipal services these are street sweepings, landscape and trimmings, general wastes from parks, beaches, and other recreational areas, sludge.

Residential Waste

Residential waste generated by households living either in single-family houses or multi-family buildings may contain organic waste (for example, from the kitchen and gardens such as food wastes, household hazardous wastes), recyclable waste (for example, plastics, paper, cans, cardboard, textiles, leather yard wastes wood, glass, metals ashes etc.), non-recyclable waste (that has no recycling value), and hazardous waste (batteries, some oils, etc.). Usually, the municipality is responsible for collection and disposal of such waste, thus it is treated as municipal waste. In some countries, the collection and transportation of waste from multi-family buildings could be the responsibility of the residents and in some; there are regulations on segregation at source for recyclable waste like hazardous waste has to be disposed of separately. Information on these regulations may also help to prepare a list of sub-categories of the waste for quantification and characterization of waste streams.

Commercial Waste:

In many places, non-hazardous commercial waste generated by the businesses is considered as municipal waste; however, waste generators through private sector usually arrange its collection. The local authorities may provide the details of the types of commercial wastes to be considered as municipal waste. They may also indicate the existing procedure for the segregation of recyclable waste and collection of the disposal waste from commercial sector. The

hazardous waste from commercial sector could be the sole responsibility of the generator. This information would help to list out different waste streams for quantification and characterization. Different wastes are paper, cardboard, plastics, wood, food wastes, Glass, metals, special and hazardous wastes found from stores, hotels, restaurants, markets office buildings etc.

Industrial Waste:

Industrial waste is categorized as hazardous waste and non-hazardous waste. Usually, industrial waste is not considered as municipal waste; however, in some places, non-hazardous waste is disposed of at municipal disposal facilities. In this case, the industries make arrangements for the transportation of the waste to the disposal facility and they may pay disposal charges. The municipality should clearly identify its role in industrial waste management as per the regulations and current practices. This would help towards quantification and characterization of different types of industrial wastes with respect to hazardous and non-hazardous, and municipal and non-municipal wastes. It includes housekeeping wastes, packaging food wastes, construction and demolition materials hazardous wastes, ashes, special waste found from Light and heavy manufacturing, Fabrication, construction sites, power and chemical plants etc.

Agricultural Waste:

Agricultural wastes are the wastes produced from agricultural land. Different wastes found such as spoiled food wastes, agricultural wastes, hazardous waste (e.g.. pesticides) from the fields of crops, dairies feed lots, farms etc.

Medical Waste:

The wastes which generated from hospitals and clinics are known as medical waste. These were gauge/bandage, syringe, saline bag, papers, medicine packet and rapping, food waste, urine, placenta, ampoule, sanitary pad, cotton, etc.

Hazardous Waste (industrial, healthcare and laboratory, and C&D)

Hazardous waste is generated by different sectors including industries, healthcare facilities, laboratories, construction and demolitions, sludge and urban agriculture. Some hazardous waste is also generated by residential sector; however, the data on residential hazardous waste is usually collected under municipal waste. For hazardous waste, the data could be collected based on the classification of hazardous waste which is based on the content of hazardous substances. Considering the nature and the complications in testing the waste for the presence of the hazardous substances, the data for such wastes is directly collected from the generator instead of going for the procedure of collection and analysis of the waste samples.

Radioactive Waste:

The radioactive waste generated by nuclear operation. These wastes are very harmful to the environment. The disposal of nuclear waste is very difficult and costly. Generally the nuclear wastes are buried in deep to the earth. In Bangladesh, some amount of nuclear wastes generated in nuclear research institute situated in Saver.

The solid waste management system in Bangladesh is very poor. The wastes are scattered along roads, rivers, canals and so on public area. Municipal solid wastes are generated from households, shops, offices, markets, school and others institution. The main types of solid waste generated in Bangladesh are vegetables and fruits debris, plastic, polythene, paper, glass, metals, agricultural waste, leaves, constructional waste etc. Most of the solid wastes are not collected and they rotten in the open environment and a portion of metals, plastic, paper are collected by poor people and sell them to the recyclers. The wastes which are collected manually by vans and finally disposed of a dumping point in an open space through trucks and tractors. These wastes are used for nothing. But developing country like Thailand has an improved solid waste management system and they produce effective amount of energy by using their waste and save their environment from hazard effect of waste.

The developed country like Japan has a better solid waste management system. The main types of solid waste in Japan are categorized in municipal solid waste (food wastes, plastic, leather, textile, hardboard, ashes etc.), industrial solid waste (oil and rubber resin, wood, cloth, straw, abrasive etc.), agricultural waste and residues, hazardous waste, radioactive waste, recyclable waste (metals, old television, refrigerator, computer etc.). The inhibitors use three separate color packets for collecting burnable, non-burnable and recyclable waste separately in the residential area. The government employers collect the packets regularly and sent burnable waste for producing energy and recyclable

wastes are sent to recycle industries. For industrial and commercial zones waste thrown in bins and by trucks the waste are sent to desired place.

Solid waste management is the most intractable problems of urban centers. The services absorb a considerable proportion of municipal effort, budget and workforce. Deficiencies in the management of solid wastes are very pronounced in cities and towns of developing countries. The indiscriminate disposal of solid waste in public places causes serious environmental hazards and health risk. It also reduces the land fill sites and increases the environmental pollution to dispose of the solid wastes in any open places in the respective cities. Therefore, using this waste to produce electricity can contribute considerably to resolve problems. We have taken a project for resolving this problem. This has led to considerable changes in the socio-economic status and the subsequent infrastructural requirements for their safe, healthy and comfortable living.



Figure 1. Radioactive waste collection

1.1 Objectives

1. Know the actual amount of waste generated in health care unit in Rajshahi city area.
2. Characterization of waste at different category with amount.
3. Know the health and management aspects.
4. Recycle the generated health care waste.

2. Literature Review

In the 1890s, Ham Huizenga, a Dutch immigrant, began hauling garbage at \$1.25/wagon in Chicago. In 1968, Wayne Huizenga, Dean Buntrock, and Larry Beck founded Waste Management, Inc. and began aggressively purchasing many of the smaller garbage collection services across the country, as the descendant firm of Ham Huizenga. In 1971, Waste Management went public, and by 1972, the company had made 133 acquisitions with \$82M in revenue. It had 60,000 commercial and industrial accounts and 600,000 residential customers in 19 states and the provinces of Ontario and Quebec. In the 1980s, WM acquired Service Corporation of America (SCA) to become the largest waste hauler in the country.

In 1998, in a pivotal development point, WM merged with USA Waste and moved its headquarters from Chicago to Houston. The merged companies retained the WM brand. However, that year also brought trouble for the newly expanded company, in the form of an accounting scandal.

In November 1999, turn-around CE was brought in to help Waste Management recover. The company has since implemented new technologies, safety standards, and operational practices, and is on a steady upward climb.

In 2003, the company had generated \$1 billion in free cash and was returning profits to shareholders in the form of dividends. Later on, in June 2008, Waste Management was named one of the world's most ethical companies by business magazine, Ethisphere, placing in the Environmental Services and Equipment category (Retrieved et al. 2013)

On July 14, 2008, Waste Management offered a \$34 per share bid to acquire arch-competitor Republic Services, Inc. (Rodriguez et al. 2013). On August 11, 2008, the bid was raised to \$37 per share. On August 15, 2008, Republic Services, Inc. denied Waste Management's bid for a second time. On October 13, 2008, Waste Management withdrew its bid for Republic Services, citing financial market turmoil. In January 2009, a global economic crisis forced Waste Management to aggressively reduce and restructure its corporate workforce.

On February 7, 2010, CBS debuted a new TV series called Undercover Boss after the Super Bowl. WM COO Lawrence O'Donnell III participated in this first episode and got a chance to see up close the inner workings of the company he helped run. O'Donnell left WM on July 1, 2010 (M.R.Islam et al.)

Solid waste management system exists in different cities of Bangladesh such as Dhaka, Rajshahi, Khulna, Chittagong City Corporation. They have individual management system but here we will discuss the solid waste management system in Rajshahi City and energy recovery from it.

Nasrin and Shumi (N Nasrin et al. 2003.) carried out a project of solid waste generation and energy recovery from solid waste but it do not give details indication about management system and this project do not determine the chemical composition of solid waste and techniques for producing energy recovery from solid wastes. There only calorific value of fuel was determined but there is no indication in which process it is to be determined.

Rahman and Ali (M.H.Rahman et al. 2011) had studied of solid waste management system of RCC and the potentials of energy recoveries. This thesis did not consist of proper management of solid waste. There did not propose to recycle the hazardous materials for the environment and proposed a 10.14 MW power plant to be established in RCC, but which technology is used to produce electricity from solid waste, there is no indication.

A work on solid waste management in Chittagong City Corporation for electricity generation is carried out by Hoque and Khan . Through the experiment it was found the management system and energy recovery from solid waste. But this system does not work for proper management of solid wastes because of financial resources, institutional weakness, improper selection of technology, transportation systems and disposal options, public's lack of concern towards environmental cleanliness and sanitation have made this service unsatisfactory. Wrong attitudes and perceptions of the people about sanitation issues contributed to solid waste management problems of the respective City Corporations. A 5 MW power plant has been established in Chittagong City but which technology is used to produce electricity from solid waste, there is no indication.

Overview of waste management of RCC:

Location

Rajshahi City Corporation is bounded in the west by Godagari Upazilla, east by Charghat Upazila, north by Paba Upazila and south by the Padma River. The town occupies the flat alluvial land bordering the northern bank of the river Padma. The core area of the city consists of high land having ground elevation around 18.5 m with higher grounds situated along the bank of the river Padma that gradually slope down towards the north to a minimum level of 15.2 m at the northwest corner of the city corporation area.

Area

The plan view of the City Corporation area looks like an inverted 'T', its maximum length along east west direction is about 13 km and that north south is 8 km. The total area of RCC is about 92.93 square km.

Population:

The population is about 0.75 million and population growth rate is about 1.48. There live huge amount of temporary people which may take into the count is very difficult. So characterization of solid waste is varied due to the various habitual people are gathered in RCC.

Climate and Rainfall

The annual maximum temperature is about 37.80C and minimum temperature is 11.20C. The annual rainfall is about 1862 mm. The weather here is different from other areas of the country. In summer the temperature is so high and in winter, temperature is so low. The rainfall is low comparing to other areas of the country.

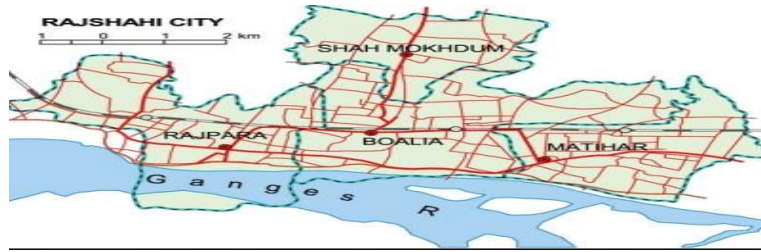


Figure 2. The map of Rajshahi City Corporation at a glance

470 metric ton waste/day is produced in RCC. The duty of the conservancy division of RCC is to dispose of and manage these wastes including the medical waste. The RCC is considered as 'Dustbin free city'. There are 30 wards in RCC. Almost all wards are covered by 'door to door waste collection' facilities. In this system the City Corporation workers go every home and collect waste by vans or trolleys and dispose of waste to secondary points. RCC is trying to provide this service to all the wards in the near future. There are one dumping site (5 feet deep in 10 acre area) and 20 secondary collection points. At present four pilot projects are running by RCC. Two of these are in ward 14, one in ward 6 (Laxmipur) and another one in ward 20, 21 and 23. Recently RCC has been involved in solid waste collection. There are hospitals, basic areas, railway station, shaheb bazaar in RCC area. Among these hospitals, railway station, shaheb bazaar is covered by RCC collection system. About 350 metric ton/day wastes are collected and disposed of in the waste disposal area. 120 metric ton/day wastes are collected by public for the purpose of producing compost in order to use in the agricultural works.

Medical Waste Disposal

Different types of waste were generated in a particular point of Rajshahi medical college and hospital from all hospitals/clinics/diagnostic centers. These were gauge/bandage, syringe, saline bag, papers, medicine packet and rapping, food waste, urine, placenta, ampoule, sanitary pad, cotton, etc. (Q. Hamidul Bari et al. 2012)

Disposal of Waste

It was found that most of the hospitals/clinics/diagnostic centers did not follow proper segregation of the waste before disposal. Few institutes, who found to segregate the waste, used two types of containers (bins, cartoons, and covered buckets). Few used yellow container for general waste and red container for hazardous waste. Those who did not segregate the waste usually dispose their waste in City Corporation's dustbin, open field or buried in an open place. In few cases, the hospital/clinics burn their waste by their own initiatives in open places. In some cases, RCC collected the un-segregated medical waste in a separate van.

The laboratory waste like syringe, needle, bandage and discarded samples are disposed off indiscriminately. In all cases, liquid waste and discarded samples from pathological laboratory were poured in basin or drain.

Transportation and Final Dumping Site of the Waste:

Usually RCC sweepers take the waste by truck or RCC's special small rickshaw van collect medical wastes from few hospitals/clinics. All medical wastes collected by RCC are sent to an incinerator for burning in RMC area. It was noted that RCC did not operate the incinerator every day to burn medical wastes. However, in some cases hospitals/clinics managed medical waste by themselves, such as buried, burning, and dumping in open space or field, and so on.

3. Methodology

Selection Of Study Area

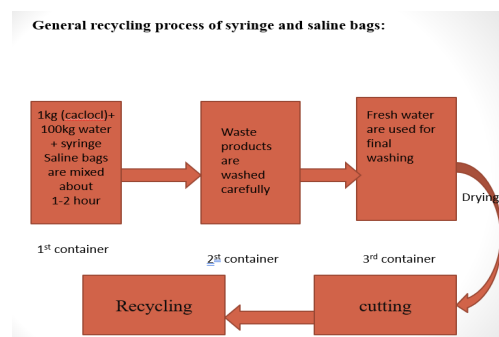
Rajshahi is the 4th largest city in Bangladesh. The area of Rajshahi city corporation is 96.72 square kilometers and divided into 30 wards. According to the census in 2009, the population in Rajshahi was 775,500 (BBS). According to RCC report there are 8 hospitals, 47 clinics, and 22 diagnostic centers at RCC (based on RCC report).

Around 0.775 million people live in the RCC area of 96.72 square kilometers. They produce 300 metric ton waste per day. The duty of the conservancy division of RCC is to dispose of and manage these wastes including the medical waste. The RCC is considered as "Dustbin free city". There are 30 wards in RCC.

Recently RCC has been involved in medical waste collection .Usually the medical waste collected daily is disposed off in the Rajshahi Medical college Hospital incinerator. Medical wastes are burnt out once a week.

Questionnaire survey

Data will be collected through semi-structured questionnaire. Basic information on hospitals/clinics and diagnostic centers e.g. type and services of hospitals, staff categories and patient type, management practices; knowledge on medical waste, reuse/recycle of waste; quantity of waste generated; health and environmental consequences; training needs, etc. will be included (Figure 3 (a) and 3 (b)).



Year	General	Infectious	Sharp	Recycli ng
2001	71	20	3	3
2004	79	13	2	6
2014	75	15	2	8

Figure 3 (a). General recycling process of syringe and saline bags Figure 3 (b). % comparison of medical waste in RCC

3.1 Data Collection

Field observations will be done through a checklist. The checklist included the inside and outside environment of the hospitals/clinics, the type of disposal bins used in the hospitals/clinics, transportation, collection, and disposal, etc.

Two discussion meetings, several orientation workshops with hospital staff, and in-depth interview with the hospital authority, owners association, and City Corporation officials will be also conducted during the baseline survey.

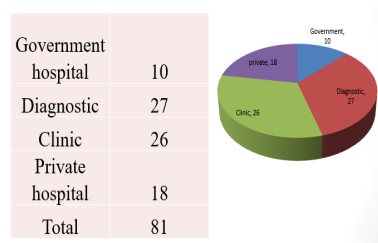


Figure 4. No of Hospital in RCC

Hospital/clinic/ diagnostic	Doctor/Admini stration	Nurse	Cleaners and aya	patients
RMCH	450	600	250	1000-1200
Royal hospital	10	12	50	20-30
Mukti clinic			80	25-30
islami hospital	12	30	20	50-70
All others health care units	1-10	5-20	5-50	10-30

Figure 5. Health Care Unit

Separate Hazards And Non Hazards

After collecting the data separation will be done including two groups .One is hazards and another is non hazards.

Recycle of Waste

Finally recycling will be done . Different method of recycling the generated waste will be applied. The type of recycling product will be studied (Table 1, 2, 3 and 4).

Main recycling products are:

- 1.Plastic: Daily 900-1200 saline bags and 2000-2500 syringe are used.
- 2.Glass
- 3.Paper

Table 1. Tentative plan schedule

	Time Work steps	Cycle
1	Questionnaire Survey	1 st - 5 th
2	Data collection	6 th - 8 th
3	Recycle	9 th – 12 th
4	Final report and publication	After examination

Table 2. Data for clinic per day in kg

Name of i	General w	Infectious	Sharp was	Recycling	Total
Dolphin c	8	2	0.7	1.5	12.2
Mukti clin	9	3	0.8	2	14.8
Mohanago	5	1.5	0.3	1	7.8
Padda clir	4	1.5	0.5	0.7	6.7
Micropath	7	3	0.7	2	12.7
Care narsi	4	1.7	0.5	0.7	6.9
Sarmin na	5	1.5	0.7	0.8	8
Al arafa n	4	1	0.5	0.8	6.3
jamuna cli	2.5	0.6	0.2	0.4	3.7
Janata clir	2.5	0.6	0.2	0.4	3.7
The ekta c	5	2.5	0.5	1	9
Doctors cl	2.5	0.7	0.1	0.4	3.7
Amana cli	5	1.5	0.4	1	7.9
Rafa narsi	3	0.7	0.3	0.7	4.7
Al modina	2	0.5	0.1	0.3	2.9
urban prin	5	1	0.15	0.7	6.85
Mataniti c	3	0.7	0.15	0.7	4.55
total	76.5	24	6.8	15.1	122.4

Table 3. Data for hospital per day in kg

Name	General	Infectious	Sharp	Recycling	Total
RMC	800	180	7	90	1077
T.B.hosp	25	1	1	1	28
City hosp	5	1.5	0.2	0.5	7.2
Mission h	15	2	0.5	1	18.5
Noudapar	120	7	2	3	132
Laxmipur	100	5	1.5	4	110.5
Jomjom is	15	2	0.7	1.5	19.2
Motherlai	6	1.5	0.5	1.7	9.7
Child hos	5	0.5	0.2	0.5	6.2
Uttarbang	1.5	0.7	0.15	0.5	2.85
Bridge ho	1.5	0.7	0.15	0.5	2.85
Modern h	1	0.5	0.2	0.3	2
CDM hos	6	1.5	0.4	1	8.9
Royal hos	8	2	0.7	1.5	12.2
Kaosar m	4	0.7	0.1	0.4	5.2
Fatema g	4	0.7	0.1	0.4	5.2
Sadia hos	1	0.2	0.5	1	2.7
Ibnesina l	1	0.2	0.5	0.1	1.8
Human ho	2	0.5	0.3	0.7	3.5
Rajshahi	7	2	0.5	2	11.5
Total	1128	210.2	17.2	111.6	1467

Table 4. Data for diagnostic center per day in kg

Name	General	Infectious	Sharp	Recycling	total
Popular di	4	1	0.5	0.5	6
Green dia	1	0.5	0.1	0.2	1.8
Medipath	2	0.6	0.16	0.3	3.06
Life sine	1	0.1	0.5	0.2	1.8
Laser diag	1	0.15	0.7	0.3	2.15
Holy path	5	0.15	0.3	0.6	6.05
Mettro dia	1	0.2	0.25	0.2	1.65
Nima Fate	1	0.2	0.3	0.3	1.8
The path c	2	0.25	0.25	0.3	2.8
Seba diag	1	0.2	0.3	0.3	1.8
Holy crice	1	0.2	0.3	0.3	1.8
Plasma dia	1	0.2	0.3	0.3	1.8
Shapla dia	1.5	0.3	0.4	0.3	2.5
Desh diag	1.5	0.25	0.5	0.4	2.65
City diago	2	0.5	0.75	0.3	3.55
Jilia medic	1.5	0.4	0.7	0.3	2.9
Raj pathol	0.5	0.2	0.2	0.2	1.1
Boishakhi	0.5	0.2	0.2	0.1	1
Total	28.5	5.6	6.71	5.4	46.21

5. Results and Discussion

They only separate syringe and saline bag.

1. Only RMC burn syringe in their incinator.
2. Only RMC use separate bin.
- 4.Saline bags, Syringes are sold.
- 5.Every day three van carry medical waste from different health care units.

6. Conclusion

The solid waste management system in Bangladesh is very poor. The wastes are scattered along roads, rivers, canals and so on public area. Municipal solid wastes are generated from households, shops, offices, markets, school and others institution. The main types of solid waste generated in Bangladesh are vegetables and fruits debris, plastic, polythene, paper, glass, metals, agricultural waste, leaves, constructional waste etc. Most of the solid wastes are not collected and they rotten in the open environment and a portion of metals, plastic, paper are collected by poor people and sell them to the recyclers. The wastes which are collected manually by vans and finally disposed of a dumping point in an open space through trucks and tractors. These wastes are used for nothing. But developing country like Thailand has an improved solid waste management system and they produce effective amount of energy by using their waste and save their environment from hazard effect of waste.

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