

Municipal Solid Waste Management in Vietnam Challenges and Solutions

Nguyen Thi Kim Thai

1 Introduction

Vietnam is located in the Center of South-East Asia. The national capital which is Hanoi City has a total land area of 329,560 km²; a coast line of 3,260 km and Mainland border of 3,730 km (Fig. 1).

Vietnam is developing rapidly and undergoing urbanization. According to the Vietnamese Governmental Decree No. 42/2009/ND-CP dated May 7th 2009 titled Classification and Management of Urban Towns, six categories of urban towns were classified based on the function, population, and population density of the towns. There were **762** urban towns up to the year 2005, of these 2 cities are of the special class; 5 Cities are first class; 13 cities are in the second category; 21 are in the third category; 54 are in the fourth category, and 586 are in the fifth category, according to the classification criteria for urban towns in Vietnam. The GDP per capita is \$2,600 and GDP real growth rate 8.5 % (Vietnam Statistical Year Book 2012).

Up to the year 2009, according to the General Survey on Population and Housing in Vietnam, the total population of this country was 85789000 with a average population growth rate of 1.3–1.7 % and the urban inhabitants made up to 28 % of the total population of the whole country.

Presently the solid waste generation is assessed to be more than 15 million tons per year with approximately 80 % from municipal sources, 17 % from industrial sources and the remaining 3 % from other sources. By year 2010 the expected solid waste generation is 24 million tons per year, with a likelihood of reaching 52 million tons by year 2020.

As a part of SWAPI book on Municipal Solid Waste Management in Asia and the Pacific Islands-2012, this chapter presents a comprehensive set of data and analysis of Municipal Urban Solid Waste over the last 5 years in Vietnam. The analysis consists of:

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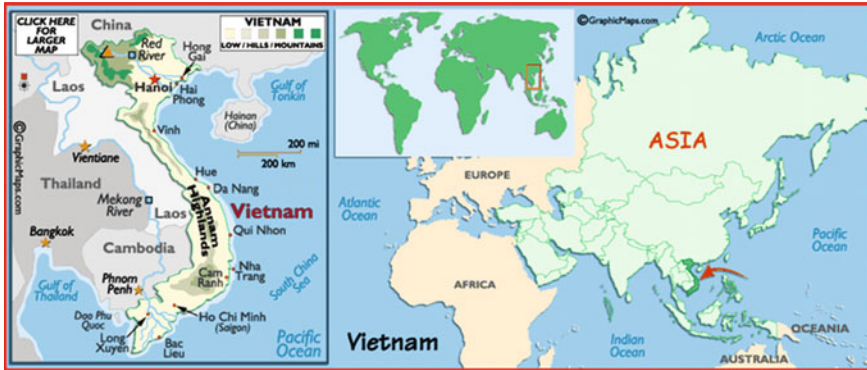


Fig. 1 Location of Vietnam in the Asia Pacific region

- Waste generation (quantity, composition and distribution)
- Waste handling (collection and disposal)
- Waste recycling, composting, and reuse
- Environmental and social concerns (environmental impacts, perception, priorities, cost contribution, public campaigns)
- Landfills (technical and management issues, ecological impacts, costs)

2 Definitions of Waste

According to the Vietnamese Law on Environmental Protection:

- Wastes mean materials that take a solid, liquid, gaseous, or other form, which are discharged from production, service, daily life or other activities.

Under the Law, the Decree No 59/2007/ND-CP on Solid Waste Management issued by the Government, the following definitions are provided:

- Solid Waste means waste in a solid form, discharged from production, business, service, daily life or other activities. Solid waste includes ordinary solid waste and hazardous solid waste. Solid Waste generated in daily-life activities of individuals, households or at public places is collectively referred to as daily-life solid waste. Solid waste generated in industrial production, craft villages, business and service activities or other activities is collectively referred to as industrial solid waste.
- Hazardous Solid Waste means solid waste containing substances or compounds that exhibit any of the characteristics of radioactivity, ignitability, explosiveness, corrosiveness, infectiousness, toxicity or other hazardous characteristics.

There is no specific definition for Municipal Solid Waste (MSW) in Vietnam.

3 Waste Classification

According to the Vietnamese Standard (TCVN 6705-2009- Non hazardous solid wastes -Classification), solid wastes are classified as follows:

- Domestic solid waste: including the solid wastes generated from house holds, commercial, and services activities;
- Construction and Demolition Solid Wastes: The wastes arising from construction/demolition activities.
- Industrial Solid Waste: The wastes arising from processing and non-processing industries and utilities.

4 Sources of Wastes

Most municipal solid waste in Vietnam comes from households and businesses. According to the report by IESE (2010), the solid waste generated from households, shops, offices, institutions, hotels and restaurants was more than 65 % of the total municipal waste generation while the industrial solid waste accounted for about 15 %; construction and demolition waste was 12.20 %, and medical waste was 1.8 % depends on the different economic regions. Table 1 shows the volume of domestic solid waste generated in six economic areas in Vietnam in 2008.

5 Waste Generation and Composition

Waste generation quantities and characteristics are strongly related to regional economic conditions, and change with economic growth. Other socio-economic factors that affect waste generation include:

Table 1 The volume of domestic solid waste generated in six economic areas in Vietnam in 2008

| No | Region | Volume (tons/day) |
|----|--|-------------------|
| 1 | Northern midland and mountainous region | 1,053 |
| 2 | Red River Delta and Northern key economic zone | 4,953 |
| 3 | North Central Region, Central coastal region and Central key economic zone | 3,110 |
| 4 | Central highlands | 919 |
| 5 | Southeast region and the southern key economic zone | 9,314 |
| 6 | Mekong River Delta | 2,195 |
| | Total | 21,543 |

Source National strategy for integrated management of solid waste to 2025 with a vision to 2050 issued attached to decision no. 2149/QĐ-TTg on December 17, 2009

- Housing development plans
- Rural/urban drift
- Road construction programs
- Improvement programs for marginal settlements

Socio-economic conditions that enable an increase in standards of living of the regional economy will influence the per capita rate of waste generation and the composition of waste generated. Per capita waste generation levels generally increase, in correlation to improvement in the standard of living. According to the data reported by provinces, the average daily generation rates in kg/person/day range from 0.8 to 1.2 kg/person-day in big cities and from 0.35 to 0.5 kg/person-day in small towns. The generation rates depend on the living conditions of the residents in urban areas, category of urban areas, the topography and the socio-economic development in each province. The increase in quantity of solid waste generation in Vietnam is shown in Table 2.

Composition of municipal solid waste is very diverse and is characterized by the (living customs, civilization level, and development rates). Generally there are some common characteristics as follows:

- Composition of organic origin accounts for a high rate (50–66 %);
- Containing a lot of soil, sand and fragment of brick, stone.
- High moisture content, low specific heat energy (900 kcal/Kg).

The composition of urban solid waste in several provinces is shown in Table 3. The data in Table 3 is based on average figures from the analysis of the composition of solid waste in different places such as in residential areas, in markets and at the landfill sites.

The figures in the Table 3 show that the percentage of recyclable materials and hazardous waste component are different between big cities and small cities in Vietnam.

Industrial Solid Waste: Together with urbanization there was a rapid growth in establishing industrial zones. According to State of Environment Report (SOE) by the end of 2009, Vietnam had 249 industrial zones covering an area of 63,173 ha, their occupancy rate was 48 %. The development of industrial areas has generated a large quantity of solid waste, especial hazardous wastes. Recent inventory of hazardous waste in the country indicates that the main industrial sectors that generated hazardous wastes are:

Table 2 Increasing of quantity of solid waste generation in Vietnam

| Type of solid waste | Unit | 2003 | 2008 |
|---------------------------|-----------|-----------|------------|
| Municipal solid waste | Tons/year | 6,400,000 | 12,802,000 |
| Industrial solid waste | Tons/year | 2,638,400 | 4,786,000 |
| Medical solid waste | Tons/year | 21,500 | 179,000 |
| Rural solid waste | Tons/year | 6,400,000 | 9,078,000 |
| Craft village solid waste | Tons/year | 774,000 | 1,023,000 |

Source Annual Report on Environment- MONRE (2011)

Table 3 Average composition of solid waste in typical urban cities in Vietnam (% By weight)

| No | Composition | Hanoi ^a | Da nang ^b | Hue ^c | Pleiku ^d |
|-------|----------------------------------|--------------------|----------------------|------------------|---------------------|
| 1 | Organic substances | 53.80 | 66.0 | 55.0 | 60.49 |
| 2 | Plastic | 3.42 | 4.0 | 5.2 | 12.77 |
| 3 | Paper, carton | 4.2 | 3.1 | 4.4 | 9.65 |
| 4 | Metal | 1.4 | 4.9 | 7.0 | 1.16 |
| 5 | Glass | 1.0 | 0.9 | 1.8 | 0.13 |
| 6 | Inert substances | 28.18 | 16.4 | 23.0 | 12.6 |
| 7 | Rubber | 4.9 | 1.6 | 1.5 | 2.8 |
| 8 | Textile rags | 1.7 | 2.3 | 3.0 | 0 |
| 9 | Hazardous substances | 1.4 | 0.8 | 0.8 | 0.4 |
| Total | | 100 | 100 | 100 | 100 |
| | Moisture content (%) | 43.04 | 51.2 | 50.0 | 50.5 |
| | Ash content (%) | 13.70 | 16.0 | 15.5 | 13.9 |
| | Bulk density, tom/m ³ | 0.41 | 0.40 | 0.40 | 0.38 |
| | Recyclable materials | 16.62 | 16.80 | 22.90 | 26.51 |

Source Monitoring report by IESE (2009), Note ^a special category city, ^b first category city, ^c second category city, ^d third category city

- Electrical mechanics
- Food processing
- Chemicals;
- Mechanical
- Metallurgy

The average quantity of Hazardous wastes generated by major industries in 33 provinces in Vietnam is shown in Table 4.

According to the National Environmental Status Report by the Ministry of Natural Resources and Environment (MONRE) (2011), the industrial solid waste generation from several cities is shown in Table 4.

Compositions of the industrial solid waste are very complicated, depending on the raw materials, technological processes and final products of each production center and its related services.

Typical components of industrial hazardous waste in Dong Nai Province –one of the Southern economic regions is illustrated in Fig. 2. A summary of a survey on components of industrial hazardous waste in Vietnam is shown in Table 5.

Medical waste: The major sources which generate the medical solid waste are hospitals. According to the report from MOH in 2009, total solid waste generated from hospitals were 100–140 tones/day of which 16–30 tones/days were hazardous. Waste generation rate are varied according to the activities of departments in the hospitals (Table 6).

There have been limited studies on the composition of medical waste in Vietnam. Under the task given by the Ministry of Natural Resource and Environment (MONRE), the Centre for Environmental Engineering of Towns and Industrial Areas (new name is Institute for Environmental Science and

Table 4 The average quantity of industrial solid wastes generated in some cities of Vietnam in 2010

| Type of category | Province/city | Normal industrial solid waste (tones/day) | Hazardous industrial solid waste (tones/day) |
|---|-----------------------|---|--|
| Special category city | Ho Chi Minh city | 4606.12 | 4606.12 |
| First category city (Belonging to the Central Government) | Da Nang | 553.79 | 83.07 |
| | Can Tho | 136.25 | 27.25 |
| | Ha noi | 254.7 | 67.42 |
| | Dak Lak/Buon Ma Thuot | 63.08 | 9.46 |
| First category city (Belonging to the Provincial Government) | Khanh Hoa/Nha Trang | 1767.19 | 441.80 |
| | Lam Dong/Da Lat | 70.48 | 10.57 |
| | Binh Dinh/Quy Nhon | 810.19 | 121.53 |
| | Dong Nai | 990.07 | 990.07 |
| Second category city (Belonging to the Provincial Government) | Tien Giang | 249.20 | 62.30 |
| | Ca Mau | 93.80 | 9.10 |
| | An Giang | 120.33 | 11.31 |
| | Binh Thuan | 464.78 | 102.25 |
| | Gia Lai | 189.75 | 18.98 |
| | Ba Ria-Vung Tau | 274.01 | 274.01 |
| | Bac Lieu | 29.02 | 2.96 |
| Third category city (Belonging to the Provincial Government) | Ben Tre | 120.29 | 24.18 |
| | Dong Thap | 512.03 | 76.80 |
| | Ninh Thuan | 116.80 | 17.52 |
| | Kon Tum | 39.67 | 2.1 |
| | Kien Giang | 34.26 | 6.85 |
| | Quang Ngai | 455.18 | 159.31 |
| | Soc Trang | 172.10 | 30.98 |
| | Quang nam | 433.00 | 82.27 |
| | Long An | 110.45 | 22.09 |
| | Binh Duong | 830.38 | 830.38 |
| | Tra Vinh | 248.00 | 37.20 |
| Phu Yen | 194.80 | 37.01 | |
| Hau Giang | 160.05 | 16.01 | |
| Vinh Long | 177.33 | 25.00 | |

Source Annual Report on Environment- MONRE (2011)

Engineering—IIESE) has conducted a survey on medical waste composition in some hospital in Vietnam. Table 7 shows the composition of waste in some hospitals in Vietnam. The data shows that the hazardous portion from medical waste varies according to the type of the hospital.

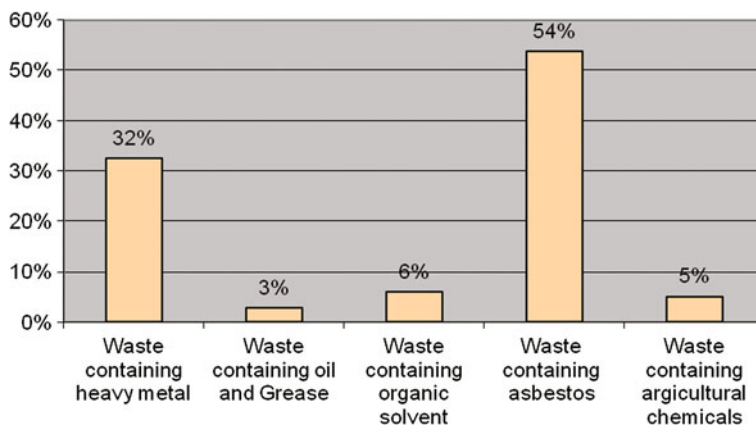


Fig. 2 Typical components of industrial hazardous waste in Dong Nai Province. *Source* Institute of Environmental Science and Engineering (2008)

The hazardous medical waste is estimated to be in a wide range (0.11–0.16 kg per bed per day from a total waste arising of 0.7–0.73 kg/bed/day) and makes up about 20–26 % of the total solid waste generated from hospital activities.

Special Hazardous Wastes: It is mentioned that together with normal hazardous waste, several specific hazardous wastes which belong to Persistent Organic Pollutants (POPs) such as used solvent, E-wastes; PCB containing from industrial activities wastes are being paid special attention to by the Vietnamese Government. These types of waste are potentials for recycling activities due to the fact that they are partly valuable waste.

In Vietnam, PCBs have not previously been considered as chemicals which need to be fully controlled, thus data and assessment of PCBs are insufficient and unsystematic. Sources of PCB releases into the environment are mainly from uncontrolled discarded waste oils from transformers or capacitors. An initial inventory conducted by Energy of Vietnam (EVN) shows that the total quantity of likely PCB-containing oils in Vietnam is approximately 73,600 liters in the form of isolating fluid and 5,297,000 kg in (old transformers and capacitors). The amount of oil suspected of containing PCBs account for 19 % compared to the total amount of oil in the transformers.

E-waste contains a number of toxic substances such as lead and cadmium in circuit boards; lead oxide and cadmium in monitor cathode ray tubes (CRTs); mercury in switches and flat screen monitors; cadmium in computer batteries; polychlorinated biphenyls (PCBs) in older capacitors and transformers; and brominated flame retardants on printed circuit boards, plastic casings, cables and polyvinyl chloride (PVC) cable insulation that release highly toxic dioxins and furans when burned to retrieve copper from the wires (Source: Vietnam National Implementation Plan for Stockholm Convention on Persistent Organic Pollutants toward 2020- MONRE 2006). Due to the hazards involved, disposing and

Table 5 The components of industrial hazardous waste in Vietnam

| No | Industrial sector | Ratio hazardous waste (HW)/Generated waste (GW) (%) |
|----|--|--|
| 1 | Mechanical industries | 47.4 % where: <ul style="list-style-type: none"> • 12.5 % Corrosive • 28.1 % Toxic • 6.3 % Combustible • 0.7 % Mixed |
| 2 | Electric, electronic industries | 76.8 % where: <ul style="list-style-type: none"> • 0.8 % Corrosive • 60.4 % Toxic • 12.8 % Combustible • 2.0 % Mixed |
| 3 | Chemical industries | 69.3 % where: <ul style="list-style-type: none"> • 18.2 % Corrosive • 43.8 % Toxic • 4.5 % Combustible • 2.8 % Oxidized |
| 4 | Food processing industries | 23.6 % where: <ul style="list-style-type: none"> • 0.5 % Corrosive • 5.3 % Combustible • 17.5 % Bio-degradation • 0.3 % Mixed |
| 5 | Textile, leather and dyeing industries | 46.5 % where: <ul style="list-style-type: none"> • 25.3 % Toxic • 4.9 % Combustible • 15.8 % Bio-degradable • 0.5 % Mixed |
| 6 | Metallurgy | 42.8 % where: <ul style="list-style-type: none"> • 14.2 % Corrosive • 26.5 % Toxic • 0.5 % Combustible • 1.6 % Mixed |
| 7 | Construction materials | 23.5 % where: <ul style="list-style-type: none"> • 1.2 % Corrosive • 18.4 % Toxic • 3.5 % Combustible • 0.4 % Mixed |

Source Vietnam Environmental Protection Agency (2006) Vietnam National implementation plan for the Stockholm convention on persistent organic pollutants toward 2020

recycling E-waste has serious legal and environmental implications. When this waste is land filled or incinerated, it poses significant contamination problems. Likewise, the recycling of computers has serious occupational and environmental implications, particularly when the recycling industry is often marginally profitable at best and often cannot afford to take the necessary precautions to protect the environment and worker health.

Table 6 The waste generation rate of the different generation sources in hospitals of Vietnam

| Generation sources | Waste generation Rate (kg/bed-day) | | | | Hazardous waste generation rate (kg/bed-day) | | | |
|---------------------|------------------------------------|-----------------------------|-------------------|---------|--|-----------------------------|-------------------|---------|
| | Central hospital | Provincial general hospital | District hospital | Average | Central hospitals | Provincial general hospital | District hospital | Average |
| Hospital emergency | 0.97 | 0.88 | 0.73 | 0.86 | 0.16 | 0.14 | 0.11 | 0.14 |
| Care Dept. | 1.08 | 1.27 | 1 | | 0.3 | 0.31 | 0.18 | |
| Incretology Dept. | 0.64 | 0.47 | 0.45 | | 0.04 | 0.03 | 0.02 | |
| Pediatric Dept. | 0.5 | 0.41 | 0.45 | | 0.04 | 0.05 | 0.02 | |
| Surgery Dept. | 1.01 | 0.87 | 0.73 | | 0.26 | 0.21 | 0.17 | |
| Obstetric Dept. | 0.82 | 0.95 | 0.74 | | 0.21 | 0.22 | 0.17 | |
| Ophthalmology Dept. | 0.66 | 0.68 | 0.34 | | 0.12 | 0.1 | 0.08 | |
| Paraclinical Dept. | 0.11 | 0.1 | 0.08 | | 0.03 | 0.03 | 0.03 | |

Source Ministry of Health (2009)

Table 7 The composition of medical waste in some hospitals in Vietnam

| Composition of solid waste | Type of hospital | | |
|----------------------------|------------------|------------------------|---------------------|
| | General hospital | Skin disease hospitals | Maternity hospitals |
| Organic waste | 42.5 | 45.0 | 41.5 |
| Package paper | 21.6 | 3.4 | 8.8 |
| Sharps, injection | 2.98 | 3.0 | 2.5 |
| Package paper | 7.48 | 8.0 | 4.7 |
| Organes | 5.39 | 0.5 | 1.6 |
| Plastics | 4.70 | 5.6 | 2.2 |
| Metal | 2.40 | 0.6 | 1.5 |
| Glass | 1.79 | 2.63 | 2.0 |
| Expired medicines | 0.60 | 0.1 | 1.0 |
| Others | 10.56 | 31.17 | 34.2 |
| Hazardous waste (%) | 18.86 | 16.78 | 14.00 |
| Non-hazardous waste (%) | 81.14 | 83.22 | 86.00 |

Source Nguyen thi Kim Thai- CEETIA (2007)

The status of solid waste separation at source: In most urban areas, solid waste has not been sorted at its source. Only a few households sort solid waste in order to sell certain waste such as bottles, jars, metal and paper to scrap collectors. In recent years, pilot solid waste sorting was implemented in some big cities as Hanoi, Da Nang and Ho Chi Minh City. However, these efforts were generally not successful for several reasons including the lack of community awareness and the lack of treatment facilities to process separated solid waste, which makes sorting at

the source meaningless as all solid waste ultimately buried in landfills. Currently, urban domestic solid waste is also being sorted by waste collectors at its generation sites, waste gathering sites or at landfills.

6 Collection and Transportation of Municipal Solid Waste

At present, the average rate of solid waste collection is about 72 % for the whole country, of which the collection rate in urban areas is increasing from 80–82 % (2008) to 83–85 % (2010) and in rural areas about 40–45 %; the reuse and recycling rate ranges from 18 to 28 %. Wastes generated in areas outside of the current services are dumped in garden areas, by the roadside, in ditches or lakes. Wastes are also burnt in areas adjacent to properties or the roadside by residents and commercial waste generators.

Solid wastes from households are collected by handcarts or waste collection vehicles running through streets according to a planned schedule. In areas where waste collection is provided, wastes are dumped in the street without any containment and can be blown about by wind or washed into the drains and ditches of the city drainage system by rainfall, thereby contributing to littering of the city and surface water pollution, respectively.

Collection of domestic solid wastes and street sweeping are often undertaken at night. The collection time is from 10.00 p.m. to 6.00 am. So many trucks are seen on the streets carrying waste at that time, causing pollution to the environment and spoiling the appearance of the city. Reasons for this practice include avoiding working in the high daytime temperatures, a public preference for discarding wastes in the evening, and the desire to avoid times of traffic congestion. A result is that sweepers—often female and working alone—can be found working with a handcart and broom late into the night, and often in streets where there is poor street lighting, or perhaps none at all. It is common in the evening to find domestic wastes dumped on the streets. In some places handcarts are left at street corners until the evening cleaning operations and so the wastes can be put into these carts. Some wastes are discarded in small plastic bags. However, a high percentage of the wastes are simply tipped out onto pedestrian pavements or roadside curbs, where they are sorted through by waste pickers (scavengers) before being picked up by waste collection workers.

Some Vietnamese cities use an ingenious collection system that has been developed in Hanoi. The handcarts have hoppers that can be lifted from the chassis and tipped into the top of a high open body. This is a very efficient transfer system, provided that carts can rendezvous with trucks without either carts or truck having to wait for a long time. The flow of waste is shown in Fig. 3.

Socialization of Solid Waste Collection: The public or Community-Based Organizations (CBOs) are interest groups formed by the member of a local community to take charge of their interests or to influence solid waste collection activities. CBOs are very varied groupings ranging from neighborhood committees

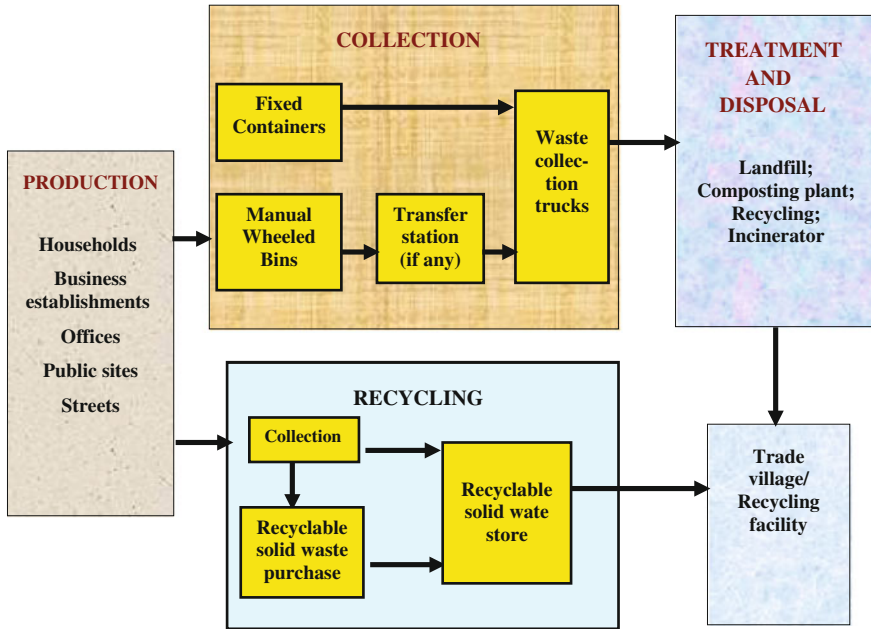


Fig. 3 The common flow of solid waste in the urban areas in Vietnam

through youth or women groups to interest groups of all possible characteristics. In a waste collection system, CBOs can be valuable partners in service provision, and they can directly participate in primary collection of domestic waste.

The participation in secondary collection, transport and final disposal of waste is usually beyond the scope of community groups, but possible on rare occasions in actively participating in solid waste management such as enhanced primary collection systems, source separation, litter prevention or domestic hazardous waste prevention.

At present, it appears that under the changes, in Vietnam the primary responsibility for street cleaning and waste collection will pass from URENCO to the Urban Wards. The Urban Wards will be responsible for employing workers in Cooperatives (It is estimated that each Ward will require between 10 and 15 workers) to clean the streets and take the collected wastes to the waste collection Points. The wastes at the waste collection Points will be picked up and transported to the landfill disposal facilities at the Landfill by Urgency’s refuse collection vehicles.

In Phu Yen Province, a Program of Work named “Collection of Domestic Waste from Urban Wards in Toy Hoax Town” has been approved by the Town People’s Committee (TPC). This Program has been on since April 2002 up to the present. By this Program, Ward People Committees organized “Collection Units” to conduct primary collection from households to the transfer/collection points. The location of transfer points also have been approved by TPC with notice at each

place so that the collection worker can temporarily dispose waste for further collection by vehicles/trucks of the town's collection enterprise.

Because of many narrow alleys in the town, the "tricycles" with a capacity of app. 1 m³ are used for primary collection and this model is quite efficient the primary collection in the urban wards.

Private companies and cooperatives are becoming more active in community solid waste management in urban areas of the whole country. There is one city on the northern border of Vietnam—Lang Son—where a private company has a monopoly in waste collection and disposal and has replaced the Urban Environment Company (URENCO) as the operator. In Buon Ma Thuot in the Central Highlands, a private company is collecting municipal waste along with the local URENCO.

Beside the waste collection service provided by URENCO in the City, solid waste is collected by local sanitation cooperatives. According to URENCO, this waste is normally dumped in the collection area of URENCO. It is needed to overcome "NIMBY" (Not in My Back Yard), which is likely to dominate and needs to be handled very delicately.

7 Treatment and Disposal of Municipal Solid Waste

In Vietnamese urban centers, solid waste is generally disposed of in landfills. Almost every urban center of category IV or higher has at least one landfill. According to provincial statistics, there are about 450 landfills in Vietnam, 80–85 % of which are not sanitary and pose a risk of environmental pollution by odor and/or leachate (*Source: Technical Infrastructure Administration—Ministry of Construction*). In addition to landfilling, Vietnam also applies incineration, composting and recycling technologies; products of recycling are construction material and construction by-products.

Incineration Technologies: Municipal solid waste of Vietnam is usually of high humidity and low calories (900–1,100 kcal/kg), therefore incinerating waste is not a common practice in Vietnam. This technology is applied for treatment of hazardous waste; a few hospitals in the country have incinerators. Very little data is available on the amount or type of waste being incinerated because they do not keep records. Whatever the case, even though the incinerators are assessed by the government for technical standards and gas emissions, Vietnam lacks the technology to be able to analyze dioxin concentrations emitted by the incinerators (Ministry of Health 2008).

Recently, a number of incinerators and other treatment facilities have been applied for treatment of hazardous wastes from hospitals and industries before dumping them with domestic waste at the landfill. The type and quantity of incinerators which are applied in Vietnam are shown in Table 8.

It was estimated by MOH that only 37 % of total health care wastes were treated by incinerators and the remains were treated in improper ways.

Table 8 The type and quantity of incinerators which have been applied in Vietnam (up to the year 2008)

| Type of incinerators | Capacity of incinerator (kg/day) | Quantity | Percentage (%) |
|-----------------------------|----------------------------------|----------|----------------|
| Very small size incinerator | <100 | 7 | 3.6 |
| Small size incinerator | 100–399 | 159 | 80.7 |
| Medium-size incinerator | 400–999 | 29 | 14.7 |
| Large-size incinerator | ≥1000 | 2 | 1.0 |
| Total | | 197 | 100 |

Source Ministry of Health (2008)

In 2003 under a research project funded by MONRE, Centre for Environmental Engineering of Towns and Industrial Areas (CEETIA) in cooperation with Hanoi URENCO produced a pilot scale incinerator to treat industrial hazardous waste for Hanoi City. The capacity of this incinerator was 150 kg/h.

Composting: Composting is potentially a very useful form of recycling of organic waste to produce a clean soil conditioner, and can help to increase the recovery rate of recyclable materials. This can contribute to a more efficient municipal solid waste system, but it is not yet widespread for a number of reasons, including inadequate attention to the biological process requirements; poor feed stock and poor quality of the fertilizers; and, poor marketing experiences. To support composting, the development of a strong market for intensive agriculture is needed (Table 9).

Centralized composting facilities are large-scale waste management plants that draw on an urban area for their organic waste supply. Several of these facilities are currently operating in Vietnam (Table 9). The compost produced at these plants often contains broken bits of glass and metals, and is therefore difficult to sell it.

Since centralized composting plants in other Asian countries have failed when relying on mixed municipal waste as their main feedstock, 12 source separation initiatives are being tested in Vietnam. In Hanoi, for example, wastes from markets or separated household wastes from test areas are being used as clean sources of organic matter. In addition, without successful composting, efforts to expand or sustain source separation will be less effective, although it can still be targeted to recyclable materials and general awareness purposes. The lessons learned from the existing Composting plants in Vietnam can be described as follows:

- The demand and market for the compost products are not carefully conducted,
- The operational practices of the plant are not suitable. Dry waste feeding is manually carried out without a regulator and the area is narrow. As a result, the loading capacity is unstable;
- Separation is still done completely manually. Fine fraction of particles, glass and metal are not well sorted. Hence, the materials projected for fermentation is not high in purity. It means a waste in transportation cost and the recovery of materials is not satisfactory.

Table 9 The Information from some typical composting plants for treatment of organic waste in Vietnam

| Name of composting plant/city | Trang Cat Hai Phong city | Cau Dien Hanoi city | Thuy Phuong Hue city |
|---|--|--|--|
| Treatment capacity (tones of waste/day) | 150 | 140 | 200 |
| Technology | Imported from Korea Forced air supply | Imported from Spain Forced air supply | Domestic technology Tam Sinh Nghia Forced air supply |
| Year of Operation | 2009 | 1992 | 2006 |
| Production (tones of compost/day) | 30 | 40 | 50 |
| Average price (VND/tonne of compost) | 600,000 | 750,000 | 500,000 |

Source Institute for Urban Environment and Industry of Vietnam (INEV) (2011)

- The composting of organic solid waste can be an appropriate technology in Vietnam only if it can be done in an affordable manner. The affordability is based on: market requirements; quality of compost products and acceptable prices to meet the ability of the farmers.

Disposal of municipal solid waste: Disposal has, until recently, generally involved uncontrolled open dumping. The use of un-hygienic landfills for dumping of municipal solid waste is normal in most urban areas in Vietnam. Up to the year 2007, there was only 19/85 from 66 Provinces having landfills that meet the national sanitary standards. The lack of facilities and responsible entities to treat and dispose many types of waste including hazardous waste has caused serious pollution to the environment and affected public health. The landfills in all localities including major cities which have already been built do not reach sanitary standards and are not planned to match the rapid development of industrialization and urbanization. The summarized current situation of landfill management in Vietnam is shown in Table 10.

The existing landfill sites are not controlled for hazardous waste, stinking smells and leachate which are a potential source of pollution of land, water and the environment. In addition, landfill sites of urban areas in the Mekong Delta still encounter flooding in the rainy season which leads to unexpected negative impacts on the environment. The key issues of dumping sites in Vietnam are shown in Table 11.

Table 10 Summarized current situation of landfill management in Vietnam

| Situation | Number of landfills |
|--|---------------------|
| Landfill sites in the whole country of which: | 85 |
| Landfill sites with total area more than 50 ha | 06 |
| Landfill sites with total area from 30 to 50 ha | 08 |
| Landfill sites with total area from 10 ha to less than 30 ha | 18 |
| Landfill sites with total area from 1 ha to less than 10 ha | 53 |
| Solid waste disposal sites for residues of composting | 08 |
| Separated sites for construction waste | 02 |
| Open dumps and poorly operated landfills | 56 |
| Engineering designed but unsanitary operated landfills | 19 |

Source IESE (2009)

Table 11 Key Issues of dumping sites in Vietnam

| Cause | Effects |
|---|--|
| Accepting all kind of wastes | <ul style="list-style-type: none"> • Hazardous wastes get mixed and cause Environmental contamination |
| Poor landfill sitting 100–150 m from the nearest residents | <ul style="list-style-type: none"> • Odor, irritating dust, noise from refuse vehicles, especially at night, risk to public health. |
| Municipal and industrial waste, sludge hospital and hazardous waste are dumped in excavated pits, without any impermeable layer or liner. | <ul style="list-style-type: none"> • Serious risk of contamination of the upper aquifer, and thus of private wells. Due to lateral flows, also possible contamination of the lower aquifer, this is important for water intake for public water supply. |
| Transport to the landfill A narrow dilapidated concrete road leads to the landfill through a residential area. | <ul style="list-style-type: none"> • Refuse collection vehicles cause noise especially during the night-time (busy night shift), odour, and irritating dust. • Risk of traffic accidents and injury. |
| Insufficient operation of landfills No fencing and no soil cover | <ul style="list-style-type: none"> • Waste littered in the surroundings, reproduction of flies, odour, and landfill gas emissions to atmosphere. |
| No separation or compacting of waste | <ul style="list-style-type: none"> • Risk of subsidence due to unstable structure • Risk of emissions of toxic and carcinogenic volatile organics |
| No collection, control or treatment of runoff water or leachate | <ul style="list-style-type: none"> • Serious risk of contamination of surface waters and groundwater. • Risk of contamination of surface waters and negative impacts to public health. |
| No landfill gas collection | <ul style="list-style-type: none"> • Risk of explosions; • Waste of potential source of energy • Risk of contamination • Odor • Increase of global greenhouse effect |

Source Ministry of Natural Resource and Environment

8 Current Waste Reduction, Reuse and Recycling Situation in Vietnam

Activities of recycling of non-organic materials: Recycling plays a critical role in reducing waste quantities, returning resources back to use, and minimizing the financial and environmental burden of MSW management. An extensive partially tiered system exists for waste recycling within each city/province comprising scavengers, small household/commercial recyclers, larger recyclers and manufacturers to produce recycled products.

It is estimated that each city in Vietnam has up to 700 scavengers. They are made up of poor unemployed women or farmers that come into the city from surrounding provinces at times when there is less agricultural activity, looking for ways of earning money. The scavengers walk the streets of the city each day to collect all type of waste from households, institutions, dumping sites, waste collection points, restaurants, hotels etc. which could be reused or recycled, and sell the collected items to the recyclers.

The recyclers collect recyclable waste materials from scavengers and factories. They separate wastes in accordance with each waste type such as paper, metal, aluminum, nylon and plastic. The waste is then compacted or packaged and sold to factories or manufacturers that use the materials in their manufacturing process. Some larger recycling operations deposit money with small recycling activities to enable them to have sufficient funds to buy wastes from scavengers. These larger recycling operations usually sell larger quantities of recyclable waste materials and act as an agency to supply secondary raw materials to manufacturers or factories. According to statistical data, there are 6,000 recyclers and scavengers in Hanoi City. These people come from other provinces. The Nam Son landfill site, it was observed that there were about 600–700 scavengers working at the landfill. The quantity of recycling materials is app. 10–15 tones/day and consists of:

| | tone/day |
|----------|----------|
| Paper | 0.5–1.0 |
| Metals | 0.1–0.2 |
| Glasses | 3.0–4.0 |
| Rubbers | 1.5–3.5 |
| Plastics | 0.5–1.0 |
| Rags | 0.5–1.0 |

Vietnam's potential for recycling is high but there is not much information available about the amount of waste recycled in Vietnam every year at the additional level. However, it is known that approximately 20 % of the municipal waste in Hanoi is recycled.

Solid waste sorting at source is a relatively new activity in Vietnam, which has not yet become a common practice and has been only experimented on household

garbage in some big cities including Ha Noi, Ho Chi Minh and Da Nang. With underdeveloped infrastructure and an uncoordinated management system, in many programs and projects, as a result of which have separated wastes had been collected and disposed together with other wastes. The effectiveness of these projects, therefore, has not been significant and as a result, people have not developed a habit of separating organic and non-organic wastes before dumping them.

Waste reduction in production, services and consumption is still almost neglected. There are no incentive policies or legal enforcement to encourage people to practice solid waste reduction in a concrete manner. Similarly, there are very few programmes encouraging people to save natural resources. There are some whose results have not been recognized. Only about 200 out of 200,000 enterprises (about 0.01 %) have been applying the cleaner production approach, which can be very effective in reducing wastes in production activities.

Waste reuse and recycling are more common and implemented by a system of individual garbage collectors and buyers. Most households in Vietnam have the habit of separating recyclable wastes such as plastic, paper, metal, etc. to be sold. Through this system, recyclable and reusable materials are collected separately and delivered to recycling facilities in craft villages. According to a general assessment, these activities contribute to solid waste reduction by about 15–20 %.

Some craft villages which recycle paper, plastic and metal, etc. have been effectively developed and contributed to job creation, poverty reduction and improved people's income and lives. Statistics in 2003 showed that about 52,000 tons of paper, 25,000 tons of plastic and 735,000 tons of waste metal were recycled by craft villages in the North. However, most recycling technologies used by craft villages are old, out-of-date, and some have caused serious pollution problems in the villages which recycle paper, plastic and metal, thus impairing people's health and lives.

Recycling organic waste from old dumping sites: Organic waste decomposes naturally in landfills and, if it is not contaminated by glass, heavy metals, or other pollutants, can be recovered for use as a soil conditioner. A private enterprise extracts waste from the Dong Thanh landfill in Ho Chi Minh City and separates organic matter which is then sold as a soil conditioner. This practice has been banned in Vietnam due to its potential health and environmental impacts.

Recovery of landfill gas: Landfill gas is produced by the degradation of organic matter in waste and contains approximately 50 % of methane, a potent greenhouse gas. Composting can also reduce landfill gas emissions by removing organic matter that would otherwise degrade under landfill conditions.

Some studies have been conducted by the Japan Engineering Consultant Co. Ltd. (JEC) in Vietnam for promoting of CDM. The typical CDM projects which have been submitted for approval are as follows:

- The model project for renovation to Increase the efficient use of energy in a brewery in Tan Hoa
- Thu Duc power plant unit 3—fuel switch project
- Landfill closure and gas recovery and utilization in Hai Phong city

- Landfill closure and gas recovery and utilization in Ho Chi Minh city
- Environmental forestation in A Luoi district, Thua Thien Hue province
- Thanh Hoa rice husk power plant in Tien Giang province

9 The Challenges of Solid Waste Management in Vietnam

The challenges of solid waste management in Vietnam can be summarized as follows:

9.1 Technical

- The unavailability of a solid waste classification and recycling system. Organic waste and nylon bags can be easily recognized in all dumpsites.
- The collection rate is low because the waste collectors only gather solid waste in village entrance sites or disposal sites.
- The lack of proper trolleys and other collection facilities for primary waste collection prevents waste collectors from hygienic working conditions
- Improper collection sites
- Lack of solid waste treatment facilities (recycling, composting etc.)

9.2 Environment, Public Health and Safety Issues

- Insufficient collection coverage
- Non-standard landfill sites. Insufficient collection and/or improper dumping bring about diseases as waste facilitates vectors like rodents, flies and mosquitoes.

9.3 Institutional and/or Organizational Issues

- Poor coordination between collection, transportation, treatment and final disposal;
- Inactive community participation in waste management. The households need to take part more directly in waste classification and treatment (e.g. composting)
- Lack of law and regulation enforcement in solid waste management

9.4 Financial, Economic and Social

- Low affordability of users
- Finance shortage (for investments and operation)
- Low ratio of cost recovery from users.

Awareness:

- Low awareness among local people in waste management.

10 The Solutions Improvement of Municipal Solid Waste Management in Vietnam

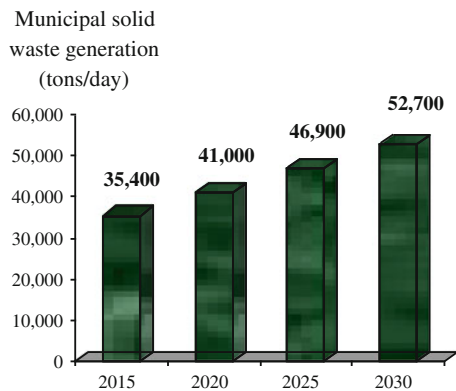
According to the results of the 2009 Population and Housing Census, with the average solid waste volume per capita in 2009 was about 1.1 kg/person-day based on the structure of Vietnam’s urban population and QCVN 07:2010/BXD the quantity of municipal solid waste generation was projected for the year 2020 and 2030 (Fig. 4).

Technical Solutions: The general layout of the proposed future urban solid waste management system is shown in Fig. 5. The system is based on the 3R principle: Reduce, Reuse and Recycle.

The main components of the system are:

- Sorting at source
- Collection from households
- Transportation
- Transfer stations (in bigger cities)
- Treatment complexes

Fig. 4 The projection of municipal solid waste generation in Vietnam to the year 2020 and 2030



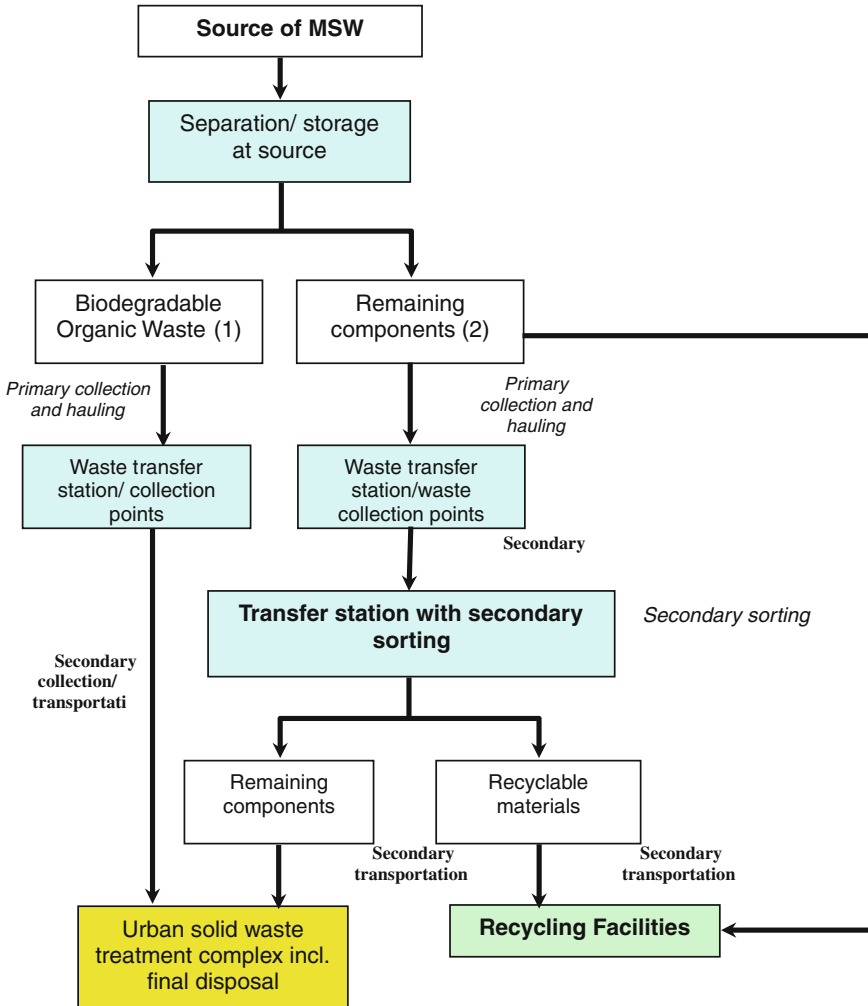


Fig. 5 General layout of urban solid waste management system in Vietnam for the future development

Treatment complexes may consist of one or several of the following facilities for sorting, composting, incinerating and final depositing in sanitary landfills. It should be noted that no matter which treatment method is applied there will always be residual waste and therefore sanitary landfills will be needed in any treatment complex.

The full implementation of the 3R principle will result in a substantial reduction of the volumes of waste to be treated and finally deposited.

Within the environmental protection policy, the “3R Initiative” of Reduce-Reuse-Recycle has been raised as an important issue in need of close attention.

There are a number of challenges in implementing 3R in Vietnam because of the increase in quantity, types of waste and the level of hazard of the waste generated while the technical infrastructure for handling and managing the waste is inadequate and the laws on environmental protection are equally lacking. However, it is lucky that Vietnam has received much support from the Government of Japan to conduct a “Project for Implementation Support for 3R Initiative in Hanoi City to Contribute to the Development of a Sound Material-Cycle Society (3R-HN Project)”, for three years from November 2006. The project aims to establish a balanced and unique 3R system centered on source separation and recycling of raw waste under the 3R Initiative, and connect this to the formation of a “Sound Material-Cycle Society” in Hanoi City. The experiences gained from the 3R-HN Project will be useful in the implementation of such projects in other urban areas of Vietnam in the future.

The government viewpoint is that the development of solid waste treatment technology must be in accordance with the urban sustainable development in order to create “Environmental Friendly Products.” The selection of treatment technology needs to be based on the 3R strategy (reduce, reuse, recycle) with a pollution prevention orientation.

To 2020, solid waste treatment technologies are mainly recycling, composting and landfill. After 2020, recycling, composting and incineration with energy recovery will be promoted while the volume to be dumped shall be minimized. Solid waste treatment complexes in key economic regions should be constructed in accordance to Decision No. 1440/2008/QĐ-TTg and Decision No.1873/2010/QĐ-TTg of the Prime Minister. Recycling, composting facilities, incinerators with energy recovery and sanitary landfills can be included in these complexes.

All landfills must be equipped with leachate treatment facilities that can treat effluent to meet environmental requirements of the receiving water bodies.

Policy’s Adjustment: In order to improve the quality of life of the people through municipal solid waste management, the Vietnamese government passed amendments to the Law on Environment 2005, adopting the Prime Minister’s decision known as “Vietnam Agenda 21,” which aims for sustainable development.

The amended Law on Environmental Protection (2005) has provided for organizations and individuals engaged in the recycling of wastes and products to be entitled to preferential policies in accordance with the solid law. The organizations and individuals that invest in the construction of waste recycling facilities shall be entitled to preferential treatment of tax, financial support and land use given by the State for constructing waste recycling facilities. Reusing or reprocessing of solid waste is being done in concentrated Industrial zones based on an information system for waste exchange, as solid waste in one place can be used as raw material in another place.

Vietnam Law on Environment Protection also states that the advanced technologies for recycling and reuse of waste to create raw materials and generate energy shall be encouraged, and the minimization of solid waste volume to be

buried whereby saving land needed for disposal shall be an important part of waste management policy for Vietnam.

The Government issued Decree No174/2007/ND-CP dated 29 November 2007 which requires that all waste producers must pay a fee for environmental protection. The environmental protection charges for wastewater as well as for solid waste will be a contribution to State revenue.

A Decree on Solid Waste Management was issued in 2007 stipulating that solid waste disposal facilities shall be merged to serve more than two provinces or shall be combined in a complex treatment facility which will include garbage incinerators with energy recovery, organic waste fertilized plants, sanitary landfills for ordinary solid waste and landfills for hazardous solid waste.

A new Construction Standard issued in 2008 dictates that the amount of solid waste that requires land-filling shall be cut down to 15 % of the total volume of collected wastes while 85 % shall be treated through proper treatment technologies.

In spite of current policies, waste reduction, reuse and recycling practices in Vietnam have been conducted simultaneously and mostly controlled by private sectors. Meanwhile, the economic and social development often goes with ever-increasing quantities, compositions, diversity and toxicity of wastes, which eventually cause serious pollution in some places and impacts on people's health.

In 2009, The National Strategy on integrated management of solid waste in Vietnam to 2025 and vision to 2050 has been approved by the Prime Minister.

The solutions for implementing the strategy:

- Improving the legal documents system and policy mechanism of solid waste management
- Planning schemes of solid waste management
- Establishing the database and data observing system of solid waste in the whole country.
- Developing strategy resources for implementing
- Promoting doing scientific research to apply effectively to general management of solid waste
- Propagandizing, educating to promote awareness

The enhancing reduction, reuse, recycling solid waste can be reached through several ways such as: Promoting classification of solid waste at source; enhancing reuse of solid waste; encouraging using recycled products; developing and applying preferential policies for recycling activities however, the handling of solid waste including reuse, recycling, collection, treatment and disposal is crucial to providing a cost effective waste management system that is able to public health and environmental risks.

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