

Zero Waste:
Replacing Waste Management
with
Discards Management
in the
Hong Kong Special Administrative Region

By
Kelly Lease, Richard Anthony, and
Neil Seldman
Institute for Local Self-Reliance
2425 18th Street, NW
Washington, DC 20009
(202) 232-4108
<http://www.ilsr.org>

For
Greenpeace China
1/F Tung Lee Commercial Building
95 Jervois Street, Sheung Wan
Hong Kong
(852) 2854-8300

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LIST OF ABBREVIATIONS

ACE: Advisory Council on the Environment
ARN: Auto Recycling Nederland
BOD: biochemical oxygen demand
C&D: Construction and demolition
CPSP: Consumer Product Stewardship Program (in British Columbia, Canada)
ECC: Environmental Campaign Committee
ECF: Environment and Conservation Fund
EFB: Environment and Food Bureau
EPD: Environmental Protection Department
EPR: Extended Producer Responsibility
EPS: expanded polystyrene
FEHD: Food and Environmental Hygiene Department
GAIA: Global Alliance for Incinerator Alternatives or Global Anti-Incinerator Alliance
GDP: gross domestic product
HHW: household hazardous waste
ILSR: Institute for Local Self-Reliance
JAMA: Japan Automobile Manufacturers Association
kg: kilogram
MELP: British Columbia's Ministry of Environment, Land and Parks
MRF: materials recovery facility
MSW: municipal solid waste
MTCE: metric tonnes of carbon equivalent
MTR: Mass Transit Railway
NMOCs: non-methane organic compounds
PET: polyethylene terephthalate
PPC: Paint and Product Care Association (in British Columbia, Canada)
RCP: refuse collection point
RTS: refuse transfer stations
SAR: Special Administrative Region
SHAR: Japan's Specified Household Appliances Recycling Law
tpd: tonnes per day
tpy: tonnes per year
TSA: Tree-Marking Paint Stewardship Association (in British Columbia, Canada)
U.S. EPA: United States Environmental Protection Agency
WEIFs: waste-to-energy incineration facilities
WMI: Waste Management, Inc.
WRC: Waste Reduction Committee
WRFP: Waste Reduction Framework Plan

HONG KONG BASIC INFORMATION

Population: 7,116,302 (July 2000 estimate)

Land area: 1,042 square kilometers, although approximately half of the land area has been designated as Country Park, used as water catchments and protected from development.

GDP: purchasing power parity - \$158.2 billion (1999 estimate)

Exports: \$169.98 billion (including re-exports; f.o.b., 1999 estimate)

Exports - commodities: clothing, textiles, footwear, electrical appliances, watches and clocks, toys

Exports - partners: China 34%, U.S. 23%, Japan 5%, Germany 4%, U.K. 4%, Singapore 2% (1998)

Imports: \$174.4 billion (c.i.f., 1999)

Imports - commodities: foodstuffs, transport equipment, raw materials, semi-manufactures, petroleum; a large share is re-exported

Imports - partners: China 41%, Japan 13%, U.S. 8%, Taiwan 7%, South Korea 5%, Singapore 4% (1998)

The sophisticated multi-block, high-rise estate built around a transportation hub and commercial core is the standard urban unit in the Hong Kong Special Administrative Region (SAR).

Table 1: Distribution of housing units by type, 2000

Housing type	Number of units (*1000)	Percent
Public rental housing	676	30.3
Subsidized sale flats	350	15.7
Private permanent housing	1,205	54.0
Total	2,231	100.0

Source: Hong Kong Census and Statistics

EXECUTIVE SUMMARY

Each year Hong Kong must dispose of mountains of waste. Total waste disposal in Hong Kong in 1999 was 8,126,000 tonnes. More than two-thirds of the domestic, commercial, and industrial materials disposed that year were comprised of paper, plastics, and putrescibles – materials that can be recycled or composted. Instead of focussing on the opportunities for cost-saving and job creation offered by recycling and composting these materials, the Government, however, has proposed building incinerators that will trade these opportunities for higher costs, substantial pollution, and environmental degradation.

Dwindling disposal capacity has become a pressing concern for Hong Kong. According to the Government reports, landfill capacity in the Region will be exhausted in 2015 or sooner. In order to address long-term waste management needs, the Environmental Protection Department (EPD) developed a "Waste Reduction Framework Plan." It states, "[w]e need to transfer emphasis from collecting and transporting waste to landfills for disposal to waste prevention and reuse of waste materials." To that end, numerous efforts in support of increased recycling have been implemented by Governmental agencies.

However, a look at current and planned spending for waste management activities reveals the Government's true priorities. In 1999, the Government's recurrent expenditure on waste management was \$1.5 billion. This does not include capital costs. Between April 1989 and March 2000, the Government invested more than \$10.2 billion in new waste management facilities. In order to address future disposal needs, the Government has reserved \$9,780 million of its Capital Works Reserve Fund for the development of two waste-to-energy incinerators with an overall capacity of 6,000 tonnes per day. Based on costs of similar incinerators around the world, the annual net cost to operate these incinerators will be an additional \$600 million. Furthermore, landfills will still be needed to handle residues from the incinerators, materials that are not suitable for burning, and waste production in excess of the incineration capacity.

In contrast to the billions of dollars the Government spends (and is planning to spend in the future) on waste disposal each year, Government investment in waste reduction, reuse, recycling, and composting is minimal. The Environment and Conservation Fund, a principle source for funding of waste reduction projects, received an initial \$50 million of capital upon establishment in 1994 and another \$50 million injection in 1998. The Government has touted its proposed 2002 injection of an additional \$100 million into the fund as a significant milestone. In summary, the Government's stated policy priorities and its spending priorities are exactly opposite.

In addition to consuming billions of dollars, development of waste-to-energy incineration facilities would create additional environmental pollution without creating a long-term solution for waste management. Waste incinerators can appear to be the answer to the problem of ever-increasing waste disposal. But to paraphrase Dr. Paul Connett, if incineration is the answer, you have asked the wrong question. Municipal waste incineration is **not** safe, it is **not** cost-effective, it is **not** sustainable, and it does **not** create net energy gains for society.

Incinerators are major – and in many areas the largest – sources of such pollutants as dioxin, lead, and other heavy metals released into the environment. Incinerators also release carbon monoxide, oxides of sulfur and nitrogen, hydrocarbons, and particulates into the air. Modern incinerators with sophisticated pollution control

equipment trap some of the toxic metals in the fly ash – the residue captured by the pollution control devices. Ironically, this means that the better the air pollution control, the more toxic the ash.

Furthermore, creation of incineration capacity would most likely lead to sustained wastefulness in Hong Kong's society. Incinerators need a minimum amount of garbage daily to operate properly and generate electricity. Because of their voracious need for discards for fuel, incinerators lock up the waste stream. They encourage increased product consumption and waste generation. They discourage waste reduction and sustainable methods of production and consumption. In addition, communities with incinerators still need landfills for ash disposal and for by-pass wastes. Ash can comprise about 25% by weight of an incinerator's throughput and must be landfilled. Thus, incineration means incineration plus landfill.

Describing an incinerator as a "resource recovery" or "waste-to-energy" facility is misleading. Incinerators recover few resources (with the exception of ferrous metals) and represent a net energy loser when the embodied energy of the materials burned is included in the accounting. When a ton of paper is burned for its heating value, it generates about 8,200 megajoules. When this same paper is recycled, it saves about 35,200 megajoules. Recycling other items typically present in MSW offers similar energy savings. Therefore, **incinerators waste energy** rather than turn waste into energy.

Greenpeace and the Institute for Local Self-Reliance (ILSR) propose Hong Kong radically change the focus of its system for handling discarded materials. This report details a blueprint for "zero waste" in Hong Kong. Critical components include programs and policies designed to:

- Reduce generation of discards (source reduction);
- Increase product reuse and repair;
- Create a source separation system for domestic, commercial, and industrial discards and construction and demolition debris;
- Establish an efficient collection system for separated materials;
- Support processing and market creation for recyclables; and
- Create composting systems for organic materials.

Greenpeace and ILSR believe that implementation of the programs proposed could result in reducing disposal needs to approximately 7,000 tonnes per day by the year 2011. This represents a greater disposal reduction than the Government proposed in its "Waste Reduction Framework Plan." Furthermore, these reductions would be achieved without relying on incineration.

In order to develop cost comparisons of the Greenpeace/ILSR proposal, ILSR developed a model of costs based on EPD data and estimated costs for proposed programs. This model compared costs for four scenarios:

- Landfill disposal alone for all waste generated;
- Development of 6,000 tonnes per day incineration capacity with landfilling of the remaining waste stream and incineration residuals;
- Development of 6,000 tonnes per day incineration capacity, waste reduction of 20% by the year 2010, and landfilling of the remaining waste stream and incineration residuals; and
- Full implementation of the Greenpeace/ILSR program.

The comparison of total operating costs for the waste management scenarios shows that the Greenpeace/ILSR proposal has the lowest costs in the long-term. Capital

costs for the Greenpeace/ILSR proposal were also the lowest among all alternatives considered. The Government has reserved a staggering \$9,780 million of its Capital Works Reserve Fund for the development of waste-to-energy incinerators.

In contrast to the Government's incineration plans, with a capital cost of \$9.78 billion, the capital costs of implementing the Greenpeace/ILSR proposal will be much lower, at less than \$2 billion. At the bottom line, ILSR estimates cumulative expenditures for implementation of the proposal from the years 2002 through 2011, would be \$8 billion cheaper than a landfill-only waste management scenario and \$11 billion cheaper than implementation of the Waste Reduction Framework Plan.

Implementation of the Greenpeace/ILSR proposal would also decrease environmental and health effects from air and water pollution, reduce greenhouse gas production, conserve energy, create and sustain thousands of jobs, and encourage product manufacturers to market products which are less wasteful and/or easier to recycle.

For example:

- Fewer emissions originate at factories using recycled feedstock than at factories using virgin material. Recycling paper cuts air pollution by about 75%. Substituting steel scrap for virgin ore reduces air emissions by 85% and water pollution by 76%.
- Recycling reduces net emissions of greenhouse gases as compared to landfilling or incineration. For example, when using the extraction of raw materials as a reference point, recycling of 1,000 tonnes of newsprint reduces greenhouse gas emissions by 418 MTCE, whereas incineration of the same newsprint increases greenhouse gases by 286 MTCE and landfilling produces 275 MTCE.
- It takes 60% less energy to manufacture paper from recycled stock than from virgin materials.
- Sorting facilities for mixed recyclables sustain an average of 12 times as many jobs as maintained at landfills and incinerators handling the same amount of materials.
- A Japanese researcher reported that three out of five companies interviewed said that the enactment of Japan's Specified Household Appliances Recycling (SHAR) Law was a strong incentive for them to consider the environmental impact of their products.

Greenpeace and ILSR acknowledge that our proposal is very ambitious. However, it is not unattainable. Numerous jurisdictions in the U.S. and around the world have achieved impressive diversion levels for municipal solid waste (MSW). In the U.S., during 1996, Seattle, Washington diverted 44% of its MSW from disposal; Portland, Oregon diverted 50%; and Bergen County, New Jersey diverted 54%. The residents of Mokattam, Cairo, divert 90% of the trash they collect. Curitiba, Brazil, recycles two-thirds of its garbage. A neighborhood participating in the Advanced Locality Management program in Sahar, Andheri, Mumbai, India, reduced their garbage disposal by half within two years. Each of these jurisdictions has implemented some of the diversion programs proposed in this report but none has implemented the entire range of programs. We believe that if Hong Kong does so, it will not only be able to reduce its waste disposal to 7,000 tonnes per day cost-effectively by 2011, it will become a model for the rest of the world.

EXISTING WASTE SYSTEM

Regulations and authority

The Government of Hong Kong consists of executive, judicial, and legislative branches. The Chief Executive, who is advised by an Executive Council, heads the executive branch. The Legislative Council (LegCo) is the legislature of the Region. The main functions of the Legislative Council are to enact laws; examine and approve budgets, taxation, and public expenditure; and monitor the work of the Government. The Legislative Council of the Hong Kong SAR is also given the power to endorse the appointment and removal of the judges of the Court of Final Appeal and the Chief Judge of the High Court, as well as the power to impeach the Chief Executive.

Numerous Government organizations play a role in waste management in Hong Kong. The principal organizations and their roles are presented below:

The Environment and Food Bureau (EFB)

(<http://www.info.gov.hk/efb/front.html>), headed by the Secretary for Environment and Food, is the executive agency responsible for policy development concerning environmental hygiene and protection, including most waste management functions in the Hong Kong SAR. EFB oversees the work of the Food and Environmental Hygiene Department and the Environmental Protection Department.

The Food and Environmental Hygiene Department (FEHD)

(<http://www.info.gov.hk/fehd/indexe.html>) is responsible for “cleansing services” which includes street sweeping and collection of municipal waste from residences, public refuse collection points, and public recycling and litter containers. The FEHD has contracted with private companies for some of the collection services. (Private companies also collect all construction and demolition materials and industrial and commercial waste.)

The Environment Protection Department (EPD) (<http://www.info.gov.hk/epd/>) plans and operates disposal facilities including the Region’s eight refuse transfer stations and three strategic landfills.

The Civil Engineering Department is responsible for reuse of inert construction and demolition materials as fill in land reclamation projects.

The Advisory Council on the Environment (ACE) (http://www.info.gov.hk/efb/board/board2_1.html) advises the Secretary for Environment and Food on

Table 2: Waste Reduction Framework Plan municipal solid waste disposal reduction goals

	Goals					
	Waste prevention		Waste bulk reduction		Total disposal reduction	
	%	Tonnes	%	Tonnes	%	Tonnes
2001	10	356,000	0	0	10	356,000
2003	14	542,000	0	0	14	542,000
2005	16	675,000	6	253,000	22	928,000
2007	20	914,000	20	914,000	40	1,828,000

Notes: The reduction figures represent disposal reduction targets for the portion of the municipal solid waste stream disposed in 1998. The Region already recycled approximately 30% of its discards, therefore the 2007 target represents a 40% reduction of the 70% disposed in 1998, corresponding to a 58% disposal reduction compared to total 1998 waste generation. Waste prevention includes source reduction, reuse, and recycling. Waste bulk reduction includes composting and incineration.

“appropriate measures which might be taken to combat pollution of all kinds, and to protect and sustain the environment.”

The Environment and Conservation Fund (ECF)

(<http://www.info.gov.hk/efb/board/ecfc/index.htm>) was established in 1994. The Secretary for the Environment and Food acts as the trustee of the ECF. The Environment and Conservation Fund Committee advises the trustee on the use of the ECF for the purposes of funding educational, research and other projects and activities in relation to environmental and conservation matters.

The Waste Reduction Committee (WRC)

(<http://www.info.gov.hk/wrc/index2.htm>)

oversees the implementation of the Waste Reduction Framework Plan and answers to the Secretary for Environment and Food. The WRC also coordinates various task forces that promote recycling. These are:

The Waste Reduction Task Force for the Hotel Sector,
The Waste Reduction Task Force for the Public Housing Sector,
The Waste Reduction Task Force for the Private Housing Sector,
The Waste Reduction Task Force for the Construction Industry,
The Waste Reduction Task Force for the Government,
The Waste Reduction Task Force for the Airport Community, and
The Waste Reduction Task Force for the Recycling Trade.

The Plan endorses the “Polluter Pays Principle” and the “User Pays Principle” and established goals for reducing landfill disposal in the Hong Kong Special Administrative Region. According to the Waste Reduction Framework Plan, its objectives are:

- “(a) to extend the useful life of our strategic landfills;
- (b) to minimize the amount of waste produced that requires disposal;
- (c) to help conserve the earth's non-renewable resources;
- (d) to increase the waste recycling rate;
- (e) to show to the administration, the Provisional Municipal Councils, commerce, industry and the public the true costs of waste management so that we can review how these costs are met; and
- (f) to encourage maximum efficiency in waste management operations and minimisation of the costs associated with the collection, treatment and disposal of wastes.”

The Environmental Campaign Committee (ECC)

(<http://www.ecc.org.hk/ebody.htm>) was established in 1990 to promote public awareness of environmental issues and encourage the public to contribute actively towards a better environment. The Chief Executive appoints Committee members. They come from environmental organizations, the education sector and academia, industrial and business organizations, professional institutions and community service agencies, and relevant Government departments.

EPD Municipal Waste Disposal Facilities

Transfer Stations:

IETS : Island East Transfer Station
IWTS : Island West Transfer Station
KBTS : Kowloon Bay Transfer Station
NLTS : North Lantau Transfer Station
NWNTRTS: North West New Territories Refuse Transfer Station
OITF : Outlying Islands Transfer Facilities
STTS : Sha Tin Transfer Station
WKTS : West Kowloon Transfer Station

Landfills:

North East New Territories (NENT) Landfill
South East New Territories (SENT) Landfill
West New Territories (WENT) Landfill

The Legislative Council Panel on Environmental Affairs

(<http://legco.gov.hk/general/english/panels/yr00-04/ea.htm>) advises the full Legislative Council on “policies and issues of public concern relating to environmental and conservation matters.”

“[t]o provide for the control and regulation of the production, storage, collection and disposal including the treatment, reprocessing and recycling of waste of any class or description, the licensing and registration of places and persons connected with any such activity, the protection and safety of the public in relation to any such activity and to provide for matters incidental thereto.”

The chief provisions of the Waste Disposal Ordinance include:

- A requirement for the Secretary for the Environment and Food to prepare a waste disposal plan that includes:
 - “(a) the arrangements made or proposed to be made for the collection and disposal of-
 - (i) all solid and semi-solid wastes other than those which may be discharged into the atmosphere as particulates or discharged into water as solids suspended in effluents; and
 - (ii) such other wastes, or classes of waste, as may be prescribed; and
 - (b) all existing and proposed waste disposal sites and the methods of waste disposal used or to be used at each site.”
- This plan is subject to approval by the Governor in Council.
- Devolution of the exclusive right to collect waste to designated collection authorities or their licensees.

Waste generation and composition

Total waste generation in Hong Kong in 1999 was 18,791,000 tonnes. Of this amount, 10,665,000 tonnes was construction and demolition (C&D) debris used in land reclamation projects. This report focuses on disposal reduction and, as such, does not address the C&D material used for fill, only the 8,126,000 tonnes of discarded materials recycled and disposed.

In 1999, of the more than 8 million tonnes of discarded materials remaining after removal of C&D materials for land reclamation, 2,710,000 tonnes generated by households and 670,000 tonnes generated by business and industry were disposed in landfills. An additional 1,540,000 tonnes of materials were reclaimed for recycling in the same year. Special wastes and C&D materials accounted for the remaining materials landfilled in the year.

Table 3: Waste generation sources and destinations

Waste Type	Recycled (1,000 tpy)	Landfilled				Public Filling Areas Inert C&D Material Reused in Land Reclamation (1,000 tpy)
		Municipal Solid Waste (1,000 tpy)	C&D Waste (1,000 tpy)	Special Waste (1,000 tpy)	Total Solid Waste Landfilled (1,000 tpy)	
1998	1,560	3,187	2,567	290	6,044	9,374
1999	1,540	3,383	2,882	321	6,586	10,665
2000	1,760	3,404	2,730	398	6,531	11,028

tpy = metric tonnes per year

Note: Figures may not add to total due to rounding.

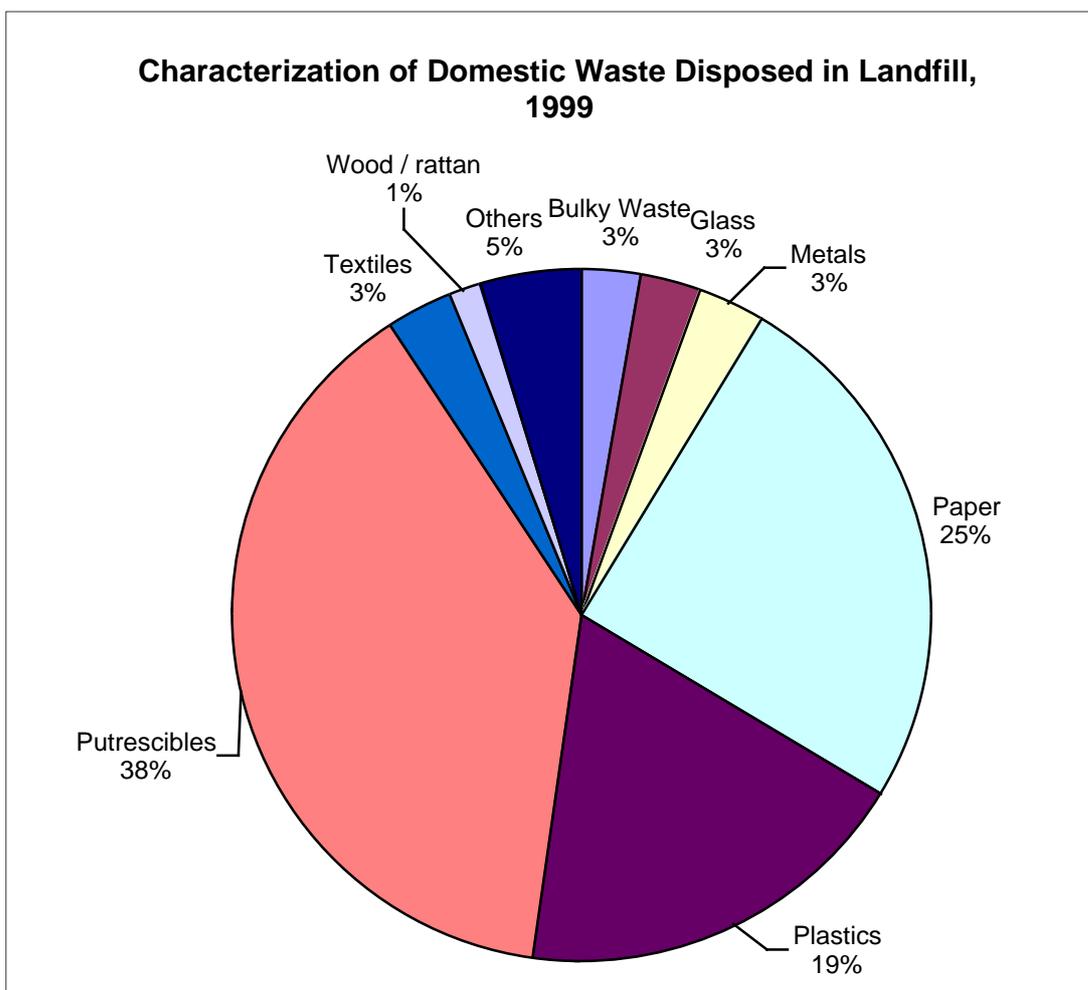
More than two-thirds of the domestic, commercial, and industrial materials disposed in Hong Kong's landfills in 1999 were comprised of paper, plastics, and putrescibles. Furthermore, recovery levels for these materials were 43%, 19%, and 0%, respectively.

Source reduction, recycling, and composting programs

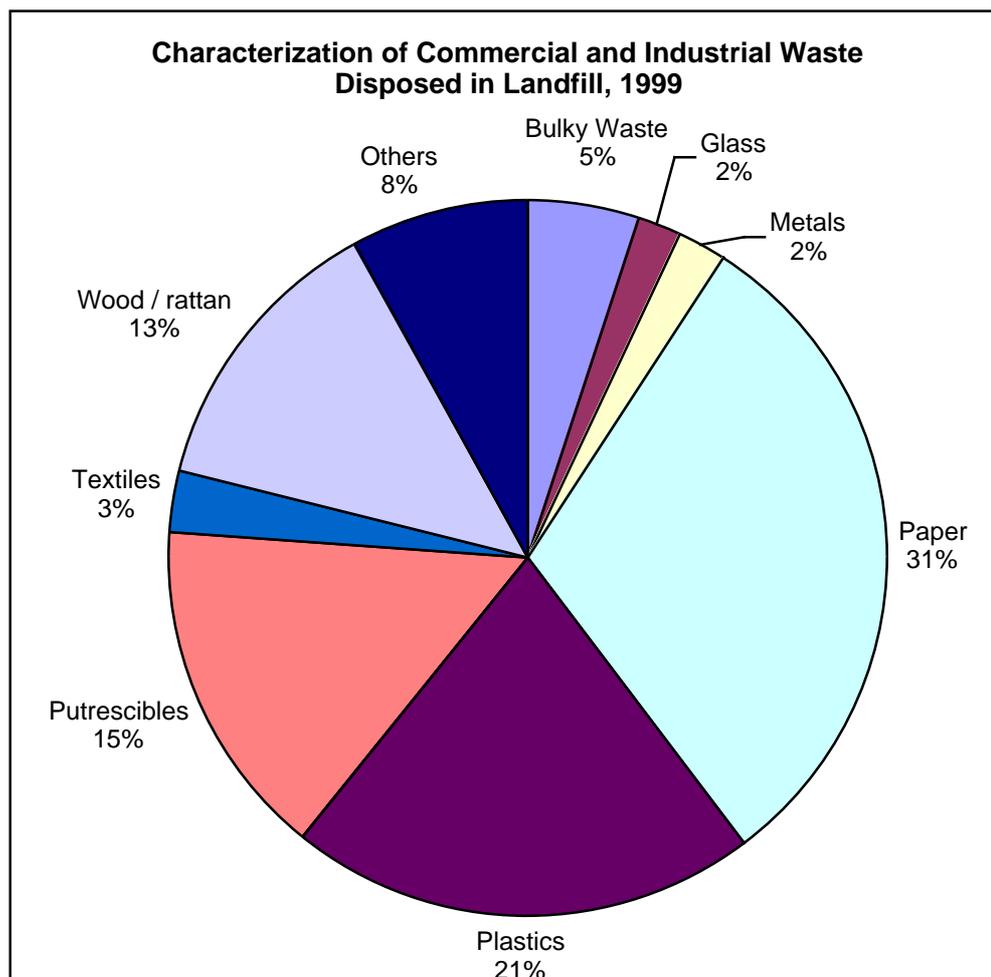
Private sector recycling

Informal sector

The Society for Community Organisation estimates that there are 5,000 elderly scavengers in Hong Kong. Many of these scavengers sort through discarded materials in public refuse stations and street litterbins. Some go to commercial establishments and ask for salable items such as office paper and cardboard boxes. The scavengers sell collected paper to brokers. Income of the scavengers is vulnerable to price fluctuations for the commodities they collect. For example, brokers paid 30 cents a kilogram for paper in June 2001, which was down from 70 cents a kilo in 2000.¹ This price reduction required scavengers to collect more than twice as much paper in 2001 as they did the previous year in order to maintain their level of income.



¹ Ella Lee, "\$10-a-day worker," *Sunday Morning Post*, June 17, 2001, Sunday Review p. 1.



Cleaning crews and trash collectors also participate in informal recycling activities in Hong Kong. Cleaning crews in housing estates often separate materials from household trash, especially clean paper and aluminum cans, for recycling. Trash collectors also often separate recyclable materials from the materials they collect.

Paper recycling

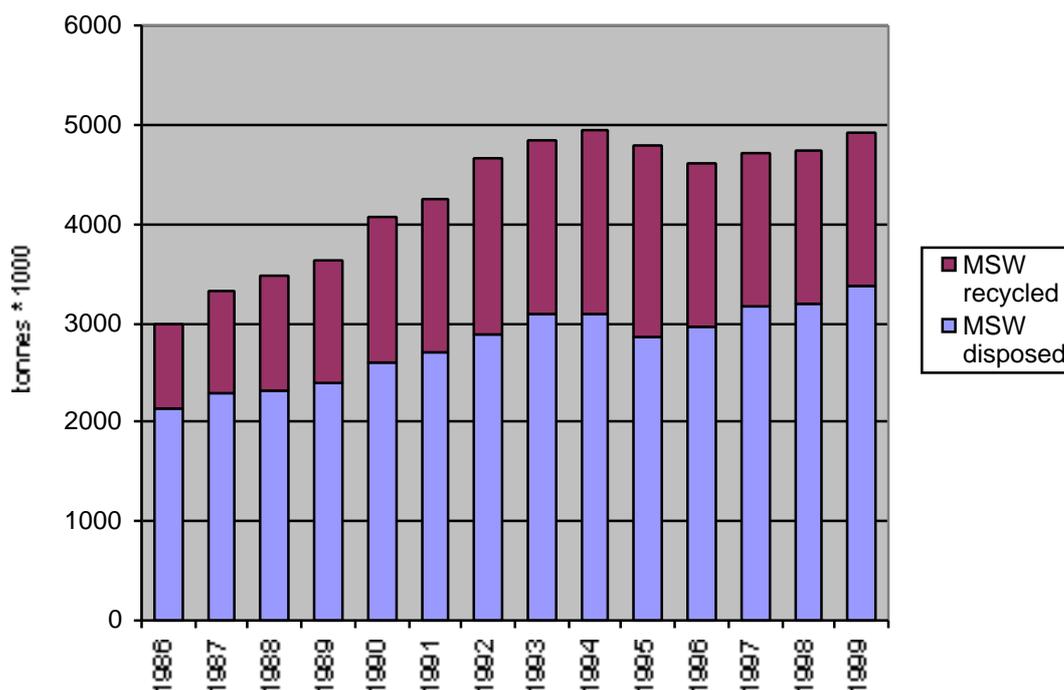
According to the EPD data, there are approximately 115 private waste paper collectors who mostly buy paper from scavengers and two manufacturers using recovered paper as feedstock located in the Hong Kong SAR. In 1999, 679,000 tonnes of paper were collected for recycling in the Hong Kong SAR. Approximately 144,700 tonnes of this paper was recycled/reprocessed locally while the remainder was exported to the Chinese Mainland or other countries for recycling.

The two paper recycling firms in Hong Kong import some of their feedstock – approximately 9,700 tonnes in 1999. Therefore, local industry used 154,400 tonnes of recovered paper as feedstock during the year. The two local firms produce corrugated cardboard and packaging products. No Hong Kong SAR companies produce office paper or newsprint using recycled feedstock.

Plastics recycling

EPD's "Directory of Recovery/Recycling Companies in Hong Kong" (searchable database available at <http://www.info.gov.hk/wrc/collst/000821/engweb4a/start.html>) listed 17 recyclers of plastics as of September 5, 2001. In 1999, Hong Kong

MSW recovered and disposed, 1986-1999



manufacturers used 22,500 tonnes of plastics as feedstock. An additional 131,000 tonnes of plastics generated in the Hong Kong SAR were exported to the Mainland and other countries for recycling. Almost all plastics collected for recycling in the Hong Kong SAR are pre-consumer materials, collected from the industrial sector.

Metals recycling

EPD’s “Directory of Recovery/Recycling Companies in Hong Kong” listed 52 collectors of ferrous metals, only one of which also was listed as a recycler, as of September 7, 2001. In 1999, about 540,000 tonnes of ferrous metal were collected for recycling. This represented about 88% of the ferrous metal waste generated in the territory. The major kinds of ferrous metals recovered included structural steel, scrap vehicles, and scrap home appliances. The recovered metals were mostly exported for recycling to the Mainland, Taiwan, and Korea.

EPD’s “Directory of Recovery/Recycling Companies in Hong Kong” listed 62 collectors of non-ferrous metals and two recycling firms, as of September 7, 2001. In 1999, the collectors recovered 79,100 tonnes, or about 81% of the total non-ferrous metal generated in the Region. Of the total non-ferrous metals recovered, about 2,100 tonnes were reprocessed locally, while the remaining 77,000 tonnes were exported for recycling, mainly to the Mainland, Japan, and Korea.

Glass recycling

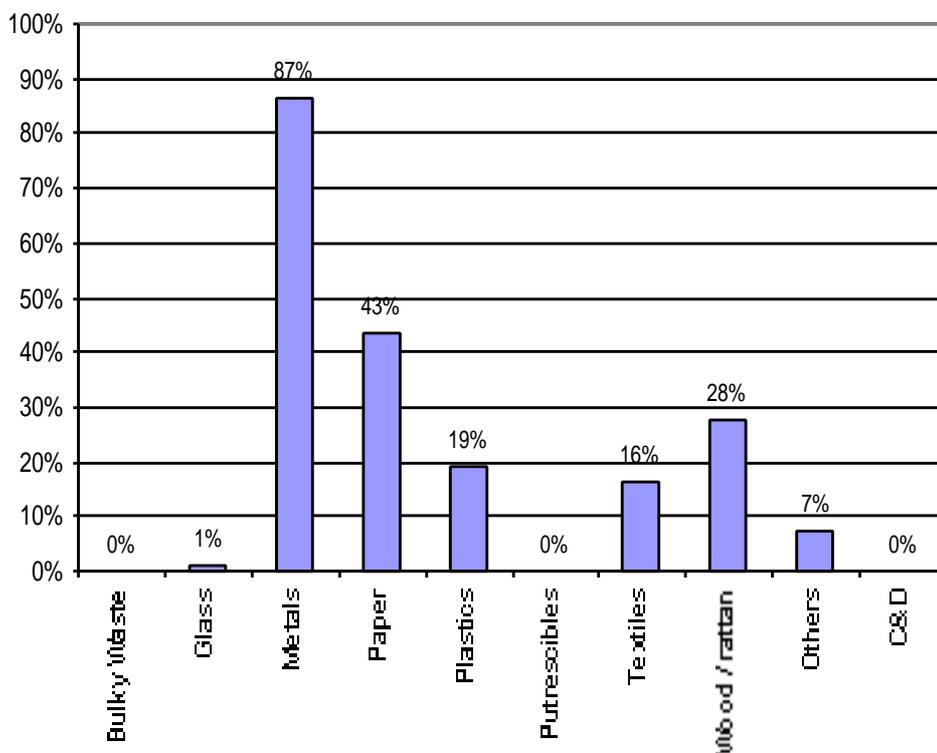
Until recently, some local beverage manufacturers in the Hong Kong SAR used returnable bottles that were subject to a deposit-refund system. However, these systems no longer exist. In 1999, 1,302 tonnes of glass bottles were recovered for reuse and recycling. Most of this glass was collected from refuse collection points, hotels, bars, and restaurants and processed by local bottle rinsers and sold to soy sauce manufacturers and fruit juice producers. There are reports that some of these bottles are sold for reuse as containers for chemicals and solvents.

Public sector recycling

Since 1991, EPD has been operating a Waste Reduction and Recycling Hotline (2755 2750). Hotline operators provide callers with specific advice on setting up waste reduction/recovery programs in offices, factories, schools or communities. From 1991 to 1999, the Hotline responded to about 11,000 requests for information from the household, commercial, and industrial sectors. Hotline users requested information about outlets for recyclables and technical information about organizing voluntary waste recovery programs most often.

In order to increase recycling of domestic waste, the Government started the Waste Recycling Campaign in Housing Estates. Phase I of the program was launched in 1998 and included 41 public housing estates. Since then, the program has spread to include all public and over 500 private housing estates. The Government provides recycling bins for waste paper, aluminum cans, and plastic bottles in each building. Usually these bins are placed on the ground floor of the buildings although the Environmental Campaign Committee commissioned Friends of the Earth and Green Power to conduct pilot programs to test the feasibility of collecting source separated materials on each floor of public housing estates. During the pilot, held in September and October 2000, recovery rates of paper, aluminum cans, and plastic bottles increased 155%, 119%, and 195%, respectively.²

Percentage of Materials in MSW Recovered, 1999



² Waste Reduction Committee, "The Waste Reduction Framework Plan Annual Report," *Waste as Resources*, Issue 4, March 2001, p. 2.

Table 4: Recovery results of Waste Recycling Campaigns at Housing Estates

		Phase I	Phase II	Phase III	Phase IV
No. of estates		41	132	298	695
No. of households		164,100	458,500	907,366	1,199,228
Date (Duration)		29/3/98 – 29/5/98 (2 months)	1/10/98 – 31/3/98 (6 months)	1/7/99 – 31/3/00 (9 months)	1/6/00 – 31/3/2001 (6 months)
Weight (kg) Recovered	Paper	1,706,890	9,365,346	47,228,529	40,279,581
	Al cans	14,096	232,146	685,053	889,938
	Plastic bottles	N/A	N/A	230,460	479,455
Weight (kg) Per month	Paper	853,445	1,560,891	5,247,614	6,713,264
	Al cans	7,048	38,691	76,117	148,323
	Plastic bottles	N/A	N/A	25,607	79,909
Weight (kg) Per household	Paper	5.20	3.40	5.78	5.60
	Al cans	0.04	0.08	0.08	0.12
Per month	Plastic bottles	N/A	N/A	0.03	0.07

Note : The figures for Phase IV are provisional only and subject to change.

Source: 2000 Review - Waste Reduction Framework Plan, September 2001.

The Waste Reduction Task Force for the Government focuses on reducing waste generation in Government operations and supporting markets for recycled products through increased Government procurement. Achievements of the task force include:

- Awarding, in August 1999, a contract for the purchase of recycled photocopying paper for consumption by Government departments;
- Development of "green specifications" for a list of priority environmentally sensitive items; e.g. paper products, paint, batteries;
- Development of a "Green Tips" web page (<http://www.info.gov.hk/gsd/english/f09.htm>) on the Government Supplies Department's homepage to disseminate information on recycling, reducing consumption, and environmentally responsible purchasing; and
- Circulation of a list of environmentally friendly products in the store of the Government Supplies Department to all Heads of Departments.
- Creation of an Inter-departmental Working Group on Waste Recycling chaired by the Environment and Food Bureau in June 2000 to co-ordinate waste reduction efforts on domestic waste separation and recycling amongst all relevant Government bureaus and departments.

Cooperative ventures

The Waste Reduction Task Force for the Private Housing Sector encourages recycling by residents living in private housing. The Task Force organized the Private Housing Environmental Ambassador Scheme to increase the environmental awareness of residents in private housing estates. As of March 2001, about 120 ambassadors had completed their training.

The Waste Reduction Task Force for the Hotel Sector set up in September 1997 to address waste reduction and other environmental measures (such as water and energy conservation) for hotels. The Task Force conducted the study "Keeping Hong Kong's Hotel Industry Competitive into the 21st Century: Environmental Management System for Hotels" to be completed by early 2000. It also created a CD-ROM and information package for ISO 14001 certification for hotels. The Task Force

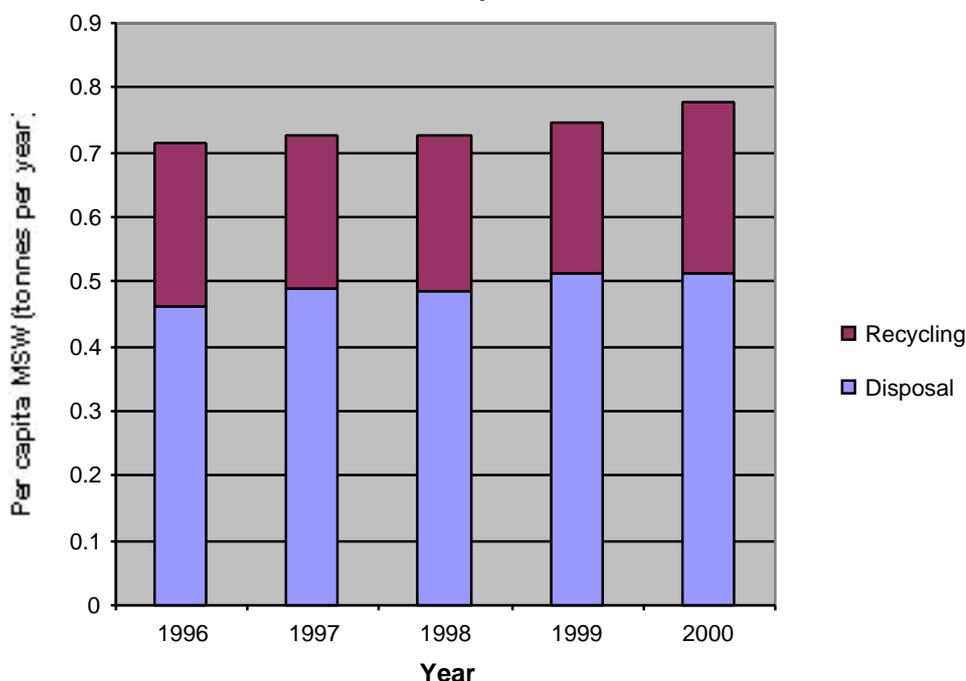
has also held waste reduction workshops, including one for hostels and guesthouses held in November 1999, one for members of the Hong Kong Hotels Association in December 1999, and one for 20 hotels held in November 2000. The Task Force has also initiated various pilot projects including the Eco-Friendly Textile Recycling Programme held in August 2000 and December 2000 with participation of 10 hotels, the Plastic Bottles Recycling Pilot Programme that began in June 2000 with 11 participating hotels in Kowloon and extended to 23 hotels by the end of the year, and the Glass Bottles Recycling Programme held in September 2000.

In recent years, mixed C&D waste has accounted for more than 40% of the total waste intake at Hong Kong's three strategic landfills. The Waste Reduction Task Force for the Construction Industry (http://www.info.gov.hk/epd/waste/cdm/en_menu.html) was established in 1999 and aims to reduce the amount of C&D waste produced, to encourage recycling and reuse, to promote greater efficiency and economy in the management of C&D waste, and to provide outlets for inert construction and demolition materials.

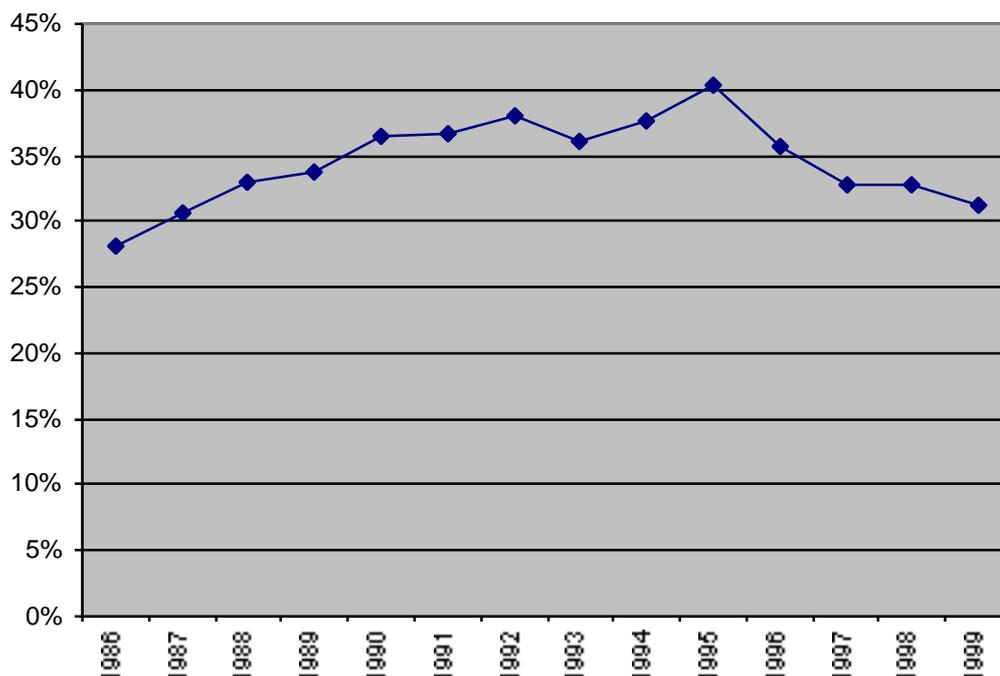
Accomplishments of the Task Force include:

- Amendment of the Buildings (Amendment) Ordinance 2000, to require mandatory provision of space for separation of waste and material recovery in all new building developments, that came into effect on 1 November 2000.
- As of August 2000, requirements on C&D material management were incorporated in the specification of the Housing Authority's contracts;
- In November 2000, Works Bureau issued Technical Circular No. 29/2000 requiring the submission of Waste Management Plans for all Public Works Programme contracts tendered on or after 1 January 2001;
- The works departments of the Government revised their specifications to allow the use of recycled aggregates in road sub-base and low-grade concrete;

Trends in per capita municipal solid waste generation and disposal



Percent of MSW recycled, 1986-1999



- In August 2000, the Civil Engineering Department set up a temporary sorting facility at Tseung Kwan O to recover public fill from mixed C&D materials;
- Since October 2000, the Construction Industry Training Authority has incorporated a 10-minute session on minimizing C&D materials at construction sites in its one-day Green Card courses; and
- Creation of “Waste Reduction Guidelines” covering the topics of “Planning for Waste Reduction,” “Low Waste Construction Designs and Technologies,” “Raw Material Management,” “Waste Management,” and “Education and Training.”

The Waste Reduction Task Force for the Airport Community is charged with reducing waste at one of the world's busiest international airports. Hong Kong International Airport is wholly owned by the Hong Kong Special Administrative Region Government and operated and maintained by the Airport Authority. The Task Force implemented a paper recycling program at the Airport Authority's offices in July 1999, collection of scrap heavy vehicle tires for re-treading in November 1999, and

Table 5: Number and type of businesses participating in the Wastewi\$e Scheme

Business Category	Number of entries*
Hotel/Hostel	45
Construction	21
Electricity and gas utilities	10
Property management	13
Government department	7
School	7
Engineering and Technical Services	9
Manufacturing	6
Retail and Trading	10
Hospital	5
Restaurant	3
**Others	9
Total	145

* Figures updated September 2001

** Others include financial institutions, associations, transport and amusement services.

collection programs for paper, toner cartridges, and aluminum cans in all Government offices sited at the airport in November 1999. The average quantity of materials recovered by the Airport Authority and the Government departments at the airport increased from 45 tonnes per month in 1999 (September to December) to 58 tonnes per month in 2000.

In 2000, the Government created a new Waste Reduction Task Force for the Recycling Trade to promote waste reduction initiatives within the recycling industry. The Task Force allocated sites to recyclers under short-term tenancy arrangements.

The EPD organized the WasteWiSe Scheme to help Hong Kong companies in protecting the environment, by providing them with free professional advice on ways to reduce and manage the waste they produce, as well as to reward them for their efforts. The Hong Kong Productivity Council is responsible for the co-ordination, assessment and provision of assistance to those companies that join the Scheme. By September 2001, over 140 organizations were participating in the Scheme.³

Other recycling ventures in Hong Kong include:

- By the end of 2000, the Food and Environmental Hygiene; Leisure and Cultural Services; and Agriculture, Fisheries and Conservation departments placed recycling bins at over 300 locations including public streets, bus termini, Mass Transit Railway (MTR) exits, and recreational venues for the collection of waste paper, aluminum cans and plastic bottles.
- The “Waste Paper Recycling Project in Schools” sponsored by the Food and Environmental Hygiene Department, the Environmental Campaign Committee of the EPD, and the Education Department. Ninety-nine schools participated in the pilot, which ran from December 1999 to July 2000. In this program the FEHD collected materials, at no cost to the schools, and delivered them to recyclers and brokers.
- Starting in 2000, commercial enterprises sponsored bin placement in public areas for paper collection in Central and Tsim Sha Tsui.

While the programs initiated so far are a step in the right direction, they do not go far enough. In fact, the recycling percentage of MSW has been lower in 1996-1999 than it was during 1990-1995.

Composting

EPD has installed a domestic size electric composter (capacity = 1kg per day) in the office at Kennedy Town.⁴

Swire SITA's wholly-owned subsidiary, Waylung Waste Collection collects livestock waste from 400 farms in the New Territories and, at its composting plant at Sha Ling, converts the waste into agricultural compost.

Education

Numerous governmental and non-governmental organizations participate in waste reduction and recycling education efforts in Hong Kong with the EPD leading the way. Examples of educational efforts include:

³ Waste Reduction Committee web site <<http://www.info.gov.hk/wrc/wastewise.htm>> visited September 28, 2001.

⁴ Waste Reduction Committee, “The Waste Reduction Framework Plan Annual Report,” *Waste as Resources*, Issue 4, March 2001, p. 12.

Table 7: Sites allocated to recycling industry since 1998

Site	Area (m ²)	Annual Rent (HK\$/year)	Tenant	Average Monthly Throughput	Original Lease Period
Sheung Shui Area 30A	16,000	642,000	Cheung Shing Metals Recycling Ltd.	Metals: 4,500 tonnes	September 1998 – August 2001
Kai Tak Main Fire Station	15,100	10,000	Hong Kong General Association of Recycling Business	Paper: 5,000 tonnes Metals: 800 tonnes	July 1999 – June 2002
Kai Tak Old Fire Station	3,900	864,000	Wai Hung Metal Ltd.	Metals: 300 tonnes	July 1999 – June 2000
Tai Po Industrial Estate	4,980	51,000	Jets Technics Ltd.	Tires: 200 tonnes Plastics: 50 tonnes	January 2000 – December 2002
Chong Fu Road, Chai Wan	2,530	600,000	Future's Safe Company Ltd.	Paper: 1,800 tonnes	July 2000 – June 2001
Yan Yue Wai, Yau Tong	2,100	364,000	Xun Xiang Metalware Co. Ltd.	Metals: 2,000 tonnes	July 2000 – June 2003
Chi Wa Lane, Sheung Shui	6,770	132,000	Yuen Hing Godown Co. Ltd.	Metals: 1,850 tonnes Plastics: 150 tonnes	July 2000 – June 2002

Note: All leases are renewable on a quarterly basis after the end of the initial lease period.

- EPD created two Environmental Resource Centres, one in each of Wan Chai and Tsuen Wan. Both Centres maintain exhibits on environmental topics; provide leaflets and publications from the Government, Environmental Campaign Committee, green groups, and other related organizations to visitors; maintain reference libraries containing environmental information; conduct guided tours for visiting groups; and house an interactive “Environmental Information System.” In addition, the Wan Chai Centre includes an environmental garden and the Tsuen Wan Centre includes a computer room and audio/visual center.
- EPD, the Healthy Living Campaign, and the Environmental Campaign Committee organized 120 environmental awareness and education programs in the year 1999 including 18 environmental community carnivals, 48 environmental training programs, 10 workshops, seminars and briefing sessions, 5 overseas training visits, and 13 environmental

Table 6: FEHD cleansing workforce and facilities

	March 31, 1999	March 31, 1998	March 31, 1997
Workforce (Persons)	7,184	7,424	7,546
Mechanical Sweepers	48	48	48
Street-washing Vehicles	77	76	76
Refuse Collection Vehicles	437	456	465
Refuse Collection Points	1,101	1,104	1,105
Public Toilets	278	272	266
Public Bathhouses	44	43	42
Aqua Privy	603	710	638

- drama sessions for schools.
- EPD is working with District Councils to enhance public awareness and participation in waste reduction at the district level. In 2000, EPD attended more than 15 District Council and their sub-committee meetings, building management seminars, and carnivals to introduce the Waste Reduction Framework Plan and solicit their support for waste reduction and recovery.

Government expenditures for waste reduction and recycling

It is difficult to arrive at a firm figure for Government expenditures on waste reduction and recycling activities. The figures are buried in the budgets of the Departments, Committees, and Task Forces involved in the numerous governmental projects. However, it is safe to say the total expenditures are well below the billions of dollars the Government spends on waste disposal each year. For example, the Government established the Environment and Conservation Fund in June 1994. The Government capitalized the fund with \$50 million in 1994 and a further \$50 million in 1998. In September 2001 the Government announced a further \$100 million injection into the fund pending approval by the Finance Committee of the Legislative Council. Other expenditures include EPD outlays of \$2.5 million in 1999-2000 to organize the environmental education program and a further \$1 million from the Environment and Food Bureau spent organizing relevant activities under the Healthy Living Campaign. Furthermore, the Government has made only limited capital investments in recycling and waste reduction facilities. The one notable exception is the Sha Ling composting plant, built in 1991 at a cost of \$14 million. In contrast, the capital cost of the three strategic landfills was over \$6 billion. In summary, the Government's stated policy priorities – which give precedence to waste reduction and recycling – and its spending priorities are exactly opposite.

Collection and disposal system

Storage

In most residential high-rise buildings, residents deliver discarded materials to trash bins located on each floor. Cleaners empty the bins at least once per day, and in some buildings twice per day, and transport the materials to the ground floor or basement via lift for storage. A few housing estates have chutes on each floor for moving trash to the basement. In some cases there are bins on the bottom floor for recyclables and reusable discards.

Commercial storage ranges from baskets and stacks of cardboard in front of buildings to bin systems in tall buildings and industrial sites.

Collection

The Food and Environmental Hygiene Department operates a fleet of about 400 modern refuse collection vehicles, most rear-loading compactor trucks. Every day, the Department staff and contractors collect nearly 6,000 tonnes of waste from residences, 158 permanent public refuse collection points, and the approximately 17,000 litter containers and 410 dog excreta collection bins placed on the streets. This includes approximately 1,300 tonnes from Hong Kong Island, 1,900 tonnes from Kowloon, and 2,800 tonnes from New Territories and outlying islands. Collection trucks deliver collected trash to one of the EPD's transfer stations or landfills.

The Marine Department scavenges and collects marine refuse through a combined fleet of 13 Government launches and 57 contractors' vessels.

Commercial and industrial waste generators pay private companies for waste collection.

Disposal

Currently, the EPD charges no tip fee at its landfills. EPD does charge a tip fee for waste delivered to its transfer stations by private waste collection companies. These fees are meant to cover the cost for transportation of materials from the transfer station to one of the Region's strategic landfills. Businesses benefit from free disposal that is paid for out of general tax revenues. The EPD is considering introducing a landfill tip fee for industrial, commercial, and construction waste in order to encourage waste reduction and recovery.

At present, the Government pays nearly all waste disposal costs. For instance, disposal at landfills is free while charges for the use of the Chemical Waste Treatment Centre is currently set at 31% of the variable operating cost. In 1999, the recurrent expenditure on waste management was \$1.5 billion. This does not include capital costs. Between April 1989 and March 2000, more than \$10.2 billion has been invested in new waste management facilities. These comprise:

- Three new strategic landfills with leachate and gas collection (\$6.1 billion);
- Seven refuse transfer stations and refuse transfer facilities for the outlying islands (\$2.8 billion);
- A chemical waste treatment center (\$1.3 billion); and
- A livestock waste composting plant (\$14 million)

In addition, \$2.3 billion is being spent on restoration of 13 old landfill sites to ensure safety and to provide for the future beneficial uses of the space created.

In Hong Kong, waste management costs are for the most part hidden from those who produce the waste. For example, public housing tenants only pay for the first step in handling their waste - moving it from their flat to the refuse collection point (RCP) - but that cost is hidden in the rent. Commerce and industry pay for the collection of their waste, but the Government pays most of the subsequent handling and all of the disposal costs. Therefore, the Hong Kong Government subsidizes wasting.

Future disposal plans

Dwindling disposal capacity has become a pressing concern for Hong Kong. According to the Waste Reduction Framework Plan (WRFP), landfill capacity in the Region will be exhausted in 2015 or sooner. More recent EPD data indicates that the three existing strategic landfills could become full between 2005 and 2008. Even the best-case scenario does not look good. According to the Government, if the municipal solid waste reduction targets set in the WRFP are achieved, the quantities of municipal solid waste requiring disposal by 2007 will be reduced from 4.57 million tonnes to 2.75 million tonnes and the life of the existing strategic landfills will be extended by 4 years, to 2019.

Since the lead-time for planning and construction of solid waste facilities can be a decade or longer, the Government has begun the process of new facilities planning. The Government is considering both incineration and new landfill development.

Incineration

According to ACE Paper 03/2000, entitled "Annual Review - Waste Reduction Framework Plan":

“Modern waste-to-energy incinerators burn combustible municipal solid waste to recover energy and reduce the volume of waste requiring final disposal by up to 85%. Reliable and proven technologies are available to meet the most stringent air emission standards.

We plan to develop waste-to-energy incineration facilities (WEIFs) capable of handling a total of 6,000 tonnes of waste per day. A feasibility study is being conducted and will be completed by early 2000. Public consultation will follow. Subject to availability of funding, it is expected that the first WEIF will be commissioned in 2007.”

To this end, the Government has reserved \$9,780 million of its Capital Works Reserve Fund for the development of two waste-to-energy incinerators with an overall capacity of 6,000 tonnes per day. This figure has been steadily increasing. In its 1996 “Draft Waste Reduction Plan” the Environment and Food Bureau estimated the capital costs of the proposed incinerators to be \$6.4 billion. Just a year later the “Waste Reduction Framework Plan” estimated the costs to be \$7.6 billion.

Table 8 presents costs of selected incinerators proposed or built around the globe. These incinerators' average capital costs are \$1.4 million per tonne-per-day of

Table 8: Capital costs of selected incinerators around the globe

Locality	Status	Capacity (tpd)	Capital Cost	Capital Cost (HK\$)	Capital Cost/tpd Capacity (HK\$)
Dongguan City, China	Unclear	900	US\$50 million	\$390 million	\$433,000
Shenzen, China	Operating	300	Y1.2 billion	\$1,130 million	\$3,770,000
Shanghai, China	Approved	1,500	US\$86 million	\$670 million	\$447,000
Chennai, India	Approved	600	US\$40 million	\$312 million	\$520,000
Ringaskiddy, Ireland	Proposed	100	IR pound 75 million	\$660 million	\$6,600,000
Tokyo, Japan	Operating	400	US\$700 million	\$5,460 million	\$13,700,000
Ibaragi Prefecture, Japan	Operating	180	18 billion yen	\$1,140 million	\$6,330,000
Lublin, Poland	Proposed	~375	US\$30 million	\$234 million	\$624,000
Kwangju, South Korea	Not operating	400	60 billion won	\$369 million	\$923,000
Sanggye-dong, South Korea	Operating	800	80 billion won	\$492 million	\$615,000
Pusan, South Korea	Proposed	200	85 billion won	\$523 million	\$2,620,000
Suwon, South Korea	Operating	600	90 billion won	\$553 million	\$922,000
Chung Lie City, Taiwan	Approved	1,350	NT\$4.6 billion	\$1,040 million	\$770,000
Kaohsiung, Taiwan	Implemented	1,800	NT\$6.9 billion	\$1,560 million	\$867,000
Kaohsiung, Taiwan	Implemented	900	NT\$3-4 billion	\$794 million	\$882,000
Tainan Town West, Taiwan	Implemented	900	NT\$3.8 billion	\$862 million	\$958,000
Phuket Island, Thailand	Operating	250	780 million baht	\$138 million	\$552,000
Tambon Nong Yai, Thailand	Proposed	Unknown	900 million baht	\$159 million	Unknown
Guam, U.S.	Proposed	~15	US\$13.2 million	\$103 million	\$6,870,000

tpd = tonnes per day

Note: Costs have been converted to HK\$ using November 2001 rates posted on the Universal Currency Converter Web site at: <http://www.xe.com/ucc>

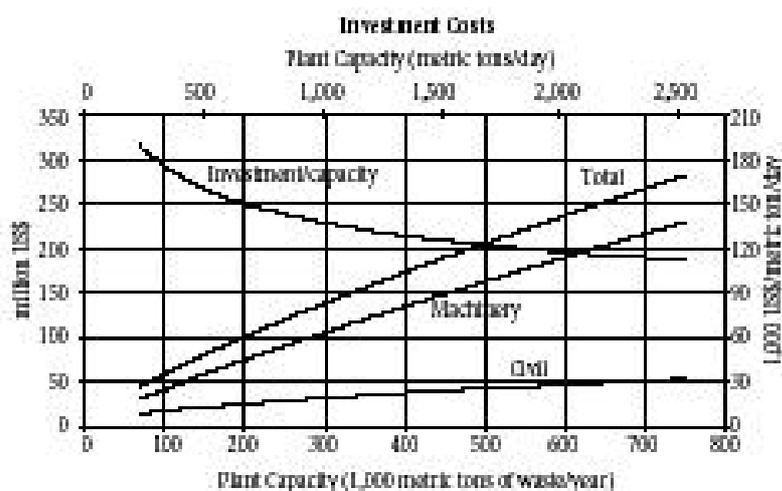
Source: GAIA's Waste Incineration Database maintained by Pawel Gluszynski, Waste Prevention Association, Krakow, Poland. For more information, contact action@essential.org.

installed capacity. Contrast this data with the World Bank's data on investment costs for incineration plants shown in Figure 1. The World Bank estimates capital costs per tonne-per-day capacity for a 2,500 tonne per day incinerator to be approximately US\$115,000 or HK\$900,000. However, this estimation is based on plants with “mid-level” air pollution control systems, i.e., plants with a medium standard for particle emission and additional standards for hydrochloric acid, hydrofluoric acid, sulfur dioxide, and the heavy metals of arsenic, cadmium, chromium, copper, lead, manganese, mercury, and nickel. A typical state-of-the-art emission control system will include stricter standards for the medium level parameters and supplementary control of oxides of nitrogen, antimony, cobalt, thallium, vanadium, and dioxins. Such a pollution control system would add approximately 15% to the project cost.⁵

According to a recent World Bank report, net treatment costs per tonne incinerated for a 2,500 tonne-per-day incinerator should be approximately US\$35 or HK\$270.⁶ Again, this figure is based on a plant with “mid-level” air pollution control systems operating at or near its design capacity. State-of-the-art pollution control systems, waste with a low heating value, and operating the plant below capacity could substantially increase these costs.

Demolition and/or decontamination of the incinerator facility at the end of its useful

Figure 1: Investment costs for waste incineration plants



Source: T Rand, J Haukohl, and U. Marxen, *Municipal Solid Waste incineration: A Decision Maker's Guide*, The World Bank, Washington, DC, 2000, p. 8.

Notes: This chart is based on costs in 1998 with the assumptions that operating time is 7,500 hours annually, the waste burned has a lower calorific value of less than 9.0 MJ/kg, and generated electricity is sold for \$35/MWh. Furthermore, plants are assumed to have “mid-level” air pollution control systems.

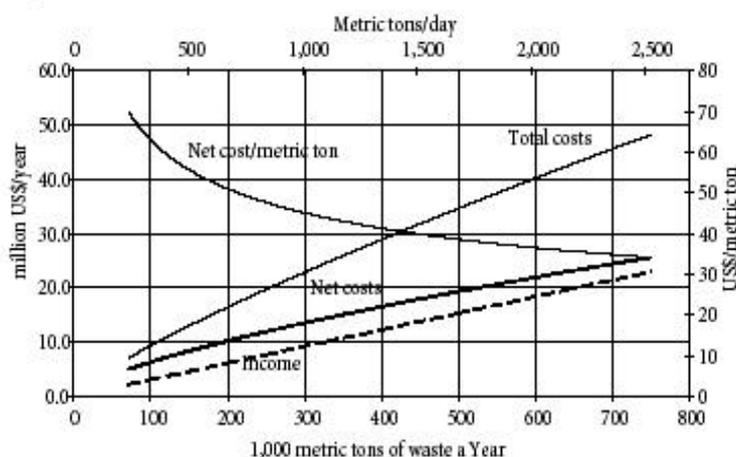
⁵ T Rand, J Haukohl, and U. Marxen, *Municipal Solid Waste incineration: A Decision Maker's Guide*, The World Bank, Washington, DC, 2000, p. 13.

⁶ T Rand, J Haukohl, and U. Marxen, *Municipal Solid Waste incineration: A Decision Maker's Guide*, The World Bank, Washington, DC, 2000, p. 8.

life will also add to the total cost. However, since most modern incinerators have a 20-year or longer lifespan and few have been retired, cost data for this process is not available.

In September 2001, the EPD announced “New Initiatives to Promote Domestic Waste Prevention and Recovery.” The initiatives include measures to provide land for businesses involved in recycling activities, creation of a fund to support community-based waste prevention and recovery programs, increased availability of recycling facilities, and education programs.

Figure 2: Estimated operating costs for MSW incineration plants



Source: T Rand, J Haukohl, and U. Marxen, *Municipal Solid Waste incineration: A Decision Maker's Guide*, The World Bank, Washington, DC, 2000, p. 8.

Notes: This chart is based on costs in 1998 with the assumptions that operating time is 7,500 hours annually, the waste burned has a lower calorific value of less than 9.0 MJ/kg, and generated electricity is sold for \$35/MWh. Furthermore, plants are assumed to have “mid-level” air pollution control systems.

Hong Kong Initiatives to Promote Domestic Waste Prevention and Recovery announced in September 2001

Long-term Land for Waste Recovery

- Twenty hectares of industrial land in Tuen Mun Area 38, with sea frontage to facilitate loading and unloading activities, has been set aside as a Recovery Park. With an area bigger than Victoria Park, the first phase of the park is expected to start operation in early 2004
- Eight pieces of land for the recycling industry have already been made available in the form of short-term tenancy. More short-term land will be identified for this purpose

Injection into Environment and Conservation Fund

- Subject to the approval from the Finance Committee of the Legislative Council, a \$100 million will be injected into the Environment and Conservation Fund to support community-based waste prevention and recovery programs
- The Fund is open to application by district groups, green groups, etc., to carry out waste reduction/recovery work and activities

Strengthened Support for Recycling

- Newly-designed separation bins will gradually hit the streets in the coming weeks --- blue for waste papers; yellow for aluminum cans, and brown for plastic bottles
- The number of waste separation bins, conveniently placed in public places, schools and public estates, will be doubled from 8,000 to 16,000
- Collection services of recyclable materials will be enhanced
- Commercial buildings, private premises and owners incorporations will be encouraged to place more waste separation bins

Setting up of a Recycling Helpline

- A recycling helpline (**2755 2750**) has been set up by the Environmental Protection Department to provide the public with professional advice and assistance on how private premises may facilitate waste reduction and separation

Sustained Public Education

- A sustained public education and community involvement program will be launched to ensure sustained participation of the public in waste prevention and recovery
- The program slogan will be "**Be Bright, Recycle Right!**"
- The central Government will provide closer cooperation with district councils, green groups, and community organizations in staging large-scale community-based waste reduction and recycling projects

Waste Reduction Work of Government Departments

- The Government will continue to increase the use of recycled paper and to reduce overall paper consumption
- The Government will formulate procurement guidelines that encourage waste prevention and recycling
- Suppliers have been asked to reduce packaging to the absolute minimum
- Wherever practicable, departments will use re-treaded tires in their vehicle fleet and those involved in greening work will use compost produced from organic waste

Producer Responsibility Schemes

- The Government, in partnership with the business sector, will actively examine trial programs to recycle special wastes such as glass bottles, batteries and computers.

Environmental impact

Major environmental impacts of waste management in Hong Kong include air pollution, water pollution, resource depletion, and greenhouse gas production.

Air

Principal sources of air pollution from Hong Kong's current waste management system include emissions from collection trucks and other transportation systems, and emissions at disposal facilities.

Transportation of refuse

Currently, the FEHD operates a fleet of about 400 refuse collection vehicles, all diesel powered. FEHD staff deliver collected refuse to one of Hong Kong's refuse transfer stations or directly to one of the territory's three strategic landfills. Diesel vehicles emit exhaust, a complex mixture of hundreds of constituents in either a gas or particle phase. The gases emitted by diesel vehicles include carbon dioxide, oxygen, nitrogen, water vapor, carbon monoxide, nitrogen compounds, sulfur compounds, and low-molecular-weight hydrocarbons. Diesel exhaust also includes particles composed of elemental carbon, adsorbed organic compounds, and small amounts of sulfate, nitrate, metals, and other trace elements.

Of particular concern for environmental protection are the oxides of nitrogen and organic compounds produced by diesel engines. Both classes of compounds are ozone precursors. Ground-level ozone can impair the ability of plants to produce and store food, inhibits growth and reproduction, and diminishes plant health. These effects, in turn, weaken the ability of plants to survive disease, insect attacks, and extreme weather. Ozone can also damage crops including soybeans, kidney beans, wheat, and cotton and disrupt ecological functions (such as water movement and mineral nutrient cycling) in forests and other ecosystems.⁷ Particulate matter in diesel exhaust can soil manmade materials, speed their deterioration, and impair visibility.

The environmental impact of the diesel emissions of FEHD's refuse collection fleet is impossible to estimate without detailed data on exact fleet composition, fleet use data, and specific emission data. Private collection vehicles produce additional air emissions but these are also impossible to estimate.

EPD waste transportation activities also produce air emissions, specifically during barging and trucking of materials from its refuse transfer station to its strategic landfills.

Flared landfill gas

Flaring of landfill gas, as done at EPD facilities in Hong Kong, releases toxic chemicals into the atmosphere. Typically, landfill gas from an MSW landfill is only 50% methane with the remainder composed of carbon dioxide, nitrogen, oxygen and non-methane organic compounds (NMOCs). The U.S. Environmental Protection Agency (U.S. EPA) has identified more than 40 halogenated NMOCs often present in

⁷ United States Environmental Protection Agency Office of Air Quality Planning and Standards, Regulating Smog and Particle Air Pollution: An Integrated Approach, Document number EPA456-F-97-003, March 1997, p. 5.

landfill gas.⁸ Combustion of halogenated chemicals in the presence of hydrocarbons can produce dioxins and furans.

Water

The primary cause of water pollution from waste management activities results from landfill leachate reaching groundwater sources. The proximity of some of Hong Kong's landfills to the harbor and ocean also places these waters at risk for contamination. All landfills produce some leachate. Factors affecting the composition of landfill leachate include materials buried in the landfill, conditions in the landfill (pH, temperature, degree of ongoing decomposition, moisture content, climate, and landfill age), and characteristics of water entering the landfill. Generally leachate has a high biochemical oxygen demand (BOD) and high concentrations of organic carbon, nitrogen, chloride, iron, manganese, and phenols. Many other chemicals may be present, including pesticides, solvents, and heavy metals.

EPD has a stringent program to prevent water pollution at its three strategic landfills. Each landfill is lined with a series of membranes to contain leachate. The program includes monitoring of pollutants in stream courses, groundwater, and seawater; sampling of leachate at the facilities; and measuring heavy metal concentration in oysters near landfills. If the measurements of any of these factors exceed standards set by the EPD, contracted landfill operators must take corrective action or lose part of their fees for operating the facility. Furthermore, the landfill contractors are responsible for aftercare at each of the facilities for a period of 30 years after the completion of operations.

Hong Kong has 13 closed landfills that cover more than 300 hectares. As part of a program to return these sites to productive use, EPD has commissioned contractors to carry out restoration work and subsequently maintain the sites for an additional 30 years. The

restoration contracts include requirements that contractors create leachate collection and treatment system to protect water resources. These efforts to protect water resources only serve to defer the problems to future

Table 9: Ranges of various parameters in leachate as determined by different researchers

Parameter	Ehrig, 1989	Qasim and Chiang, 1994	South Florida Water Management District, 1987	Pohland and Harper, 1985
BOD (mg/L)	20 – 40000	80 – 28000	---	4 -57700
COD (mg/L)	500 – 60000	400 – 40000	530 – 3000	31 - 71700
Iron (mg/L)	3 – 2100	0.6 – 325	1.8 – 22	4 -2200
Ammonia (mg/L)	30 – 3000	56 – 482	9.4 – 1340	2 -1030
Chloride (mg/L)	100 – 5000	70 – 1330	112 – 2360	30 - 5000
Zinc (mg/L)	0.03 – 120	0.1 – 30	---	0.06 - 220
Total P (mg/L)	0.1 – 30	8 – 35	1.5 – 130	0.2 - 120
pH (units)	4.5 – 9	5.2 - 6.4	6.1 - 7.5	4.7 - 8.8
Lead (mg/L)	0.008 - 1.020	0.5 - 1.0	BDL - 0.105	0.001 - 1.44
Cadmium (mg/L)	< 0.05 - 0.140	< 0.05	BDL - 0.005	70 - 3900

Source: Debra R. Reinhart, Ph.D. and Caroline J. Grosh, *Analysis of Florida MSW Landfill Leachate Quality*, Florida Center for Solid and Hazardous Waste Management, University of Central Florida, Gainesville, July 1998.
BDL - below detection limits

⁸ US Environmental Protection Agency Office of Air Quality, *Air Emissions from Municipal Solid Waste Landfills - Background Information for Proposed Standards and Guidelines, Document # EPA/450/3-90/011A*, March 1991.

generations. According to the U.S. EPA “even the best liner and leachate collection systems will ultimately fail due to natural deterioration.”⁹ When failure does occur, leaks may occur via small holes, rips, tears, and points of deterioration, allowing finger-like plumes of leachate to pass into the surrounding areas. These plumes are likely to pass between monitoring wells without being detected and contaminate groundwater.¹⁰ Furthermore, these leaks may occur after the 30-year monitoring requirement for landfills in Hong Kong has expired.

However, liner failure is not the only way contaminants can escape from landfills. Chemicals typically present in leachate, such as chlorinated solvents, benzene, trichloroethylene, and vinyl chloride can pass through intact flexible membrane liners.¹¹

In summary, the only way to prevent water pollution from landfills is to eliminate landfills.

It is difficult to predict the environmental consequences of water pollution from Hong Kong's landfills. The effects will come many years in the future and the amount of leachate released and its chemical composition are unknown. Furthermore, since much of the contamination will result from future liner failure, it is impossible to predict where the contamination will occur.

Resource use

Most of Hong Kong's industries rely on imported raw materials and Hong Kong's consumers rely on imported goods for many of their needs. For example, Hong Kong is the fourth largest printing and publishing center in the world - home to 44 newspapers, 708 periodicals, 140 international media organizations, and more than 200 publishing houses. In 1997, materials printed in Hong Kong had a value of HK\$33,843 million, almost all produced on imported paper. Yet Hong Kong has a vast supply of raw materials from which to manufacture paper, plastics, metals, glass, and compost. Unfortunately, most of these resources are buried in landfills.

In 1999, 883,300 tonnes of paper, 653,350 tonnes of plastics, and 94,900 tonnes of metals were disposed in Hong Kong landfills. Based on the market prices paid to Hong Kong recyclers for these recovered commodities on the export market in 1999, more than HK\$2 billion dollars worth of resources were simply buried.¹²

Burying resources in landfills also removes land from productive use for the foreseeable future. Hong Kong has 6,571 residents per square kilometer of land. In actuality the population is much denser because much of the existing land cannot be developed. Waiting times for public housing units is often years. High land prices have driven industry to locate on the Chinese Mainland and other countries. New large developments often have to be sited on reclaimed land, Chek Lap Kok Airport, for example, was built on 1,250 hectares of reclaimed land. In fact, human remains buried in public cemeteries in Hong Kong must be exhumed after six years for

⁹ United States Environmental Protection Agency, “Solid Waste Disposal Facility Criteria; Proposed Rule,” *Federal Register* 53(168), 40 CFR Parts 257 and 258 (Washington, DC: U.S. EPA, August 30, 1988), pp. 33314-33422.

¹⁰ G. Fred Lee, Ph.D., P.E., D.E.E., and Anne Jones-Lee, Ph.D., *Three R's Managed Garbage Protects Groundwater Quality*, (El Macero, California: G. Fred Lee & Associates, May 1997).

¹¹ G. Fred Lee and A. Jones-Lee, "Landfill Leachate Management," *MSW Management* 6:18-23 (1996).

¹² ILSR calculated this value based on \$2,234/tonne for plastics, \$1,055/tonne for ferrous metals, and \$601/tonne for paper. These figures represent the average value per unit weight of exported recyclable materials in 1999 as reported in “Monitoring of Solid Waste in Hong Kong 1999,” by the Hong Kong Environmental Protection Department and assumes all metal disposed consisted of ferrous scrap. Furthermore, this calculation does not include the value of other materials disposed, including glass, textiles, and wood.

Table 10: Methane yield from selected landfilled solid waste components

Material	Selected Methane Yield (metric tons of carbon equivalent (MTCE) / wet tonne)
Newspaper	0.285
Office Paper	1.328
Corrugated Boxes	0.591
Coated Paper	0.323
Food Scraps	0.369
Grass	0.235
Leaves	0.183
Branches	0.187
Yard Trimmings	0.210

Source: U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response, *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, EPA530-R-98-013, September 1998, p 104.

impacts of the build up of greenhouse gases in the atmosphere of especial concern to Hong Kong are rising sea levels and the spread of infectious diseases and increased heat-related mortality.

The U.S. EPA estimated the methane yield of various materials commonly buried in landfills. Using these results, a conservative estimate of the methane yield of Hong Kong refuse buried in the Region's landfills in 1999 is 567,000 metric tonnes of carbon equivalent.¹³ It would be necessary to burn nearly 64 million gallons of gasoline to produce an equal amount of greenhouse gases.

Social impacts

Solid waste management systems affect employment, health, and the quality of life of residents in the Region. Furthermore, the distribution of these effects raises questions of environmental justice, such as, whether specific population groups shoulder a disproportionate share of burdens imposed by the system.

Employment

Of all waste management systems, bulk disposal in landfills and

cremation or re-interment in an urn cemetery. Ironically, only waste gets a permanent burial in Hong Kong. This removal of land from productive use imposes significant costs on society that are often not included in conventional accounting.

Greenhouse gases

Landfill disposal of wastes produces greenhouse gases. As materials in the wastes decompose, they release methane, a gas that traps radiant heat in the Earth's atmosphere, creating global warming. Methane is a very powerful greenhouse gas that has a heat-trapping potential 21 times that of CO₂. Potential

Table 11: Job creation in the U.S. from reuse and recycling Vs. disposal

Type of Operation	Jobs per 10,000 tpy
Product Reuse	
Computer Reuse	233
Textile Reclamation	93
Misc. Durables Reuse	69
Wooden Pallet Repair	31
Recycling-based Manufacturers	
Paper Mills	19
Glass Product Manufacturers	29
Plastic Product Manufacturers	102
Conventional Materials Recovery Facilities	12
Composting	4
Landfill and Incineration	1

tpy = tonnes per year
 Note: Figures are based on interviews with selected facilities around the U.S.
 Source: Brenda Platt and Neil Seldman, *Wasting and Recycling in the United States 2000* (GrassRoots Recycling Network, Athens, Georgia: 2000), p 27.

¹³ ILSR calculated this value assuming all paper landfilled in the year was newspaper, the category with the lowest methane yield. The putrescible component of disposal was assumed to be half food discards and half leaves.

incinerators sustains the fewest jobs. For example, typical landfills and incinerators in the United States sustain only one job on average for every 10,000 tonnes of materials handled each year. In contrast, sorting facilities for mixed recyclables employ an average of 12 people for every 10,000 tonnes per year, and paper mills using recycled feed stocks employ 19 jobs for every 10,000 tonnes of material recycled.

Health impacts

Air pollution from landfills

Principal gases found in landfills include ammonia (NH₃), carbon dioxide (CO₂), carbon monoxide (CO), hydrogen (H₂), hydrogen sulfide (H₂S), methane (CH₄), nitrogen (N₂), and oxygen (O₂). While methane and carbon dioxide typically constitute around 80-90% of the gas produced, numerous other gases are often present in small amounts including toluene, benzene, chloroform, carbon

Table 12: Potential health effects from gaseous components of landfill gases and their combustion products

Compounds	Potential health effects
carbon monoxide (CO)	Exposure to low levels of carbon monoxide can produce throbbing headache, dizziness, fatigue, and shortness of breath. Exposure to high levels can result in severe headache, weakness, dizziness and nausea, and irregular heartbeat and unconsciousness.
hydrogen sulfide (H ₂ S)	Short-term exposure to moderate amounts of hydrogen sulfide produces eye, nose and throat irritation, nausea, dizziness, breathing difficulties, headaches and loss of appetite and sleep. Continued exposure can irritate the respiratory passages and can lead to a buildup of fluid in the lungs. Exposure to high levels can cause muscle cramps, low blood pressure, slow respiration and loss of consciousness.
toluene	Damage to the brain, liver, bone marrow and kidneys
benzene	Acute: drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness Chronic: aplastic anemia, acute myelogenous leukemia, liver cancer
chloroform	Damaged liver or kidney function, cancer
carbon tetrachloride	Nerve damage, digestive disorders, weight loss, tiredness, confusion, depression, loss of color vision and liver damage including cancer.
vinyl chloride	Liver, lung and several other types of cancer; increased risk of miscarriage and birth defects; damage to male sperm-producing organs; damage to liver, kidney, lung, spleen, nervous system and immune systems; decrease in bone strength; and blood disorders
trichloroethylene	Heart defects in the offspring of exposed pregnant women; kidney, liver, and lung damage
methylene dichloride	Probable human carcinogen, damage to the heart and nervous system.
Dioxins and furans	Cancer; behavioral effects and learning disorders; decreased immune responses; decreased male sex hormone; diabetes; chloracne; sperm loss; and endometriosis.

Sources: Wisconsin Department of Health and Family Services, Toxic Chemical Fact Sheets for carbon monoxide, toluene, chloroform, carbon tetrachloride, vinyl chloride, and methyl chloride. Fact sheets available at <http://www.dhfs.state.wi.us/dph_beh/Env_Health_Resources/Chemical_Fact_Sheets/ChemFactShtslndex.htm>. New York State Department of Health Hydrogen Sulfide Chemical Information Sheet, available at <<http://www.health.state.ny.us/nysdoh/envirom/btsa/sulfide.htm>>. The Clark Fork-Pend Oreille Coalition, Health and Environmental Effects of Dioxin, available at <<http://www.clarkfork.org/health.html>>. All sites visited on October 16, 2001.

tetrachloride, vinyl chloride, trichloroethylene, and methylene dichloride. The composition of the waste buried in landfills is varied; therefore, it is impossible to predict the exact composition of gases produced.

Combustion of landfill gas, either in a flare or for energy production, does destroy some of the pollutants in it. However, combustion of landfill gas can transform halogenated compounds into dioxins and furans, compounds that can cause adverse health impacts.

Water pollution

Landfill leachate can be extremely toxic. A 1988 study reported that leachate from municipal waste landfills in the U.S. is as dangerous to human health as the leachate from hazardous waste landfills. The study found 32 chemicals that cause cancer, 13 that cause birth defects, and 22 that cause genetic damage, present in leachate from municipal waste landfills.¹⁴ As with assessing environmental impact, it is difficult to assess health effects of landfill leachate on human populations because of variability in the conditions at each landfill. The only certainty is that leachate **will** escape the landfill.

Occupational hazards

Workers in waste management industries are exposed to multiple hazards while performing their jobs. According to the World Health Organization, these hazards can include:

- Skin and blood infections resulting from direct contact with waste and from infected wounds;
- Eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations;
- Diseases resulting from bites by wild or stray animals feeding on wastes;
- Enteric infections transmitted by flies feeding on wastes;
- Musculoskeletal disorders resulting from the handling of heavy containers;
- Wounds, most often infected, resulting from contact with sharp items;
- Poisoning and chemical burns resulting from contact with small amounts of hazardous chemical waste mixed with general wastes; and
- Burns and other injuries resulting from occupational accidents at waste disposal sites or from methane gas explosion at landfill sites.¹⁵

Of especial concern in Hong Kong are the working conditions of itinerant waste scavengers. Hong Kong does not have communities of waste pickers living at its disposal facilities as in many other Asian countries. However, the working conditions of the scavengers are still very difficult. A June 2001 article in the *Sunday Morning Post* profiled one of the many scavengers collecting recyclables in Hong Kong. Lui Yick-kiu, 83, works 10 hours a day sorting through refuse stations and litter bins for newspaper and cardboard she can sell. Her income is so meager she often cannot afford nutritious food, such as meat and vegetables.¹⁶ Furthermore Lui Yick-kiu would lose her scavenging income in the event of injury or illness.

¹⁴ Dr. Kirk Brown and Dr. K.C. Donnelly, "An Estimation of the Risk Associated with the Organic Constituents of Hazardous and Municipal Waste Landfill Leachates," *Hazardous Wastes and Hazardous Materials*, Vol. 5, No. 1 (Spring, 1988), pp.1-30.

¹⁵ World Health Organization, "Poor Sanitation: the Global Magnitude of the Problem: Extracts from the WHO's report to the Special Session of the UN General Assembly, June 1997," *Environmental Health Newsletter*, No. 27, October 1997.

¹⁶ Ella Lee, "\$10-a-day worker," *Sunday Morning Post*, June 17, 2001, Sunday Review p. 1.

Quality of life

Hong Kong's current waste management system does not offer residents and businesses truly convenient opportunities to recycle. Furthermore, the system does not adequately discourage littering or provide clear social or economic signals supporting waste reduction. Consequently, Hong Kong's society is wasteful, and growing more so. For example, per capita generation and disposal of municipal solid waste has shown a steady increasing trend since 1996.

The Hong Kong Government has made great strides in making recycling more convenient in public areas. The proliferation of products in disposable packaging makes consumption away from home much easier than in the past. Without recycling opportunities that are clearly marked and as easy to use as trash receptacles, many recyclable materials end up in landfills. While Hong Kong now has more than 300 recycling receptacles in public areas, the number is dwarfed by the more than 17,000 trash receptacles located in public spaces. Consequently, it is often much easier to simply drop beverage containers and newspapers in trash receptacles or on the ground than hunt for one of the few recycling points.

In the absence of convenient recycling bins, deposit-refund systems can provide an economic incentive to discourage disposal of recyclables and littering. In fact, in the U.S. most deposit-refund systems were first implemented as litter control efforts.

The ease of disposal versus recycling is also present in most residential properties. For example, in most public housing developments, residents may set their trash outside their flat door where it will be collected by cleansing staff. On the other hand, recycling opportunities, when present, consist of bins located in public areas – usually in lobbies or on ground floors. Residents must store recyclables in their flats until they are going past the bins or make a special trip to recycle.

Many businesses also find it more convenient to simply dispose of recyclable items. Without economic feedback, such as tip fees for waste disposal, many businesses will not make the extra effort to source separate garbage. Many businesses could start recycling programs for the low costs of the placement of bins and a basic educational program, but the extra cost is difficult to justify when disposal is free. In contrast, in other countries such as the U.S. and Germany, where recycling helps companies avoid disposal charges, businesses find recycling programs favorably affect their bottom line.

Creation of incineration capacity would most likely lead to sustained wastefulness in Hong Kong's society. Incinerators need a minimum amount of garbage daily to operate properly and generate electricity. Because of their voracious need for discards for fuel, incinerators lock up the waste stream. They encourage increased product consumption and waste generation. They discourage waste reduction and sustainable methods of production and consumption.

If recycling programs successfully reduce waste streams below the amount of waste needed by an incinerator, local authorities can find themselves paying for the incineration of waste that does not exist. A more likely scenario is that the incinerator will hamper waste reduction efforts, because it needs to burn materials to make good on its debt payments. Furthermore, these behemoths soak up so much of a solid waste budget that usually little money is left for comprehensive recycling and composting programs. For example, the Polish National Fund for Environmental Protection (NFOSiGW) provided a loan to build a municipal solid waste incinerator in Warsaw on the condition that the Warsaw authorities continue to finance separate waste collection and recycling. However, right after they obtained the loan, the

Warsaw City Council violated the agreement and cut finances for its recycling program.¹⁷

Environmental justice

What is environmental justice? There is no single answer but most definitions boil down to the concept that no sector of the population should shoulder an unfair burden (whether exposure to pollution or a disproportionate share of expenses) as the result of activities that affect the environment.

In Hong Kong, perhaps the most glaring example of environmental injustice is that waste generators do not pay for waste management in proportion to their generation. Businesses pay for Government services through a flat 15% tax on business profits. Therefore, a company producing 2,000 tons of waste a year and earning \$1,000,000 in profits pays the same taxes as another company with the same profits which only produces 500 tons of waste a year.

The itinerant recyclers in Hong Kong suffer other environmental injustices. Most work long days for little compensation and receive no Government compensation although they provide a valuable service to the Government. Each ton of waste collectors divert from disposal saves the Government more than \$100 in disposal costs.

Environmental and health impacts of incineration

The Hong Kong Government's plans to develop waste-to-energy incineration facilities capable of handling a total of 6,000 tonnes of waste per day will create additional environmental pollution without creating a long-term solution for waste management.

Air pollution

Incineration proponents argue that it is safe. But, in fact, incinerators are major – and in many areas the largest – sources of such pollutants as dioxin, lead, and other heavy metals released into the environment. Incinerators also release carbon monoxide, oxides of sulfur and nitrogen, hydrocarbons, and particulates into the air. Table 13 compares the pollution from a typical 2,000-ton per day (1,800 tonnes per day) incinerator with the pollution produced by automobiles.

In developed countries, air pollution control equipment lessen the release of many pollutants, but they also increase costs significantly. The better the pollution control and regulatory oversight, the higher the costs. In the United Kingdom, for example, around 30% of the capital costs of a conventional British incineration facility is attributable to the flue gas clean-up system.¹⁸ In the Netherlands, a 1,800 tonne-per-day facility, which went on line near Amsterdam in 1995, cost US\$600 million with half the investment going into air pollution control.¹⁹ In the United Kingdom, owners of the Sheffield incinerator spent over 28 million pounds bringing the facility up to the new European standards. As a result, the local government council can no

¹⁷ GAIA's Waste Incineration Database maintained by Pawel Gluszynski, Waste Prevention Association, Krakow, Poland. Please contact GAIA at <gaia@no-burn.org> for more information on this database.

¹⁸ UK Department for Environment, Food & Rural Affairs, "Waste Strategy 2000 for England and Wales, Part 1 & 2," May 25, 2000, updated 10 August 2000, available at <http://www.defra.gov.uk/environment/waste/strategy/index.htm>.

¹⁹ Dr. Paul Connett, "Medical Waste Incineration: A Mismatch Between Problem and Solution," available on the Global Alliance for Incinerator Alternatives web site <<http://www.no-burn.org/Library/mismatch.pdf>>. Site visited August 26, 2001.

longer afford to service the debt on it and plans to sell it.²⁰

Public concern over environmental impacts of waste incineration has forced plant owners and operators to install high-cost advanced pollution control devices.

Increased emission control standards in the United States have required incinerator owners and operators to spend millions of dollars to update older, more polluting facilities. Yet, modern incinerators with expensive “state-of-the-art”

pollution control devices still do not eliminate or adequately control toxic emissions from today’s chemically complex municipal discards. The heterogeneous mixture of natural and synthetic materials that comprises the urban discard stream undergoes a variety of chemical reactions during and after combustion. Even new municipal solid waste incinerators emit toxic metals, dioxins, and acid gases.

Typical incinerator emissions include acid gases, particulate matter, carbon monoxide, nitrogen oxides, metals, dioxins and furans, and at least 190 volatile organic compounds.²¹ Many of these chemicals are known to be persistent, bioaccumulative, and toxic. These pollutants cause a wide variety of adverse health effects including cancer, respiratory disease, and disruption of the endocrine system.²²

Reported health impacts on workers at incinerators include chloracne, hyperlipidemia (elevation of lipids, such as cholesterol, cholesterol esters, phospholipids and triglycerides (fats) in the bloodstream), allergies, and hypertension. Some studies have also identified links between working at an incinerator and increased risk of death from heart disease, lung cancer, esophageal cancer, and gastric cancer.²³

Numerous studies have reported increased incidence of cancers, respiratory ailments, and congenital birth defects among residents residing near incinerators. Other studies indicate that distant populations can be exposed to pollution from incinerators by ingesting contaminated plant or animal products.²⁴

The costs to society of these adverse health effects are rarely included in economic analyses, and are indeed difficult to quantify, but should not be ignored.

Table 13: Comparison of typical 2,000 tpd (1,800 tonnes per day) incinerator and automobile air pollutant emissions

Pollutant	Pounds Per day	Automobile Equivalent*
CO	2,100	1,800
NOx	14,000	134,000
SOx	1,800	187,000
Hydrocarbon (non-methane)	260	2,000
Total Suspended Particulates	540	27,000
Total (Weight Basis)	18,700	28,000

*Automobile equivalents represents the number of average, light weight motor vehicles traveling 33.5 miles per day necessary to produce the same amount of pollution.

²⁰ Graham Woe, community activist, Sheffield, United Kingdom, personal communication, April 20, 2001.

²¹ K. Jay and L. Steiglitz, "Identification and Quantification of Volatile Organic Components in Emissions of Waste Incineration Plants," CHEMOSPHERE Vol. 30, No. 7 (1995), pp. 1249-1260,

²² Michelle Allsopp, Pat Costner and Paul Johnston, "Incineration And Human Health: State of Knowledge of the Impacts of Waste Incinerators on Human Health," Greenpeace Research Laboratories, University of Exeter, UK, March 2001, pp. 6-7.

²³ Ibid, pp. 19-23.

²⁴ Ibid, pp. 25-35.

Ash hazards

Modern incinerators with sophisticated pollution control equipment will trap some of the toxic metals in the fly ash – the residue captured by the pollution control devices. Ironically, this means that the better the air pollution control, the more toxic the ash. Not only are toxic metals captured in the fly ash, but a number of toxic compounds, including dioxins and furans, are actually created on the fly ash particles in a process called post-combustion formation. A hundred times more dioxin may leave the incinerator on the fly ash than is emitted into the air from the smokestacks. The toxicity of the fly ash means that an expensive hazardous waste landfill site must be found for its disposal. Incinerator operators typically mix toxic fly ash from the stack with the less toxic “bottom” ash (ash left on the incinerator grate), thus enabling the ash to be labeled less toxic. While the industry continues to promote “recycling” of incinerator ash, at a minimum, it should be disposed in a lined landfill with leachate collection systems. However, all landfills eventually leak; the dioxins and heavy metals in the fly ash will eventually find their way into the groundwater around the landfill and then perhaps into drinking water sources or the sea. A modern, properly regulated landfill will only delay this process, not prevent it.

Still need landfills

Communities with incinerators still need landfills for ash disposal and for by-pass wastes. Ash can comprise about 25% by weight of an incinerator’s throughput and must be landfilled. Thus, incineration means incineration plus landfill.

Furthermore, there are two kinds of by-pass waste. Materials that do not fit into the incinerator, and waste that is generated when the incinerator is down for regularly scheduled maintenance. These materials must also be landfilled. According to a consultant report for King County, Washington (United States), an incinerator project could still need to landfill up to 50% of its design capacity, by volume.

Dr. Paul Connett, a prominent U.S. scientist noted that incinerator company Ogden Martin claims in its publicity materials that its incinerators reduce burned waste 90-95% by volume. However, he responds, "That's very deceptive. Ogden Martin says that as if [the company was] reducing the total waste stream by 90 to 95 percent, but it's not. First of all, a significant part of the waste stream doesn't burn well and goes straight to the landfill. Second, studies have demonstrated that in the real world, even burning everything they can, incinerators reduce the volume of the total waste stream by 60 to 70 percent, not 90 to 95 percent." Furthermore Connett points out, "People must also keep in mind that in a raw waste landfill, the volume of waste is often reduced 60 percent through compaction. So, at enormous public financial cost and great risk to human health, incineration offers little or no advantage when it comes to volume reduction."²⁵

Energy gains from WTE are illusory

Describing an incinerator as a “resource recovery” or “waste-to-energy” facility is misleading. Incinerators recover few resources (with the exception of ferrous metals) and represent a net energy loser when the embodied energy of the materials burned is included in the accounting. When a ton of paper is burned for its heating value, it generates about 8,200 megajoules. When this same paper is recycled, it

²⁵ Eric Weltman, "Ogden Martin : Trash and Burn." *The Multinational Monitor*, July/August 1993, Volume 15, Numbers 7 and 8. Available on the web at <http://www.essential.org/monitor/hyper/issues/1993/08/mm0893_01.html>, site visited November 29, 2001.

saves about 35,200 megajoules. Recycling other items typically present in MSW offers similar energy savings. Therefore, **incinerators waste energy** rather than turn waste into energy.

GREENPEACE/ILSR PROPOSAL FOR WASTE REDUCTION IN THE HONG KONG SAR

Critique of current waste management programs and plans

The Hong Kong Government, led by the EFB has made great strides in moving towards disposal reduction. The EFB endorses a waste management hierarchy that sets avoidance, minimization, recycling, treatment, and disposal – in that order – as the preferred options for handling materials. The EPD's Waste Reduction Framework plan states, “[w]e need to transfer emphasis from collecting and transporting waste to landfills for disposal to waste prevention and reuse of waste materials.” To that end, numerous efforts in support of increased recycling have been implemented by Governmental agencies. For example, the first recycling programs in public housing estates began with a two-month trial in 41 estates in 1998 and have now spread to a permanent program in every estate. Furthermore, in 2000, the Buildings Ordinance was amended to require all new buildings to provide space for waste separation and recovery.

However, Hong Kong still has a long way to go in order to cost-effectively and environmentally-soundly manage discarded materials. For example, while the EDP endorses the waste management hierarchy that prefers avoidance, minimization, recycling above incineration and landfilling, spending by the EPD does not reflect this preference. In 2000, the EPD spent more than half of its total expenditures for contract payments for the treatment and disposal of municipal and chemical wastes.²⁶ Clearly, considering that the department also is responsible for air, water, and noise pollution control, expenditures for the top of the hierarchy are dwarfed by expenditures on options at the bottom.

The Government has used the argument that direct funding of recycling and waste reduction businesses would constitute interference with the “free market.” However this argument is a red herring. The Government interferes substantially in the markets for discarded materials by not accounting for and charging for the full costs of wasting.

Another look at the waste management hierarchy may lead to a question concerning the meaning of the fourth waste management option – “treatment.” In the Waste Reduction Framework Plan, this fourth option is referred to as “waste bulk reduction” which, the Plan explains, may entail incineration or composting. Including incineration as a waste bulk reduction option actually puts the plan at odds with itself. One of the Plan's stated purposes is to “help conserve the earth's non-renewable resources,” however, incineration destroys rather than conserves resources.

As of 2001, Hong Kong pays lip service to the concept of a hierarchy for management of discarded materials. Rather than fully fund and implement aggressive programs to reduce, compost, and recycle discarded materials, the Government plans to build an incinerator that will turn valuable resources into toxic air pollutants and ash and locate a new landfill on reclaimed land, guaranteeing resulting water pollution **when** the landfill liner leaks. For all the widely publicized disposal reduction programs, very little actual progress has been made. The Government needs to recognize that neither landfills nor incinerators are safe. Any plan that includes new disposal facilities does not make the best use of discarded resources or adequately protect the environment.

²⁶ Environmental Protection Department, *Environment Hong Kong 2001*, p. 20.

A new paradigm

Greenpeace and ILSR propose Hong Kong radically change the focus of its system for handling discarded materials. The very first step is to change its perception of the problem and create a new terminology that reflects this change. All the Government laws, the Government agencies, and their publications, focus on “waste” management. There is the Waste Disposal Ordinance, the Waste Reduction Framework Plan, the Waste Reduction Committee, Waste Reduction Task Forces, and programs such as the Waste Recycling Campaign in Housing Estates and the School Waste Paper Recycling Scheme. But materials are only wasted when they are turned into smoke and ash in an incinerator or entombed in a landfill.

Materials put to good use through reuse, recycling, and composting are better referred to as “resources.” A source-separated steel can headed for a recycling plant is no more “waste” than newly mined iron ore is “waste.” A better terminology calls materials cast off by their original owners as “discards.” When the problem of growing amounts of discarded materials is posed as “What shall we do with our waste?” bulk collection and disposal almost seems a reasonable answer. But when the question is rephrased “What should we do with these discarded resources?” using them as valuable feedstock for industry is a much more sensible answer. After all, we would never dream of taking that newly mined iron ore and burying it in a landfill. Yet, every day around the world we burn and bury paper, metals, and plastics that, if recycled, could eliminate the need for cutting down millions of trees and degrading thousands of acres of land during mining. In fact, cities, especially those in developed areas, are actually urban forests, iron mines, bauxite mines, and oil wells.

Policy can encourage manufacturers to eliminate materials and products that are not reusable, recyclable, or compostable. Careful segregation of remaining discarded materials facilitates their recovery as resources ready for use by industry. How much “waste” can be eliminated through such systems? A relatively new school of thought postulates that it is not unreasonable to envision zero waste.

The zero waste movement

When most people first hear the term “zero waste” they think it’s a new catchphrase invented by radical environmentalists, and furthermore, an unattainable goal. In the early 1980s a small group of recycling experts started talking about the idea of ‘Total Recycling’.²⁷ Zero waste concepts followed. One of the first formal zero waste policies was created in 1995 when Canberra, Australia endorsed a goal of “No Waste by 2010.” Since 1995, zero waste has been endorsed as a goal by governments in New Zealand; Denmark; Seattle, Washington; Del Norte County, California; Santa Cruz County, California; Edmonton, Alberta; Ottawa, Ontario; and Nova Scotia. Furthermore, businesses such as Xerox, Sony, Mitsubishi, IBM, Bell Canada, DuPont, Kimberley Clark, Hewlett-Packard, and Toyota have adopted zero waste principles.²⁸

According to the U.S.-based GrassRoots Recycling Network:

²⁷ Warren Snow and Julie Dickinson, *The End of Waste: Zero Waste by 2020: A Vision for New Zealand*, Zero Waste New Zealand Trust, Auckland, New Zealand, 2001, available at <http://www.zerowaste.co.nz/files/An_End_to_Waste_1.pdf>.

²⁸ Target Zero Canada, “What Is Zero Waste?” 2000, available at <http://www.grrn.org/zerowaste/zerowaste_index.html>, site visited August 14, 2001.

“Zero Waste is a philosophy and a design principle for the 21st Century. It includes 'recycling' but goes beyond recycling by taking a 'whole system' approach to the vast flow of resources and waste through human society.

Zero Waste maximizes recycling, minimizes waste, reduces consumption and ensures that products are made to be reused, repaired or recycled back into nature or the marketplace.”

On a practical level, zero waste is a system that:

- Redesigns the current, one-way industrial system into a circular system modeled on nature's successful strategies;
- Challenges badly designed business systems that "use too many resources to make too few people more productive;"
- Addresses, through job creation and civic participation, increasing wastage of human resources and erosion of democracy;
- Helps communities achieve a local economy that operates efficiently, sustains good jobs, and provides a measure of self-sufficiency; and
- Aims to eliminate rather than manage waste.²⁹

The following sections detail a blueprint for zero waste in Hong Kong. Critical components include programs and policies designed to:

- Reduce generation of discards (source reduction);
- Increase product reuse and repair;
- Create a source separation system for domestic, commercial, and industrial discards and construction and demolition debris;
- Establish an efficient collection system for separated materials;
- Support processing and market creation for recyclables; and
- Create composting systems for organic materials.

Finally, a section addresses projected disposal needs.

Many of the programs and policies included in the following blueprint incorporate principles of Extended Producer Responsibility (EPR). EPR entails making manufacturers responsible for the entire lifecycle of the products and packaging they produce. One aim of EPR policies is to internalize the environmental costs of products into their price. Another is to shift the economic burden of managing products that have reached the end of their useful life from government and taxpayers to product producers and consumers.

Extended Producer Responsibility

Thomas Lindhqvist first formally introduced the concept of EPR in Sweden in a 1990 report to the Swedish Ministry of the Environment.³⁰ In subsequent reports prepared for the Ministry, the following definition of EPR emerged:

“Extended Producer Responsibility is an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the

²⁹ GrassRoots Recycling Network, “What Is Zero Waste?” available at <http://www.grrn.org/zerowaste/zerowaste_index.html>, site visited August 14, 2001.

³⁰ Thomas Lindhqvist & Karl Lidgren, "Modeller för förlängt producentansvar" ("Models for Extended Producer Responsibility," in Swedish), 26 October 1990, published by the Ministry of the Environment in "Från vaggan till graven — sex studier av varors miljöpåverken" ("From the Cradle to the Grave — six studies of the environmental impact of products," in Swedish), DC 1991:0.

entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product."³¹

By shifting the costs of managing wastes to producers who make packaging decisions, EPR policies influence product design. Manufacturers develop and design products or packages, and therefore, it is the manufacturers who choose the materials used. Faced with the knowledge that they will eventually have to pay for proper management, manufacturers can make product decisions at the product development stage, the most efficient and effective point at which to reduce waste and encourage reuse, reduction, and recycling.

The Government of Hong Kong has endorsed the concept that polluters and the users of environmental services should pay the costs involved. EPR programs represent a mechanism for passing these costs onto the entities responsible for decisions that influence creation of discards.

Furthermore, the fact that most of the goods consumed in Hong Kong are manufactured elsewhere should not be a barrier to creating EPR programs. For approximately a decade, the world's multinational corporations have been adjusting their business practices to requirements of numerous countries' EPR programs. Companies based in one country have been forced to act more responsibly because of legislation from other countries. For example, despite opposition by U.S. automobile manufacturers, European Union legislation passed in 2000 requires that by 2006, vehicles sold in Europe contain no heavy metals, such as lead, mercury or cadmium, and be manufactured from recyclable materials. In addition, automakers will be held responsible for disposal of the car after it is retired. According to U.S.-based environmentalist Charles Griffith, "It will be hard to come up with separate designs for the European and U.S. markets, so the U.S. automakers are going to seek to meet the European Union phaseouts across the board."³²

Deposit-refund systems

Deposit-refund systems for beverage containers were the norm worldwide through most of the 20th century. Unfortunately for government agencies responsible for litter clean-up and waste disposal, beverage manufacturers largely switched to non-refillable bottles over the last thirty years. The result was huge profits for beverage companies, and huge costs imposed on governments for the management of the discarded bottles. Today nearly all beverages and numerous other consumer products, including health and beauty products (shampoo, mouth wash, etc.), foods, household cleaners, and laundry aids are sold in disposable containers.

Many jurisdictions worldwide; from South Australia, to Israel, to the Canadian province of British Columbia, to Sweden; have implemented deposit-refund systems. In the U.S., recovery of beer and soda containers is higher in "bottle bill" states than in the rest of the country. Americans discard 62% by weight of all beer

³¹ Thomas Lindhqvist, "Mot ett förlängt producentansvar — analys av erfarenheter samt förslag" ("Towards an Extended Producer Responsibility — analysis of experiences and proposals," in Swedish), 30 April 1992, published by the Ministry of the Environment and Natural Resources in "Varor som faror — Underlagsrapporter" ("Products as Hazardous — background documents," in Swedish), Ds 1992:82. The definition was published in English for the first time in: Thomas Lindhqvist, "Extended Producer Responsibility," in the proceedings of an invitational seminar at Trolleholm Castle, 4-5 May 1992: "Extended Responsibility as a Strategy to Promote Cleaner Products," edited by Thomas Lindhqvist, Department of Industrial Environmental Economics, Lund, June 1992.

³² Joel Bleifuss, "The Big Stick Approach: The European Union Quietly Holds Corporations Responsible," InThesesTimes.com, April 17, 2000. Available at <<http://www.inthesetimes.com/issue/24/10/bleifuss2410.html>>. Site visited April 18, 2002.

and soda containers sold annually, but in states where these containers have a refund value, less than 15% are thrown away. About half the beer and soft drink containers recycled in 1998 came from bottle bill states (29% of the population). In 1999, the beverage industry in British Columbia, Canada, achieved a province-wide recovery rate of over 84% of containers covered by the program. Container recycling rates are 91% in Sweden and more than 90% in Denmark, because of those countries' deposit-refund schemes.

While most extant deposit-refund systems cover beverage containers, the concept can be expanded to include almost any type of product or package. For example, the Republic of Korea's deposit-refund system covers food, beverage, detergent, and medicine packaging, batteries, tires, automotive lubricants, and some household appliances.

Deposit-refund systems can also spur manufacturers to switch to environmentally preferred containers. For example, in the Republic of Korea metal can producers have changed their production as a result of the country's deposit-refund system. They increased production of metal cans with "push-down" type tabs (deposit of 2 won per container), while production of cans with removable tabs (deposit of 5 won per container) decreased.

In typical deposit-refund systems, consumers pay the deposit at the time of purchase and receive a refund when returning the container. The middlemen are often retailers or depots that buy back containers from consumers. Manufacturers or distributors typically reimburse these middlemen the refund value of the package plus a handling fee. Manufacturers and distributors pay the costs of the programs but also gain by keeping not only the scrap value of the recycled containers but the unclaimed deposits on the unredeemed containers that are never returned. Often an entire industry sets up a third-party organization whose sole purpose is to oversee the deposit-refund system, lessening administrative costs for individual companies.

Opponents of deposit-refund systems often argue that the programs undermine the success of other recycling programs, such as curbside collection programs.

However, Franklin Associates, Ltd. in *The role of Beverage Containers in Recycling and Solid Waste Management: A Perspective for the 1990s*, compared the number of tons recovered with a combined curbside/deposit system vs. a curbside system only. Data from the study showed that the combined system of deposits and curbside diverts 45% more from the waste stream in Vermont than a curbside program alone could accomplish, and 17% more in New York State. In another study, the Seattle Solid Waste Utility studied the potential impact of a bottle bill on their successful curbside recycling program and found that a combined curbside/deposit system would divert more tonnage AND would result in a cost savings to the City of between \$591,245 and \$849,219 annually. The study concluded that even after compensating recycling companies for lost collection revenue and lost revenue from the sale of recyclables, the combined system would "divert additional tonnage with no significant impact to either City costs or curbside recycling profits."³³

A well-implemented deposit-refund program can increase recovery rates for covered materials to close to 100% in a very short time. Furthermore, these programs deter litter and ensure recycling-based industries will have a long-term source of clean materials for use as feedstock.

³³ Container Recycling Institute, *The Ten-Cent Incentive to Recycle*, March 1999. Available on line at <<http://www.container-recycling.org/publications/tencent/tencent.html>>.

Proposal	Implement a deposit-refund system for single-use packaging materials (including all bags, boxes, bottles, and cans, regardless of the product sold in it), requiring manufacturers/importers to pay for recovery.
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Product take-back programs

Companies around the world have begun accepting end-of-life responsibility for their products through take-back programs for several reasons. While, for some companies the chief reason for adopting take-back programs has been the establishment of mandates, others have done so for economic, environmental, or public relations reasons. Today 29 countries have EPR laws on the books for packaging; 15 have them for batteries, and about nine have take-back laws for electronics products. Discarded products can be a cheap feedstock for manufacturing new high-value products. Product take-backs can also help a company gain good publicity for environmental protection.

Companies have started product take-back programs for such diverse products as appliances, electronics, batteries, automobiles, motor oils, and pharmaceuticals. Many of the products present special disposal challenges due to bulk and/or hazardous components. Take-back programs ensure the materials will be handled in an environmentally appropriate manner. For example, a used oil take-back and recycling program can reduce energy use and soil and water pollution. Re-refining used oil completely restores the original lubricating properties at about one-third of the energy consumption of refining crude oil to lubricant quality.³⁴ Oil released into the environment can contaminate soil, groundwater, the oceans, and the atmosphere.

Industry programs

Kodak received much negative publicity in the 1980s when it began marketing single-use cameras, which ended up as throwaways. In response, the company redesigned their single-use cameras to facilitate recycling and reuse of parts and worked with photofinishers to set up a collection system for obtaining discarded cameras. Today, every part in Kodak’s single-use cameras, except for the battery, can be recycled or reused.³⁵

Xerox is a worldwide leader in product stewardship. Since the early 1990s, the company has integrated the concept of efficient use of materials and energy into the design of equipment, supplies and packaging. Xerox maximizes the end-of-life potential of products and components by designing their products for easy disassembly, durability, reuse, and recycling. Xerox encourages customers to return a wide range of products, including printers and toner bottles, for reuse or recycling. Employees disassemble and sort parts from returned equipment. Suitable items are remanufactured and incorporated into new products. Those that can not be remanufactured or repaired are ground, melted, or otherwise converted into basic raw materials. In 1999, the company’s equipment remanufacture and parts reuse and recycling programs prevented more than 148 million pounds of waste from entering landfills, significantly reduced the use of raw materials and the energy

³⁴ U.S. EPA Office of Solid Waste, *Managing Used Oil: Advice for Small Businesses*, EPA530-F-96-004, November 1996.

³⁵ Eastman Kodak Company, “A Tale of Environmental Stewardship: the Single-Use Camera.” Available on the company web site at <<http://www.kodak.com/country/US/en/corp/environment/performance/recycling/suc.shtml>>. Site visited October 26, 2001.

needed to manufacture new equipment, and saved the company several hundred million dollars.

Prior to 1996, 13 U.S. states had passed laws to facilitate the collection and recycling of used rechargeable batteries. Although somewhat similar, there were differences in the laws enacted by the states. To complicate matters, some jurisdictions in Canada had also enacted recycling requirements for rechargeable batteries. The battery industry found that it had to comply with varying, and sometimes conflicting, labeling and waste management regulations. In response, battery manufacturers established a self-funded system in the U.S. and Canada (<http://www.rbrc.org/>) for taking back spent Ni-Cd batteries in order to avoid piecemeal, state-mandated take-back requirements.

In The Netherlands, the automobile industry voluntarily introduced an Extended Producer Responsibility program. Of the approximately 250,000 end-of-life vehicles scrapped in the country each year, prior to 1995, only the metals from these vehicles were recycled. In 1993, the automobile industry created Auto Recycling Nederland (ARN), a combination of manufacturers, importers, car dismantling companies, garages, car repair shops, and shredders. ARN began recycling operations in 1995 and set an initial target of recycling 86% (by weight) of end-of-life vehicles by the year 2000. ARN achieved 85.3% recycling in 1998. ARN not only reduces the volume of waste from discarded automobiles, but also improves the safety and environmental friendliness of car dismantling by removing and processing hazardous materials in a responsible manner.

To fund operations, a mandatory 150 Guilders fee is charged on all vehicles when first registered, newly purchased, or imported into The Netherlands. ARN processes all discarded vehicles without any charge to the last owner.³⁶

Government programs

Japan's Specified Household Appliances Recycling (SHAR) Law, which became effective in 2001, provides for the take-back of refrigerators, air conditioners, televisions, and washing machines. The SHAR law divides responsibility for covered products among producers and/or importers, retailers, local governments, and consumers. The law requires retailers and local governments to accept covered end-of-life appliances from consumers, for a fee. Retailers must take back products they themselves sold and old products when they sell similar new products. Local governments must collect covered appliances retailers will not accept.

Manufacturers and importers must assume physical responsibility, including collection from retailers and local governments and recycling, for their brands of end-of-life products. Manufacturers and importers must create and fund designated legal entities for the recovery of orphaned products (products of brands no longer produced or imported into the country). Many Japanese manufacturers began pilot collection and recycling projects prior to 2001 in anticipation of the EPR mandate.³⁷

The SHAR law sets recycling targets for iron, copper, and aluminum from all collected products and glass from televisions. The targets are more than 60% for air conditioners, 50% for washing machines and refrigerators, and 55% for televisions.

³⁶ Recycling International, "Recycling end-of-life vehicles in Japan, The Netherlands and the U.S.," January/February 2000. Available at <<http://www.salyp.com/2832.htm>>. Site visited October 30, 2001.

³⁷ Bette K. Fishbein, "EPR: What Does It Mean? Where Is It Headed?" *Pollution Prevention Review*, Autumn 1998, pg. 47. Also available on the INFORM web site at <<http://www.informinc.org/eprarticle.htm>>.

The SHAR law has spurred manufacturers to invest in appliance recycling facilities and explore “design for the environment” practices. For example, Panasonic has reduced the number of components in its televisions and the number of plastic resin types in many of its products in order to facilitate recycling. In fact, a Japanese researcher reported that three out of five companies interviewed said that the enactment of the SHAR Law was a strong incentive for them to promote Design for the Environment.³⁸

British Columbia, Canada has established take-back programs for four main product types: (1) used motor oil; (2) unwanted industrial and post-consumer paints; (3) solvents, flammable liquids, domestic pesticides, and gasoline; and (4) pharmaceuticals.

In 1992, B.C. enacted the Return of Used Lubricating Oil Regulation to provide consumers the opportunity to return used oil for recycling. The regulation requires all sellers of oil to take back used oil, at no charge to the consumer. Sellers of oil must either accept oil at the point of sale or arrange for a third party located near the seller to accept it. In April 2000, British Columbia’s Ministry of Environment, Land and Parks (MELP) reported that the province’s used oil collection and recycling program diverts about 40 million liters of used oil every year. This represents approximately 80% of the estimated 50 million liters of lubricating oil available for recovery each year.

The 1994 Post-Consumer Paint Stewardship Regulation requires producers of consumer paint products to take full life-cycle responsibility for these products. The regulation was amended in 1997 to include paints in pressurized containers. Industry created two non-profit associations to collect and manage leftover paint, Paint and Product Care Association (PPC) and the Tree-Marking Paint Stewardship Association (TSA). PPC established over 100 collection depots throughout the province. TSA established drop-off sites for tree- and road-marking paints and regulated consumer paint products on location at 26 distributors of industrial aerosols. From 1994 through June 1999, PPC and TSA collected nearly 12 million equivalent liter containers of paint. In 1998, PPC reported that 76% of paint returns were recycled, 8% reused, and 16% blended with fuel. TSA contracts with a private company to manage the collected paint.



Source: B.C. Ministry of Environment, Land, and Parks, *Post-Consumer Paint Stewardship Program Regulation Annual Report to the Director, 1999*.

The B.C. paint stewardship program is funded by “eco-fees.” The fees, assessed at the point of sale, are effectively product price increases; however, they are shown as a separate line item on consumers’ receipts. The “eco-fees” for paint products are as follows:

³⁸ Naoko Tojo, “Analysis of EPR Policies and Legislation through Comparative Study Of Selected EPR Programmes for EEE - Based on the In-Depth Study of a Japanese EPR Regulation,” International Institute for Industrial Environmental Economics, Lund University, Lund, Sweden; 1999. Available for download at the International Institute for Industrial Environmental Economics web site at: http://www.lu.se/IIIEE/publications/communications/2000/2000_10.pdf.

250 ml	Can\$0.10
251 ml to 1 liter	Can\$0.25
1.01 liters to 5 liters	Can\$0.50
5.01 liters to 23 liters	Can\$1.00
Aerosol paint (all sizes)	Can\$0.10

B.C.'s stewardship programs for solvents, flammable liquids, pesticides, and gasoline; and pharmaceuticals were created under the 1997 Post-Consumer Residual Stewardship Regulation. Two non-profit associations of brand-owners of solvents, flammable liquids, domestic pesticides, and gasoline jointly sponsor the Consumer Product Stewardship Program (CPSP). The CPSP established and operates a network of 35 depots and collection points that accept residuals covered by the regulation. In 1998, B.C. residents delivered nearly 130,000 equivalent liter containers of product residuals covered by the regulation to CPSC collection points. CPSP disposes domestic pesticides at licensed hazardous waste facilities and uses a contractor that blends flammable materials for industrial fuel use. CPSP hopes to identify better end-use recycling markets in the future.

The Post Consumer Residual Stewardship Program Regulation does not allow brand-owners to charge consumers at the time of return of regulated solvent, flammable liquid, pesticide, and gasoline materials. The gasoline industry internalizes its share of the costs for the stewardship program. As in the paint stewardship program, brand-owners of other household hazardous waste (HHW) in covered by the program have instituted a system of "eco-fees" to pay for product recovery. The "eco-fees" are as follows:

Aerosol solvents	Can\$0.10 per container
Other solvents and flammable liquids	Can\$0.40 per liter
Up to 1 liter or kilogram of domestic pesticides	Can\$0.60
1 – 1.99 liters or kilograms of domestic pesticides	Can\$1.20
2 or more liters or kilograms of domestic pesticides	Can\$2.40

In November 1996, before the enactment of the Post-Consumer Residual Stewardship Regulation, B.C.'s pharmaceutical industry had voluntarily established a stewardship program in which consumers could return unwanted pharmaceutical products to pharmacies for no fee. The Regulation made the program mandatory.

Product take-back programs around the world have reaped many benefits. Waste streams handled by local governments have been made safer by the removal of potentially hazardous components. Industry has re-examined products and their impacts on the environment. Some products have been re-designed to facilitate reuse and recycling or to reduce waste. Furthermore, some companies have reported increased profits as a result of their product stewardship programs. Finally, product stewardship programs shift the costs of managing product disposal away from society at large, onto product producers and consumers.

The Government should set reduction targets and dates for meeting them against which voluntary efforts should be measured. These could be modeled on reduction rates that are considered reasonable or have been proven achievable in other nations. For example:

- The Canadian province of British Columbia recovers approximately 80% of the estimated 50 million liters of lubricating oil available for recovery each year;
- The European Union draft proposal on electronic waste sets minimum percentages for the recovery of this waste. These would come into force no later

than 2006, and would range between 60 and 80%, depending on the product category.

- The Japan Automobile Manufacturers Association (JAMA) and automobile makers have formulated and announced action plans on their own initiative to deal with the recycling of end-of-life vehicles. The initiative sets landfill disposal targets for end-of-life vehicles at 60% or less of 1996 levels after 2002 and 20% or less of 1996 levels after 2015.

Proposal	Encourage industries such as the electronics and disposable camera industries, and manufacturers of difficult to manage wastes (household chemicals, automotive fluids, batteries, and pharmaceuticals) to establish take-back programs for their products. Establish mandatory programs if voluntary efforts do not meet reduction targets.
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User fees

Fees at disposal facilities provide a clear economic incentive for disposal reduction. Furthermore, the lack of disposal fees distorts local markets, handicapping recycling efforts.

Disposal fees should be set to cover the “true” costs of disposal, not just the apparent immediate costs to the Government. For example, landfills remove land from productive use for an indefinite period. Furthermore, the current requirements for 30-year postclosure monitoring may not be sufficient to adequately protect human health and the environment. Under Hong Kong’s Design-Build-Operate system, the Government paid contractors for facility construction and pays for ongoing costs. The Government also incurs ongoing expenses for EPD staff who provide oversight at the landfill sites, administration of the contracts, and Government-provided laboratory services.

Therefore, landfill tip fees should be set to cover the land value; the establishment of a fund for post-closure monitoring and remediation for an indefinite period; and capital, operating, and maintenance costs for the facility (including contract payments and the full costs for EPD staff and laboratory services).

Not charging for collection and disposal sends the wrong message to Hong Kong residents and businesses. The increased recycling in the business sector as compared to the residential sector demonstrates that fees can be an incentive to recycle. If the Government imposes disposal charges, the incentive would be greater, increasing recycling. To the Government's credit, the solid waste framework calls for implementing landfill charges. However, despite the plans, no such charge has yet been implemented.

Later in this report, Greenpeace and ILSR recommend that no unseparated materials be accepted at Hong Kong landfills. All residents and businesses would be required to source-separate discards into wet and dry fractions. As a result, no discards will be accepted at landfills for disposal and the existence and level of disposal fees becomes a moot point. However, we propose a system whereby wet and dry discard streams are delivered to public facilities for sorting, processing, and composting. These facilities should charge a tipping fee for materials based on the true costs for their operation and the cost of landfilling residuals. If the recycling and composting facilities are well run, the cost per ton of handling materials will be lower than the costs of disposal.

The potential to lower costs upon the implementation of wet/dry collection should provide an incentive for businesses to support the new system.

Proposal	Impose user fees at disposal facilities as soon as possible and at material recovery facilities (MRFs) and composting facilities once wet/dry collections systems are implemented.
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Source reduction

Source reduction is the prevention of discards at the source. Examples of source reduction programs include home composting, replacing disposable goods with durable products, and buying in bulk. Home composting and its applicability to Hong Kong will be discussed further in the later section on composting.

Switching from disposable to durable

The current marketplace is flooded with single- and limited-use versions of items, most of which replace products that were formerly meant for repeated long-term use. Examples include disposable diapers, pens, plates, napkins, flatware, chopsticks, and razors. The useful life span of many of these products is minutes, after which they spend untold years in landfills.

In 1992, the Republic of Korea established a “Waste Treatment Charge System” aimed at making manufacturers consider the full environmental impact of their products at the production stage. Under the system, manufacturers must pay non-refundable fees on “products and containers which are difficult to collect, treat, or recycle, or likely to render waste management generally difficult” to the Special Account for Environment Improvement. Products covered under the system include those made of synthetic resins, chewing gum, confectionery products, antifreeze, fluorescent lamps and batteries that fail to satisfy specific standards set for the products, disposable diapers, cigarettes, toxic substance containers, and cosmetic containers. Table 14 lists the product categories covered by the charge system and the level of fees.

The fees collected under the Waste Treatment Charge System are deposited in the “Special Account for Environment Improvement” and used to finance the Korea Resources Recovery and Reutilization Corporation and to subsidize local governments' waste management projects.

Collection of fees on single- and limited-use products would encourage the use of re-usable and repairable products. These fees could be used to mitigate the costs that materials have on the environment. These costs could include the price of reforestation, pollution abatement, and ozone depletion.

In some ways, landfills and the single-use products industry support each other. The industry cannot sell this type of product without subsidized disposal. Adding the real cost of disposal to the product price would make most single-use products prohibitively expensive. The landfill industry is dependent on a throwaway society for its huge profits.

Table 14: Korea's Waste Treatment Charges

Product	Charge (South Korean won)	Charge in HK Cents
Toxic substance container, under 500ml	6.0 won per unit	3.6¢ per unit
Toxic substance container, over 500ml	11.0 won per unit	6.7¢ per unit
Cosmetic container, glass bottle, under 30ml	1.0 won per unit	0.6¢ per unit
Cosmetic container, glass bottle, between 30ml and 100ml	3.0 won per unit	1.8¢ per unit
Cosmetic container, glass bottle, over 100ml	4.5 won per unit	2.7¢ per unit
Cosmetic, spray metal container	8.0 won per unit	4.9¢ per unit
Cosmetic, other metal container	4.0 won per unit	2.4¢ per unit
Cosmetic, plastic container	0.7 won per unit	0.4¢ per unit
Confectionery packaging, up to 3 composite materials	6.0 won per unit	3.6¢ per unit
Confectionery packaging, 4 or more composite materials	12.0 won per unit	7.3¢ per unit
Lithium, cadmium, and nickel batteries	2.0 won per unit	1.2¢ per unit
Insecticide container, under 500ml	7.0 won per unit	4.2 ¢ per unit
Insecticide container, over 500ml	16.0 won per unit	9.7¢ per unit
Antifreeze	30.0 won per liter	18.2¢ per liter
Fluorescent lamp, low-mercury lamp	6.0 won per unit	3.6¢ per unit
Fluorescent lamp, other	8.0 won per unit	4.9¢ per unit
Chewing gum	0.27% of sale price	0.27% of sale price
Diaper	1.2 won per unit	0.7¢ per unit
Plastic – polyacetal resin	0.35% of sale price	0.35% of sale price
Plastic – other	0.7% of sale price	0.7% of sale price
Cigarettes	4.0 won per package	2.4¢ per package

Source: OECD Database on Environmentally Related Taxes, Database at <http://www.oecd.org/env/policies/taxes/index.htm>. March 6, 2001

Proposal	Impose non-refundable product charges on single- and limited use products, such as disposable diapers, disposable chopsticks, cups and dishes, and disposable razors. Deposit revenues generated by the charges in a special fund used to mitigate the costs that these materials have on the environment.
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Many disposable products are relatively new to the marketplace. For example, only in the last few years have smaller local restaurants started using disposable wooden chopsticks instead of reusable ones. Similarly, disposable plastic shopping bags have only recently replaced reusable shopping bags provided by customers. Other available disposable products that have durable alternatives include paper napkins and towels, bath towels, cups, dishes, and razors. While consumers may avoid using disposable products at home, many are forced to use them needlessly when they are away from home.

To address the growing use of disposable products in the service sector; including restaurants, stores, public baths, and lodging facilities; the Republic of Korea, restricted their distribution under the 1992 Act Relating to Promotion of Resources Saving and Reutilization. Table 15 shows the regulated workplaces and items covered under the restrictions. A similar law in Hong Kong could help reverse the trend toward increasing use of disposable products and reduce the waste stream.

In order to limit the distribution of disposable items, Greenpeace/ILSR propose Hong Kong adopt laws prohibiting the use of disposable items at restaurants and cafeterias; outlawing the free distribution of these items by carry-out restaurants;

banning the distribution of free plastic bags and shopping bags by all retail and food service establishments; and requiring lodging facilities to distribute products such as soap, shampoo, and hair conditioner from bulk dispensers. To further limit waste at lodging facilities, require the businesses to charge patrons for other personal care items, such as razors and toothpaste instead of providing them for free.

Proposal	Prohibit the use of disposable cups, containers, plates, chopsticks, toothpicks, napkins, moist towelettes, spoons, forks, knives at restaurants and cafeterias by customers who dine on-site.
Proposal	Outlaw the distribution of free disposable cups, containers, plates, chopsticks, toothpicks, napkins, moist towelettes, spoons, forks, knives at restaurants and cafeterias by customers who take food away from the premises. Set the prices of the disposable items high enough to encourage patrons to bring their own reusable items.
Proposal	Ban the distribution of free plastic bags and shopping bags by all retail and food service establishments. Allow customers to purchase bags but set the price high enough to encourage customers to switch to reusable bags.
Proposal	Require lodging facilities to distribute products such as liquid soap, shampoo, mouthwash, and hair conditioner from bulk dispensers and to charge for the distribution of other personal care products.

Businesses that provide services that replace otherwise disposable products reduce wasting. These businesses include baby diaper services and milk/beverage services that supply fresh beverages and take back, wash, and refill containers. These businesses will thrive when wasting is not subsidized and corporations are made responsible for their products.

An example of a business service that replaces disposable items has recently emerged in Germany. More than a dozen German towns have banned disposable products at public festivals, spurring development of new businesses offering decentralized mobile washing units for reusable dishes and cups.

Table 15: Regulated disposable goods in the Republic of Korea

Workplace	Regulated Items
Restaurants and cafeterias (with serving spaces larger than 33 square meters)	Prohibited from using disposable cups, containers, and plates, wooden chopsticks, toothpicks, disposable spoons, forks, knives, etc. Must not circulate advertising leaflets coated with synthetic resin
Department stores, shopping centers, wholesale shops, and shops with sales floor space larger than 200 square meters	Prohibited from distributing free plastic bags and shopping bags (can only be purchased by customers) Must not circulate advertising leaflets coated with synthetic resin
Food manufacturing and processing businesses/spot sales food manufacturing and processing business	Prohibited from using disposable lunchboxes made of synthetic resin
Lodging facilities with more than seven rooms and public baths	Prohibited from providing free disposable shaving sets, toothpaste, shampoo, and hair conditioner.

Source: Green Korea 1999, Republic of Korea Ministry of Environment, available at <http://www.moenv.go.kr/english/tit00/eng10.html>.

Proposal	Encourage the development of businesses that provide consumers with alternatives to single- and limited use products.
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Reuse and repair

Currently, most reuse and repair activities in Hong Kong occur in the informal sector and through charitable institutions. Many reusable items are passed on to family and friends. Some are donated to thrift shops and charitable institutions. Others are collected by individuals and sold off the street to brokers. Most discarded textiles are collected by cleaners and sold to local waste material collectors. Some housing estates have informal arrangements to store and redistribute reusable and repairable materials such as clothing and furniture.

Reuse is the top of the waste management hierarchy. To recover the most materials for reuse and repair, the process should be formalized. The Government can facilitate recovery of bulky and reusable items by contracting for the collection and storage of items on a periodic basis, perhaps monthly. Multiple contractors, including private companies and charities, could each be responsible for a certain geographical area. Contractors could handle the collected materials by selling them to repair businesses and recycling industries; repairing and reselling them in their own businesses; or donating them to charitable organizations as part of a collaborative venture. The Government could further support these reuse efforts by creating a centralized store for resale of collected products or by assisting contractors create an internet-based list of materials available for reuse. Examples of reusable items that can be collected for reuse and/or recycling include office supplies, furniture, shipping containers, small and large appliances and electronics, clothing, paint and other chemicals, building materials, rugs and carpets, dinnerware, pots and pans, toys, bicycles, decorative items (bric-a-brac, art, collectibles, etc.), books, movies, record albums, tapes, and compact discs.

Montgomery County, Maryland, sponsors a reuse program for furniture in collaboration with the Housing Opportunities Commission (HOC), a local organization serving needy residents. The County refers callers with usable, but unwanted, furniture to HOC. HOC collects the items from residents and distributes the items to needy families the same day. Saint Paul, Minnesota, also collaborates with local charities in a reuse program. The City's recycling collection contractor collects small reusable items as part of its regular curbside recycling collection. The contractor passes the collected items to Goodwill industries. Goodwill sells many of the collected items in its network of thrift stores. They bale and sell unusable textiles for recycling.

ReUse Industries in Albany, Ohio, is a community-owned, non-profit organization that saves reusable items from the landfill. ReUse Industries accepts both small and large donations from organizations and individuals. ReUse Industries cleans, stores, repairs, and sells the donated items to businesses, agencies, and the public. ReUse Industries also provides employment to local citizens. The organization works with the county government to provide job training and work experience to low-income citizens through their Work Experience Program. Participants in the Program learn every aspect of the business, from transporting, receiving, sorting, cleaning, and repairing of materials to retail functions such as stocking, pricing, selling, and banking.

The Monterey Regional Waste Management District in Marina, California, created Last Chance Mercantile as a means of increasing reuse. Originally the District collected and redistributed materials at a quasi-flea market located at the landfill.

The program developed into a once-a-month auction for the better materials, and eventually weekly sales of all materials. As business expanded, the District began using an old storage building and yard to house the re-sellable materials, christening the operation as the "Last Chance Mercantile." In 1996, Last Chance Mercantile moved to a new facility just outside the landfill gates. Sales at the new 5,000 square foot facility are so brisk, the Mercantile is now open five days a week.

Wooden pallet reuse and repair can also sustain new businesses. Continental Pallet Company, in Lubbock, Texas, handles 360,000 pallets per year. The company collects excess pallets from regional businesses. Employees sort the pallets into three categories; those that can be repaired; those that can be dismantled; and unusable pallets. Parts from dismantled pallets are used in the repair operations. The company repairs or reuses 95% of the pallet materials it processes and employs 40 full-time workers.

Proposal	Contract with charities and private companies to collect bulky, reusable, recyclable, and/or repairable products on a monthly basis. Assist companies in distribution of collected materials through creation of a centralized store for resale of collected products or by assisting contractors create an internet-based list of materials available. Examples of reusable items that can be collected for reuse and/or recycling include office supplies, furniture, shipping containers, small and large appliances and electronics, clothing, paint and other chemicals, building materials, rugs and carpets, dinnerware, pots and pans, toys, bicycles, decorative items (bric-a-brac, art, collectibles, etc.), books, movies, record albums, tapes, and compact discs.
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Source-separation

Source-separation is perhaps the most critical factor in successful recovery of discarded materials. Mixed collection systems can result in contaminated materials. Contamination can lower material value and leads to higher residue levels at processing plants. Program planners must balance the collection costs of multiple streams against the cost for sorting materials into usable fractions. Also important is designing a system that is simple and practical for its users. Confusing sorting requirements or those that require too much effort from users will ultimately be ignored.

Greenpeace and ILSR believe the sorting scheme best suited to Hong Kong is a modified wet/dry system. In a typical wet/dry system users separate materials into two-streams – one for papers and containers and non-recyclable/non-compostable materials, and another for food, vegetative debris and food dirty paper. The system is easy to understand and does not require much storage space.

In Hong Kong's current recycling system, only paper, plastic, and aluminum containers are source-separated for recycling. This sorting regime leaves other easily recyclable materials such as glass, steel, and other plastics, mixed in with garbage headed for disposal. But most importantly, this system results in the mixture of compostable and non-compostable materials. Organics are a large proportion of the Region's waste stream. Composting is much cheaper and less polluting than disposal, but in order to be successful, it is critical the organic stream be as clean as possible.

In 1995, Guelph, Ontario, became one of the first jurisdictions in the world to implement a wet/dry collection system. Residents (and businesses that receive

municipal curbside trash service) must sort all discards into two streams – wet and dry. The wet stream includes food discards, plant debris, wood, pet wastes, clothes dryer lint, tissues, and food-soiled paper products. The dry stream is comprised of containers, metals, clean paper, and non-recyclable/non-compostable materials such as shoes, pantyhose, and small household items. In 1999, Guelph collected and processed 12,309 tonnes of material, recovering 7,675 tonnes, or 62%, of it through recycling and composting.

Greenpeace/ILSR suggest the Government modify its Three Colour Recycling Bins program. The material sort at the recycling bins would be changed to one bin for paper, one for all containers, and the third for all other dry materials. Residents would be limited to setting out wet materials only for collection by housing estate cleaning staff. Businesses would also be required to sort their wastes according to this system.

Eventually, as containers are collected through a deposit/refund system and the use of non-recyclable/non-compostable items decreases, the number of bins necessary could decrease to just two – one for wet materials to be composted and one for dry materials to be sorted and recycled and/or disposed. Reducing the number of sorts would make the system easier to use and lower collection costs.

Proposal	Implement a modified wet/dry collection scheme for source-separated materials from all residences and businesses. The system would initially require waste generators to separate materials into four streams – paper, containers, all other dry materials, and wet materials.
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The placement in public areas of cans for mixed discarded materials without separate containers for recyclable and compostable materials encourages disposal. Only the most committed recyclers will carry a newspaper home for recycling as opposed to dropping it in the nearest trash receptacle. Furthermore, the system for handling discards generated away from the home should mirror the system at home, thereby constantly reinforcing the concept of proper materials management.

Greenpeace and ILSR recommend that at the more than 17,000 trash receptacles located in public spaces, a second can be placed. The cans should be clearly labeled "wet" and "dry," and perhaps, painted separate colors. In no case should a single container for mixed waste be placed in a public area.

Waste deposited at public refuse collection points must remain source-separated. Therefore, all public refuse collection points must provide separate bins or areas for each of the waste streams.

Proposal	Ensure recycling opportunities are available everywhere trash receptacles are located and recycling opportunities in businesses and residences are as convenient as trash disposal. Provide separate wet and dry waste containers at all public refuse collection points and signage to clearly illustrate the proper system.
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The 7,475 tonnes of C&D materials deposited in Hong Kong's landfills in 2000 comprised 44%, by weight, of all materials disposed in the landfills. Furthermore, 11,028 tonnes per day of C&D materials were used for land reclamation. However, C&D materials often contain many valuable items such as metals, wood, aggregate, and drywall. Metals are a much too valuable commodities to be buried. Some wood from construction and demolition activities could be reused, as is, and others could

be used as feedstock in new industries manufacturing particle-board or pressed-wood products. Other new industries could use recovered drywall in the manufacture of new drywall or as an additive in composting.

In order to recover most efficiently the valuable items from C&D discards, materials must be source separated on the job site. Numerous projects around the world have demonstrated that source separation of C&D materials is both feasible and cost-effective.

For example, the demolition of existing structures at the Marion County Senator Block in Salem, Oregon, demonstrated that high recovery rates can be achieved during demolition in crowded urban conditions. The Marion County Senator block consisted of seven buildings, including a parking garage, retail stores, and an apartment building. Prior to demolition, Marion County's Facility Management Department salvaged more than 20 types of items for future reuse, such as light fixtures, air conditioners, and fire prevention equipment. The contractor's crews then removed metal pipes and heat, ventilation, and air conditioning ducts from each room using a small loader. The crews also removed asphalt roofing, concrete, and wood, such as large, old growth timbers, small timbers, and doors.

After salvage operations were completed, the contractor's crew demolished the buildings using a large track excavator and a crane with a wrecking ball. The crew then sorted the remaining wreckage, both mechanically and by hand and delivered metal (590 tons), asphalt and asphalt roofing (845 tons), and concrete (11,571 tons) to local recycling companies. These companies recycled these materials into new metal, roadbed mix, and slope stabilization materials. The contractor diverted 92% of the materials from landfill disposal: 13,700 tons (82%) through recycling and reuse, and 1,600 tons (10%) through the generation of wood chips for use as fuel in industrial boilers. Recycling and reuse saved Marion County and Salem Area Transit over US\$165,000. The additional US\$58,000 in equipment and labor costs for the materials recovery operations were more than offset by US\$188,000 savings in hauling and disposal tip fees and US\$36,000 in revenue from materials sales.

The contractor that renovated the Whole Foods Market Corporate Headquarters Building, in Austin, Texas, was able to divert 42% of the project's discards despite working in cramped quarters. Because the renovation took place on the third floor of an existing building, staff had to load all materials into a freight elevator and transport it through the loading dock. The loading dock had only enough space for one 30-cubic-yard roll-off at a time and, therefore, staff had to rotate roll-offs for disposal and recycling. Staff had to store materials on the job site until they could be placed into the appropriate roll-off. Due to careful planning on the relatively small site area, increased labor costs for moving materials for reuse to and from on-site storage locations were only \$209. In fact, by recycling and reusing materials, Whole Foods saved over US\$32,000 on the project.

Proposal	Require generators of all construction and demolition materials, whether generated from a household repair job, new construction, or a major building demolition, to separate into wood, metal, aggregate, and other categories.
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Collection

A well managed wet/dry system of separation and collection does not have to be more labor intensive than mixed waste collection.

Once separated into wet and dry categories, materials can be collected and transported with existing equipment. One option for Hong Kong may be to have cleaners in housing estates collect wet and dry materials on alternating days, perhaps collecting wet materials on Mondays, Wednesdays, and Fridays, and dry materials on Tuesdays, Thursdays, and Saturdays. FEHD would then collect only wet or dry materials on the appropriate days. Another is for cleaners to collect source-separated household materials each day using two-bin carts. The FEHD could then divide its fleet, having some collect wet materials and others collect only dry materials. The main difference in a wet/dry collection system is that trucks deliver collected materials to processing centers rather than the landfill.

Since the FEHD can use existing equipment to implement a wet/dry collection system, the major start-up costs would be education and signage. However, as the FEHD and its collection contractors replace aging collection trucks, they may want to consider switching to split two-compartment trucks so they can collect both streams simultaneously. When Guelph, Ontario, switched to split-compartment trucks for simultaneous collection of wet/dry streams, the City was able to reduce the size of its collection truck fleet by 15%.

Proposal	Use existing cleaning and waste collection staff and equipment to collect source-separated recyclables and materials for composting.
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In a study by Hong Kong Census and Statistics Department, nearly 40% of recyclers surveyed reported that the major reason they recycled was the possibility of a reward – that they "could obtain proceeds from selling recyclable waste materials by oneself or the refuse collector, or obtain award from recycling competition."³⁹ The Government could exploit this motivation to encourage increased participation in source-separation efforts.

The system for rewarding recycling in public housing estates could take many forms. For example, the Government could simply allow cleaning staff in public housing estates to sort and sell the dry stream of materials on the open market, retaining the revenue generated. Under this scenario, the Government would also save by not having to collect materials. Another option is for the Government to return a portion of revenues earned from sale of recyclables to individual housing estate governing bodies, perhaps based on volume or tonnage collected. This money could be earmarked for improvements in public areas or a similar activity that benefits everyone in the estate.

Proposal	Allow staff and/or residents of public housing estates to retain some or all of the revenue from sales of recyclables.
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The private sector provides waste collection services for most businesses and commercial establishments in Hong Kong. Because the Government is not directly involved in collection in this sector, it may be difficult to garner the cooperation of private companies in implementing a new collection system. However, creating this buy-in is essential to reducing commercial waste disposal. Furthermore, once commercial collection companies become enthusiastic recyclers, they can become

³⁹ Hong Kong Census and Statistics Department, "Participation of households in source separation and recovery of domestic wastes," *Social Data Collected Via the General Household Survey: Special Topics Report No. 20*, p. 30.

allies of the Government in assisting commercial enterprises implement source-separation programs. Recognizing that source-separation requirements will complicate hauling businesses, one way to create enthusiasm among haulers is to provide an incentive.

Reduced taxation on revenues can be used as an incentive to increased hauler cooperation with new government programs. For example, in Seattle, Washington, the City charges a tax on trash collection revenues, but excludes revenues from recyclables collection from the tax. Currently in Hong Kong, the business taxation system is quite simple. Profits of unincorporated businesses are taxed at 15% and profits of corporations are taxed at 16%. One simple way of providing a credit would be to provide a credit for each tonne of source separated materials delivered to processing centers.

In November 2001, Thailand's Board of Investment announced a plan to allow businesses involved in recycling of domestically collected materials to receive up to eight years of corporate income tax exemptions. Eligible businesses will also be exempt from import duties on machinery. The length of the exemptions will be determined according to which investment zone the recycling business is located in, based on proximity to Bangkok. Businesses in the most distant, and most rural, zone will be allowed the maximum tax exemptions.⁴⁰ Hong Kong could provide similar incentives for companies collecting source-separated recyclables.

Proposal	Provide tax breaks for private companies providing source-separated recyclables collection.
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Housing estates, businesses, and residents will need equipment to assist them in implementing new source-separation programs. For residents, equipment may include small, stacking containers that take up no more floor space than a single trash can. Cleansers may need carts with two compartments to enable them to keep collected wet and dry streams separate. Housing estates should have at least one wet and one dry waste bin on every floor. Furthermore, housing estates may need additional bins in their trash collection areas or to replace large roll-off containers with two smaller containers. Similarly, hauling companies may need to provide additional cans, carts, or roll-off containers so their commercial clients can properly sort their discards.

Some businesses and housing estates may want to sort and market recyclables from the dry stream themselves. Equipment such as small conveyors for sorting and balers would enable them to create cleaner, higher-value commodities, make more effective use of storage space, and more cheaply transport materials.

Proposal	Assist businesses, housing estates, and residents purchase recycling equipment (such as bins and carts).
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Recyclables processing

Once collected, dry materials can be processed at materials recovery facilities (MRFs). The Government could encourage private companies to build these facilities or construct and operate them themselves. It may be possible to site MRF facilities at existing transfer stations. As disposal volumes decrease, these sites

⁴⁰ Bureau of National Affairs, *Daily Tax Report*, December 4, 2001, p. G-1.

should become underutilized. Another advantage of siting MRF facilities at transfer stations is that barges can then be used to cost-effectively transport sorted recyclables to markets.

At a typical MRF, materials travel along sorting lines and are pulled out either manually or mechanically. In a wet/dry system, manual processing of the incoming stream to remove larger items and remove fiber products may be necessary before any automated sorting. After this initial sort, magnets can be used to separate ferrous metals from a mixed stream, eddy currents can selectively remove aluminum, and air classifiers can remove plastic bottles and film from mixed material streams. Automated systems can also be used to separate some fiber grades. To maximize recovery, additional sorting after automated sorting may improve recovery rates or create specialized sorts. For example, no reliable technologies exist for separating plastics according to resin or glass according to color. Furthermore, most automated systems do not remove 100% of their target materials.

The Europeans have taken the lead in innovation of MRF technology. Several European firms have developed optical systems that aid in the recognition and separation of individual recyclable items without manual removal. These systems use an image-processing system and pattern recognition software, to identify the contours of known products ranging from rectangular shapes to curved bottles and cans and can scan more than 40 objects per minute. Processors have achieved fully automated separation rates as high as 90% with these technologies. However, these systems are significantly more expensive than typical mechanical separation technologies and would only be cost-effective if prices paid for recyclables are high and/or landfill tipping fees are excessive.

Proposal	Develop MRF facilities at current transfer station sites.
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According to the Waste Reduction Framework Plan, the Government recognizes that high land costs and instability in recycling markets may inhibit the establishment of new recycling facilities. To address this issue the Government plans to facilitate siting of recycling industries by:

- Leasing appropriate short-term tenancy sites to the waste recycling industry for up to five years;
- Co-locating waste recycling activities at existing and future waste facilities such as refuse transfer stations (RTSS) and strategic landfills;
- Using restored landfill sites for waste recovery and recycling facilities;
- Publicizing the availability of industrial land/premises suitable for the recycling industry; and
- Encouraging suitable waste recyclers, incorporating new technologies and significant capital investment, to apply for land at the Hong Kong Industrial Estates Corporation's estates.

The Government has allocated some land under short-term tenancy to recyclers. However, to accommodate the increases in recovered materials projected in this plan, much more land will be necessary for processors and re-manufacturers. These companies could also be located with other new industries that will result if this plan is implemented, such as electronics and bulky item reuse and repair, diaper services, and deposit/refund system facilities.

In the United States, several new industrial sites have been set aside for recycling and related businesses in "resource recovery parks." A typical resource recovery park is the co-location of reuse, recycling and composting processing, manufacturing and retail businesses in a central facility to which the public can bring wastes and recoverable materials. At resource recovery parks, participating businesses keep costs low by sharing space and facilities; operating equipment (e.g., forklifts, balers, shredders, loaders, and trucks); technical, administrative and professional services; promotions and advertising; communications equipment and services (e.g., copiers, computers, web sites, fax, radios, phones); staff recruitment and training; and educational facilities and services.

One example of a resource recovery park is under development in Berkeley, California. Urban Ore; a for-profit business that sells items for reuse, designs disposal facilities for zero waste, and publishes technical papers; is developing the 2.2 acre site at a former steel pipe manufacturing facility. Urban Ore plans to move its operations to the park and lease additional space to other businesses that focus on reuse or manufacturing from recycled feed stocks. Although no subleases have been signed yet, potential subtenants include:

- A nonprofit organization that rebuilds and upgrades computers and then sells them at low cost to low-income people
- A company that makes fancy countertops out of recycled glass embedded in Portland cement (looks like granite);
- Overflow warehousing for another reuse company
- A blacksmith who makes things out of scrap steel.

Urban Ore is exploring interest in shared overhead or equipment as part of its negotiations with potential tenants. They will also be designing in a big meeting room to host community and recycling groups, training for employees on site, and classes on how to use recycled building materials.

The 53-acre SMaRT Station owned and operated by Waste Management, Inc. (WMI) in San Leandro, California, is not called a "resource recovery park," but it functions as one. Although the site was initially a transfer station, WMI has stated that it is their goal to transform this facility into the most innovative and largest recycling park in the United States. Activities at the site include:

- A 4.5 acre integrated yard and wood waste processing system;
- California's first tire recycling and crumb rubber facility;
- A Building Materials Exchange Facility that accepts a wide variety of used items/materials for reuse and re-sells them at greatly reduced prices;
- The SmaRT Station Education Center, where students are provided lessons about garbage and landfill history and why and how to practice the four Rs (reduce, reuse, recycle, and rot/compost); and
- Retail sales of soil products and recycled-content landscape products.

While land is scarce in Hong Kong, potential sites for development of resource recovery parks include the old airport, closed landfill sites, and on or near transfer station sites.

Proposal	Increase allocation of land for recycling industries and resource recovery parks.
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Markets for recyclables

The success of any recycling and/or composting program relies on having markets for finished products. Currently, Hong Kong exports many of its recyclable materials, primarily to Mainland China. China and other Asian countries import recyclable materials from both the United States and Europe. If Hong Kong could take advantage of shorter transport distances and offer clean recyclables at a lower price than these other sources, the regional markets could absorb their materials.

Exportation of recyclable feed stocks is one option, but a better one is ensuring local markets by encouraging the development of local recycling capacity. Government can support the development of recycling-based local manufacturing by spurring demand for their products. Incorporating minimum-recycled-content specifications for government purchasing does just that.

In June 1988, the U.S. EPA issued its original guidelines on buying recycled paper. These guidelines specified minimum recovered-fiber-content levels for a variety of paper and paperboard products. They have since been updated and expanded to other products. Today, 62 federal guidelines for recycled-content product procurement are in effect. These guidelines have been replicated by states and localities and could be replicated by businesses. Furthermore, they have provided industries with a clear definition of products that are acceptable, and thus have helped increase production of recycled products that meet the standards.

King County, Washington, adopted the federal guidelines as its minimum content standards and updates its standards in accordance with federal updates. King County's recycled paper purchases have grown from 8% in 1989 to 94% in 1998, exceeding the County's 60% goal. In 1998, County agencies purchased recycled paper goods valued at \$1.6 million.

The Hong Kong Government has made strides in procurement of recycled content goods. In 1999, the General Supplies Department awarded a contract, worth \$1,183,600, for the purchase of recycled photocopying papers for consumption by Government departments. GSD also offers other recycled paper products, such as paper towels and toilet paper. In January 2000, the Environmental Protection Department commissioned the Hong Kong Productivity Council to devise environmentally responsible specifications for products it purchases on a regular basis. Adoption of these specifications is critical to supporting industries using recycled feed stocks, especially as the supply of such feed stocks are expected to grow.

Proposal	Include minimum recycled-content requirements in Government purchasing guidelines.
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While government procurement can help develop healthy markets for recycled-content goods, the private sector can have a much greater impact. In 1999, purchasing contracts arranged by the GSD on behalf of Government departments and the Hospital Authority amounted to HK\$6.8 billion, contrasted with total Government and private consumption expenditures of HK\$864 billion in the same year.⁴¹

⁴¹ Mr. Nigel Shipman, "Environmental concerns and the purchasing manager," speech delivered at the Forum for Environmental Supply Chain Management, City University of Hong Kong, October 10, 2000. Text available at <<http://www.info.gov.hk/gia/general/200010/10/1005244.htm>>. Site visited November 9, 2001.

In order to increase use of recycled feed stocks in available products, numerous U.S. jurisdictions have passed legislation that requires certain products sold within their borders to have a minimum recycled-content. For example, California law requires that by January 1, 2000, at least 50% of newsprint used by printers and publishers in the State have at least 40% post-consumer paper content.⁴² In 1996, California's publishing and printing industry reported using 800,000 tons of recycled newsprint. This surpassed the State's 1996 goal of 35% and fell just shy of the State's requirement for the year 2000, accounting for 49.3% of total newsprint used.⁴³ Nationally, the average amount of recycled fiber in newsprint has grown from 10% in 1989 to 25% in 1997.⁴⁴

Newsprint is the material most often targeted by minimum-content policies. California, Connecticut, the District of Columbia, Illinois, Oregon, Maryland, Missouri, and Wisconsin have all set minimum-content goals or requirements for newsprint. Other materials targeted by minimum-content programs include telephone directories, glass containers, plastic trash bags, plastic containers, and other paper products. Oregon and California, for instance, require rigid plastic containers to maintain a 25% recycling rate or to contain 25% post-consumer recycled material. Industry has already met Oregon's requirements. In California, recyclers recovered 21.9% of rigid plastic containers generated in 1997, short of the requirement. In 1998, the State moved to enforce its law by sending out letters to 500 manufacturers at random asking for compliance information.⁴⁵

New York is one state that has taken a successful voluntary approach to encourage industry to use recycled feedstock. In 1989, the State brought to the negotiating table representatives of eleven companies that together bought or produced more than 80% of all newsprint in the country. New York asked the manufacturers to voluntarily increase use of recycled-content newsprint and offered to help with technical difficulties (e.g., sponsoring research into the quality of recycled-content paper versus virgin paper). In the 18 months following these negotiations, industry invested \$1.5 billion in recycled newsprint de-inking capacity in North America.⁴⁶

Proposal	Set recycled-content guidelines or requirements for classes of products sold in Hong Kong, including newsprint, office paper, cardboard, glass, and plastics.
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Composting

Compostable materials comprise more than one-third of domestic discards in Hong Kong. While compostable materials comprise a much smaller portion of the commercial waste stream, the waste stream from some business types can be almost

⁴² California Integrated Waste Management Board, Recycled-Content Newsprint Program (Public Resources Code Sections 42750-42791). California Integrated Waste Management Board. Web page at <<http://www.ciwmb.ca.gov>>, site visited June 1999.

⁴³ California Integrated Waste Management Board, January 29, 1998 News Release: Waste Board Fines Printing Service.

⁴⁴ "Facts About Newspapers 1997: Newsprint Recovery Continues to Climb," Web site <<http://www.naa.org/info/facts97/13.html>> (Vienna, Virginia: Newspaper Association of America), site visited August 1999.

⁴⁵ Raymond Communications, Inc., *State Recycling Laws Update Year-End Edition 1998*, College Park, Maryland, 1998, pp. 19, 21; and Rick Best (Californians Against Waste, Sacramento, California), personal communication, November 23, 1999.

⁴⁶ Tom Kacandes (Empire State Development Environmental Management Investment Group, Albany, New York), personal communication, July 16, 1999.

totally organic. For example, organic residues can represent 75 to 90% of the total waste stream from supermarkets. In schools, restaurants, and personal care facilities, organic materials often make up two-thirds of the total waste stream.

Burial of these materials uses valuable landfill space while preventing the natural decomposition processes that can turn the materials into a valuable soil amendment. Landfill studies have unearthed 35-year-old newspapers that were still legible and 15-year-old onions that were still recognizable. In contrast, composting of food-rich discards produces a product that can replace chemical fertilizers and mulch.

Composting operations can range from household-scale to those processing over 1,000 tonnes per day. Composting operations can also range from low-technology operations to high-technology operations. Low-tech composting operations can simply consist of long piles of organic materials, where the piles of materials are turned periodically. High-technology operations may employ in-vessel composters, size reduction equipment, dedicated windrow turners, and screening equipment.

Space requirements for composting facilities depend on many factors, including the facility's design capacity, waste composition, design and operating conditions, expected level of compost maturity, and site conditions. Low-technology operations generally require more time to complete the composting process and, consequently, more land area. In general, small capacity facilities of 100-400 tons per day will require 10-20 acres.

Small and medium-scale composting operations can reduce the material amounts necessary to be handled at central facilities. These operations can range from composting by individual residents, to small facilities serving individual businesses, office buildings, or small commercial or residential developments.

In Patna, India, a city of one million people, some of the city's apartment dwellers have created an innovative way to handle their organic discards using their balconies and windowsills. Residents combine organic waste, soil, floor sweepings, and dried moss from rooftops in clay pots. The mixture matures into compost in three to four months. Residents use the finished compost to grow flowers, ornamental plants, spinach, and tomatoes.⁴⁷

A computer company in Tokyo's Chuo Ward has been composting its cafeteria discards since the end of 1995. The company cafeteria serves 3,300 lunches daily. Staff collect 600 kilograms a day of scraps from the kitchen and the tables and process them in a composting unit in the company basement. A fertilizer manufacturer collects finished compost. By adding the food-composting program, the company raised its overall recycling rate from 54% in 1995 to 71% in one year.⁴⁸

Proposal	Encourage small-and medium-scale composting of food discards in individual apartments, housing estates, and office buildings.
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Due to limited land availability, the sheer volume of materials to be composted, and the high food-content of materials to be composted in this proposal, Greenpeace and ILSR suggest that the most appropriate centralized composting technology would consist of grinding, large in-vessel composting, followed by windrow curing. The

⁴⁷ I. Maumdar, "India," *Warmer Bulletin*, Number 34, August 1999, p. 3.

⁴⁸ Trends in Japan web site edited by Japan Echo Inc., "Garbage to Gold: Organizations Put Waste to Good Reuse," available at <<http://jin.jcic.or.jp/trends98/honbun/ntj970731.html>>. Site visited November 9, 2001.

initial in-vessel processing will reduce odor and vector problems, reduce land requirements for the facilities, and produce usable compost in a shorter time than lower-technology options.

Wet materials collected in the new collection program would be the feedstock for these composting operations. Former landfill sites provide locations for composting facilities close to generators, potentially cutting transportation times and costs of delivery of the material to Hong Kong's active landfill sites.

Proposal	Develop composting sites for the wet component of the waste stream at former landfill sites and at existing landfill sites on those sections that are temporarily closed for dumping.
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Although the scale of farming activities in Hong Kong is not sufficient to absorb the amounts of compost that would be produced, numerous Government departments use compost in their daily operations. By providing finished compost to other Government departments, such as the Country and Marine Parks Authority, the Architectural Services Department, and the Highways Department, Government expenditures for imported compost would be reduced. Small amounts of finished compost could also be sold at the retail level to individuals and greenhouses.

Proposal	Provide compost to the Parks and Highway Departments for use in landscaping projects. Sell additional compost on the retail market.
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Disposal

This proposal sets a goal of zero waste. This goal can be achieved by implementation of producer responsibility programs and handling discarded materials in sustainable systems. Shifting responsibility for many discarded materials to manufacturers, importers, and consumers does not constitute a departure from free market systems. Rather, producer responsibility policies embody a free market system where true environmental costs of products and consumption are borne by the parties responsible for creating waste.

Government's traditional role in waste management has been to make discarded materials go "away." As Hong Kong's current shrinking disposal capacity so poignantly illustrates, there is no "away." The waste management paradigm for the next millennium must charge governments with creation of sustainable systems for handling discards that do not foul our air or water, remove land from indefinite productive use, or rob future generations of valuable resources. Neither landfills nor incinerators meet these standards. Only aggressive, well-implemented waste elimination, recycling, and composting systems based on source-separation will start leading us down the path to zero waste.

In recognition of the importance of source-separation to maximizing material recovery, the Government should ban mixed municipal and C&D materials from disposal at landfills. The existing landfills should only be used for disposal of residues left over after recycling and composting. Furthermore, the generation of these residues should not be considered inevitable. Constant refinement and innovation in products, manufacturing, and recovery systems should bring Hong Kong incrementally closer to zero waste each year. If so, the Region may never need to build another landfill or incinerator.

Proposal	Ban mixed municipal and C&D materials from disposal at landfills.
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Waste incinerators can appear to be the answer to the problem of ever-increasing waste disposal. But to paraphrase Dr. Paul Connett, if incineration is the answer you have asked the wrong question. Municipal waste incineration is **not** safe, it is **not** cost-effective, it is **not** sustainable, and it does **not** create net energy gains for society.

The stated objectives of the Waste Reduction Framework Plan are:

- "(a) to extend the useful life of our strategic landfills;
- (b) to minimise the amount of waste produced that requires disposal;
- (c) to help conserve the earth's non-renewable resources;
- (d) to increase the waste recycling rate;
- (e) to show to the administration, the Provisional Municipal Councils, commerce, industry and the public the true costs of waste management so that we can review how these costs are met; and
- (f) to encourage maximum efficiency in waste management operations and minimisation of the costs associated with the collection, treatment and disposal of wastes."

Burning of municipal solid waste is in direct conflict with objectives (c), (d), and (f). Furthermore, viable alternatives exist. The implementation of the programs presented in this proposal could reduce Hong Kong's disposal needs below the target levels set in the Waste Reduction Framework Plan, and would do so without the need for dangerous incinerators.

Proposal	Ban incineration.
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As stated earlier, even the best landfill liner and leachate collection systems will ultimately fail due to natural deterioration. Furthermore, these leaks may occur after the current required 30-year post-closure monitoring period for landfills in Hong Kong has expired. Requiring any future landfill contracts to include provisions for post-closure monitoring and/or remediation in perpetuity will not prevent pollution from closed landfills, however, it may provide warning of leaks early enough for restoration to occur before catastrophic contamination takes place. Furthermore, landfill costs will more nearly represent the "true" costs of wasting, if they include the costs of clean-up – even clean-ups that are necessary in our grandchildren's time.

Proposal	Require any future landfill contracts to include provisions for post-closure monitoring and/or remediation in perpetuity.
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Education

The cornerstone of this ambitious proposal to reduce disposal is education. Educational efforts must focus on both the "how" and the "why" of reducing waste. The importance of linking the need to recycle to overall quality of life was demonstrated by a recent survey of Hong Kong residents about their recycling habits and attitudes. In this study, less than one percent of non-recycling respondents reported that they did not know how to recycle. However more than a quarter of the non-recyclers reported that they "[f]elt that there was no need/use for

one's household in general" to participate.⁴⁹ Many of these respondents do not see the link between individual actions and broader environmental quality.

Proposal	Implement an ongoing and comprehensive education program covering all aspects of disposal reduction.
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Estimated disposal reductions achievable as a result of proposed programs

The composition of materials landfilled and recycled in Hong Kong in the year 2000 is shown in Table 16. The flow charts in Appendix 1 show expected disposal reductions for the years 2002 through 2011 as a result of implementing the Greenpeace/ILSR proposed solid waste management system. Greenpeace and ILSR believe that implementation of the programs proposed could result in reducing disposal needs to approximately 7,000 tonnes per day by the year 2011. This represents a greater disposal reduction than the Government proposed in its "Waste Reduction Framework Plan." Furthermore, these reductions would be achieved without relying on incineration.

The assumptions used to calculate these reduction levels are:

- Pre-existing recycling remains at current levels;
- The deposit/refund system would divert 90% of the glass bottles, 10% of ferrous and non-ferrous metals, and 90% of the polyethylene terephthalate (PET) and other beverage containers that are currently disposed, for recycling;
- Take-back programs would divert 20% of the bulky waste, 3% of the other glass (fluorescent tubes), and 5% of the "other" category (household batteries, hazardous products, etc.) from disposal;
- Implementing landfill charges for commercial materials would spur business and industry to recycle 75% of the cardboard, newsprint, and writing paper; 25% of the other paper; and 90% of the plastic off-cuts and scrap they currently dispose;
- Implementation of disposal fees would result in 10% less consumption of plastic bags, expanded polystyrene (EPS) and other polyfoam containers, and plastics in the "other" category;
- Establishment of reuse businesses would decrease the generation of EPS, other polyfoam, and plastics in the "other" category wastes by 10%;
- Separate collection of material collection programs would handle 80% of the currently generated bulky materials, recovering half of it for reuse or repair;
- Implementation of a wet/dry collection system, followed by sorting of dry materials and composting of wet materials would divert approximately 80% of the glass bottles, metals, plastic bottles, and plastics in the "other" category that remain in the waste stream; 80% of residential paper; 20% of total commercial cardboard, newsprint, and writing papers; 60% of total commercial generation of paper in the "other" category; 75% of the total generation of plastic bags; 40% of the total generation of plastics in the "other" category; more than 80% of putrescibles; 25% of textiles; and 50% of the wood and rattan for recycling and composting.
- Mandatory source separation of C&D materials could reduce the current disposal levels by at least half; and

⁴⁹ Hong Kong Census and Statistics Department, "Participation of households in source separation and recovery of domestic wastes," *Social Data Collected Via the General Household Survey: Special Topics Report No. 20*, p. 40.

- Small-scale composting programs in apartments and businesses could recover 4-5% of putrescibles from the waste stream.

Greenpeace and ILSR acknowledge that our proposal is very ambitious. However, it is not unattainable. Numerous jurisdictions in the U.S. and around the world have achieved impressive diversion levels for MSW. In the U.S., during 1996, Seattle, Washington, diverted 44% of its MSW from disposal, Portland, Oregon, diverted 50%; and Bergen County, New Jersey, diverted 54%. The residents of Mokattam, Cairo, divert 90% of the trash they collect. Curitiba, Brazil, recycles two-thirds of its garbage. A neighborhood participating in the Advanced Locality Management program in Sahar, Andheri, Mumbai, India, reduced their garbage disposal by half within two years.⁵⁰ Each of these jurisdictions has implemented some of the diversion programs proposed in this report but none has implemented the entire range of programs. We believe that if Hong Kong does so, it will not only be able to reduce its waste disposal to 7,000 tonnes per day cost-effectively by 2011, it will become a model for the rest of the world.

Greenpeace and ILSR emphasize that the projected reductions are *conservative*. For example, we estimated a diversion rate of 50% for source-separated C&D materials, however, a well-implemented program could easily achieve disposal reductions of 75 to 80%.

⁵⁰ Shiv Kumar, "Mumbaiites resort to self-help to tackle civic issues, India Abroad News Service, June 5, 2000.

Summary list of Greenpeace/ILSR proposals for management of Hong Kong's waste stream

- Implement a deposit-refund system for single-use packaging materials (including all bags, boxes, bottles, and cans, regardless of the product sold in it), requiring manufacturers/importers to pay for recovery.
- Encourage industries such as the electronics and disposable camera industries, and manufacturers of difficult to manage wastes (household chemicals, automotive fluids, batteries, and pharmaceuticals) to establish take-back programs for their products. Establish mandatory programs if voluntary efforts do not meet reduction targets.
- Impose user fees at disposal facilities as soon as possible and at material recovery facilities (MRFs) and composting facilities once wet/dry collections systems are implemented.
- Impose non-refundable product charges on single- and limited use products, such as disposable diapers, disposable chopsticks, cups and dishes, and disposable razors. Deposit revenues generated by the charges in a special fund used to mitigate the costs that these materials have on the environment.
- Prohibit the use of disposable cups, containers, plates, chopsticks, toothpicks, napkins, moist towelettes, spoons, forks, knives at restaurants and cafeterias by customers who dine on-site.
- Outlaw the distribution of free disposable cups, containers, plates, chopsticks, toothpicks, napkins, moist towelettes, spoons, forks, knives at restaurants and cafeterias by customers who take food away from the premises. Set the prices of the disposable items high enough to encourage patrons to bring their own reusable items.
- Ban the distribution of free plastic bags and shopping bags by all retail and food service establishments. Allow customers to purchase bags but set the price high enough to encourage customers to switch to reusable bags.
- Require lodging facilities to distribute products such as liquid soap, shampoo, mouthwash, and hair conditioner from bulk dispensers and to charge for the distribution of other personal care products.
- Encourage the development of businesses that provide consumers with alternatives to single- and limited use products.
- Contract with charities and private companies to collect bulky, reusable, recyclable, and/or repairable products on a monthly basis. Assist companies in distribution of collected materials through creation of a centralized store for resale of collected products or by assisting contractors create an internet-based list of materials available. Examples of reusable items that can be collected for reuse and/or recycling include office supplies, furniture, shipping containers, small and large appliances and electronics, clothing, paint and other chemicals, building materials, rugs and carpets, dinnerware, pots and pans, toys, bicycles, decorative items (bric-a-brac, art, collectibles, etc.), books, movies, record albums, tapes, and compact discs.
- Implement a modified wet/dry collection scheme for source-separated materials from all residences and businesses. The system would initially require waste generators to separate materials into four streams – paper, containers, all other dry materials, and wet materials.
- Ensure recycling opportunities are available everywhere trash receptacles are located and recycling opportunities in businesses and residences are as convenient as trash disposal. Provide separate wet and dry waste containers at all public refuse collection points and signage to clearly illustrate the proper system.
- Require generators of all construction and demolition materials, whether generated from a household repair job, new construction, or a major building demolition, to separate into wood, metal, aggregate, and other categories.
- Use existing cleaning and waste collection staff and equipment to collect source-separated recyclables and materials for composting.
- Allow staff and/or residents of public housing estates to retain some or all of the revenue from sales of recyclables.
- Provide tax breaks for private companies providing source-separated recyclables collection.
- Assist businesses, housing estates, and residents purchase recycling equipment (such as bins and carts).
- Develop MRF facilities at current transfer station sites.
- Increase allocation of land for recycling industries and resource recovery parks.
- Include minimum recycled-content requirements in Government purchasing guidelines.

Hong Kong Waste Management Plan

- Set recycled-content guidelines or requirements for classes of products sold in Hong Kong, including newsprint, office paper, cardboard, glass, and plastics.
- Encourage small-and medium-scale composting of food discards in individual apartments, housing estates, and office buildings.
- Develop composting sites for the wet component of the waste stream at former landfill sites and at existing landfill sites on those sections that are temporarily closed for dumping.
- Provide compost to the Parks and Highway Departments for use in landscaping projects. Sell additional compost on the retail market.
- Ban mixed municipal and C&D materials from disposal at landfills.
- Ban incineration.
- Require any future landfill contracts to include provisions for post-closure monitoring and/or remediation in perpetuity.
- Implement an ongoing and comprehensive education program covering all aspects of disposal reduction.

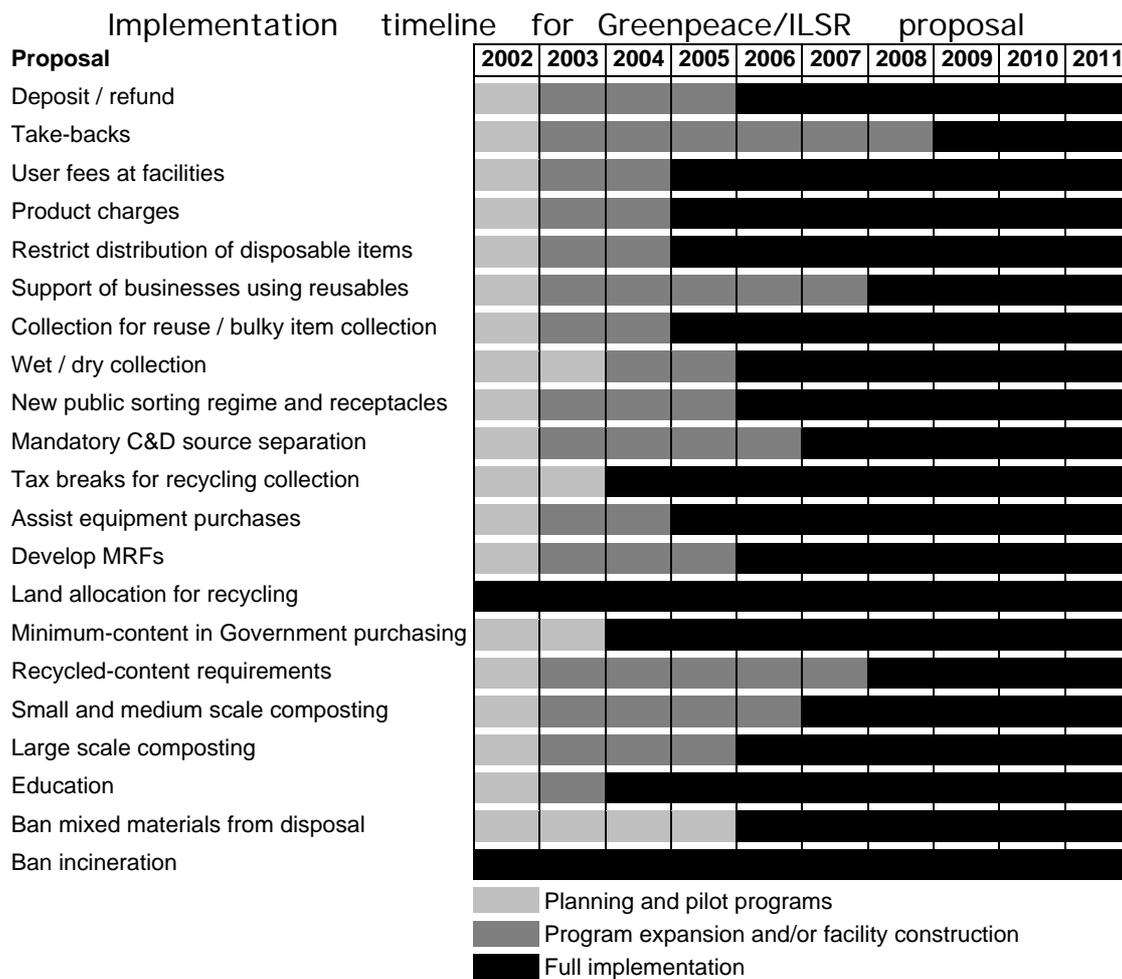


Table 16: Waste generation, composition, and recycling, 2000

	Domestic materials landfilled (tpd)	Commercial materials landfilled (tpd)	Materials recycled (tpd)	C&D landfilled (tpd)	Total generation (tpd)	Total disposed (tpd)	Percent recovered
Bulky Waste	223	106			329	329	0
Glass	260	28	2		290	288	0.7
<i>Brown bottles</i>	37	3					
<i>Clear bottles</i>	151	13					
<i>Green bottles</i>	61	5					
<i>Other</i>	11	7					
Metals	232	52	2000		2,284	284	88
<i>Ferrous</i>	188	46	1,745				
<i>Non-ferrous</i>	44	6	255				
Paper	2,003	490	2,263		4,756	2,493	48
<i>Cardboard</i>	114	69					
<i>Newsprint</i>	900	74					
<i>Writing paper</i>	111	68					
<i>Other</i>	878	279					
Plastics	1,210	334	452		1,996	1,544	23
<i>Clear bags</i>	122	76					
<i>Colored bags</i>	563	64					
<i>EPS food/drink containers</i>	61	20					
<i>Other polyfoams</i>	12	15					
<i>PET bottles</i>	51	12					
<i>Other beverage bottles</i>	56	9					
<i>Off-cuts & scrap</i>	1	22					
<i>Other</i>	344	116					
Putrescibles	2,792	299			3,091	3,091	0
Textiles	224	73	66		363	297	18
Wood / rattan	152	247	16		415	399	4
Others	444	166	19		629	610	3
C&D				7,475	7,475	7,475	0 ¹
Total	7,540	1,795	4,822	7,475	21,632	16,810	22

Notes: tpd = tonnes per day.

Figures may not add to total due to rounding.

¹In 1999, more than 29,200 tons per day of C&D materials were recovered for use in land reclamation projects.

This tonnage is not considered in this plan and therefore not included in the table.

SYSTEM COSTS AND FUNDING

Most of the proposed programs will impose costs or reap savings for consumers, industry, and the Hong Kong Government. The amount of these costs can vary considerably depending on how the programs are implemented and the level of participation in the programs. In the next section, we plan to discuss the costs to each sector and give specific information whenever possible.

Deposit/refund system

Consumers: Costs to consumers of deposit/refund systems depend on the level of the charges, the rate at which customers return containers subject to the charges, and increased costs of products due to the system. The deposits must be set at a high enough level to provide an incentive to return the containers. In the U.S., most states with deposit/refund systems impose a US\$0.05 charge. This corresponds to roughly 5% of the cost for beverages such as soft drinks.

Individual consumers incur increased costs for each container in the system they fail to return for refund. This cost is in direct proportion to their level of consumption and the amount of the deposits. However, many containers unredeemed by their purchaser, are collected and redeemed by others. Deposit/refund systems direct the energies of some poor people into cleaning up roads, parks, beaches, and other public spaces, and recovering valuable materials for recycling.

In British Columbia, Canada, unredeemed deposits on all beverage containers totaled approximately Can\$16.0 million (Can\$8.9 million from non-alcoholic beverage containers and Can\$7.1 million from alcoholic beverage containers) in 1998, for an average of Can\$11 (HK\$ 54.45) per household.⁵¹ This figure is somewhat misleading, though, because the costs are spread out unevenly among households. The costs are borne only by those who purchase packaged beverages and most heavily by those who do not redeem deposits. Thus, in B.C. the polluter pays for the impact of beverage containers, rather than all of society paying through municipal solid waste programs.

It is difficult to assess the impact of deposit/refund systems on product prices because prices are dependent on numerous other factors, including industry price increases and general economic conditions. Shortly after implementation of the Massachusetts bottle bill, Donald J. Dowd, Vice President of Coca-Cola New England was quoted in the *Boston Globe* as saying, "Our prices pre-bottle bill and post-bottle bill are virtually the same."⁵² Residents in Oregon experienced an increase in beer prices after implementation of the State's bottle bill, however, brewers indicated that the increases were caused by labor and materials costs, not by the deposit law.⁵³ The New York Beer Wholesalers Association reported that beer

⁵¹ Clarissa Morawski, "Beverage Container Recovery in B.C.: Brand Owner Responsibility Increases Recovery Rates, Reduces Taxpayer Subsidies," *Solid Waste & Recycling*, August/September 1999. ILSR calculated per household costs based on Can\$16.0 million divided by 1.4 million households in B.C. as reported by the 1996 Statistics Canada census. Statistics Canada 1996 census data are available on the Internet at <<http://www.statcan.ca:80/english/census96/nation.htm>>.

⁵² Container Recycling Institute, *The Ten-Cent Incentive to Recycle*, March 1999. Available on line at <<http://www.container-recycling.org/publications/tencent/tencent.html>>.

⁵³ Bottle Bill Resource Guide, "Bottle Bills at a Glance: Oregon." Available at <<http://www.bottlebill.org/USA/states-oregon.htm>>. Site visited November 6, 2001.

prices increased by 11-18% after the State's bottle bill was enacted. The Association attributed half the increase to the system costs and half to inflation.⁵⁴

Industry: Industry often fights deposit-refund systems on the grounds that they will result in higher costs that they will have to pass onto consumers, causing lower sales. However, the general pattern of beverage sales in U.S. deposit law states has been a slight decline followed by a return to normal growth patterns. In the United States, sales figures for a 3-5 year period after the laws have passed show sales increased at or above the national average in most of the states with deposit laws.⁵⁵

The net cost of deposit-refund systems for containers varies by system type. In Alberta, Canada, the province's depot-based deposit-return system is financed by depot operators and manufacturers through a charge of CNS\$0.0005 (HK\$0.0025) per container recovered. With the costs of operation, regulation, and enforcement fully borne by the system, in 1997, the net system cost per container sold in the province was CNS\$0.008 (HK\$0.0395).⁵⁶

Government: Every tonne of material removed from the waste stream saves the Government the cost of its collection and disposal. Assuming a disposal cost of \$110 per tonne and an estimated recovery of an additional 387 tonnes per day of containers under a deposit/refund system, the Hong Kong Government could save more than \$15 million per year for disposal. Furthermore, reductions in litter should decrease Government costs for street and marine clean-ups. U.S. states with bottle bills have experienced total litter reductions of between 34 and 47%.⁵⁷

Under some deposit/refund systems, a portion of unredeemed deposits are forfeited to the government or used to finance other environmental initiatives. In the Republic of Korea, the quasi-governmental Resources Recovery and Reutilization Corporation distributes some unclaimed deposits to local governments, schools, military units, and community organizations to implement collection programs.

	Cost		
	Residents	Private sector	Government
Deposit-refund	Source: Unredeemed deposits. Amount: Incalculable. Depends on level of deposits, number of containers in system, return rate.	Source: Program implementation and operation. Amount: Incalculable. Depends on how system organized, designated ownership of unredeemed deposits.	Source: Lower collection and disposal costs, reduced litter. Amount (2011): \$15.5 million savings in landfill costs assuming \$110 per tonne cost and diversion of 387 tonnes per day.

Product take-backs

Consumers: Costs to consumers of product take-back programs would depend on how the program is implemented and on their consumption of covered products. In Japan's appliance take-back program, consumers must pay government-set fees to

⁵⁴ Bottle Bill Resource Guide, "Economic Impacts." Available at <<http://www.bottlebill.org/Economic/sales.htm>>. Site visited November 6, 2001.

⁵⁵ Bottle Bill Resource Guide, "Economic Impacts." Available at <<http://www.bottlebill.org/Economic/sales.htm>>. Site visited November 6, 2001.

⁵⁶ Clarissa Morawski, "Alberta's Deposit-Refund System: Eighty per cent container recovery at 0.8 cents per unit sold," *Solid Waste and Recycling*, August/September 1998.

⁵⁷ Bottle Bill Resource Guide, "Environmental Impacts." Available at <<http://www.bottlebill.org/Environmental/Litter/litter.htm>>. Site visited November 6, 2001.

cover industry's actual costs for take-back, transportation, and recycling. They are (in U.S. dollars): washing machine, \$24; air conditioner, \$35; refrigerator, \$46; and television, \$27. These fees must be paid when consumers return appliances for recycling. One of the reasons the Japanese Government allows industry to pass financial responsibility for household appliance recycling to consumers is the hope that they may realize how much it costs to throw away a product. The cost may lead consumers to reconsider disposing of a product that still functions or is repairable.

In Taiwan's product take-back system, the costs are not charged directly to consumers. All producers and importers of covered products are required to submit bi-monthly reports containing actual sales data for the previous two months and pay processing fees to a designated fund. Costs are indirectly passed on to consumers in product prices.

Take-back systems could save consumers money if the system encourages innovation in product design. Xerox's take-back program saves the company several hundred million dollars a year, some of which is returned to consumers through lower product prices.

As in the case of deposit/refund systems, mandatory take-back programs shift waste management costs from society at-large to consumers, manufacturers, and importers of covered products.

Industry: Take-back and recycling requirements, especially for older equipment, would undoubtedly increase costs in the short-term for industry. However, take-back requirements encourage companies to use fewer resources in the production process and to design products for reuse and re-manufacturing. In Japan, the SHAR law has spurred manufacturers to invest in appliance recycling facilities and explore "design for the environment" practices. For example, Panasonic has reduced the number of components in its televisions and the number of plastic resin types in many of its products in order to facilitate recycling. In fact, a Japanese researcher reported that three out of five companies interviewed said that the enactment of the SHAR Law was a strong incentive for them to promote Design for the Environment.⁵⁸ In the U.K., the ECTEL Cellular Phones Group found that the component value of telephones released onto the market after 1995 is greater than the cost of disassembly.⁵⁹ As industry designs products, in awareness that they will bear the responsibility for recycling them after their useful life is over, recycling costs will drop, perhaps becoming a profit center for manufacturers.

Government: As with deposit/refund systems, the most immediate impact of product take-back on Government expenditures will be reduced collection and disposal costs. Furthermore, removal of products that are hazardous or contain hazardous components from the waste stream will reduce the likelihood of long-term contamination of the environment from landfills. Mixed municipal solid waste, which often includes numerous hazardous components, can cause environmental problems as serious as those posed by dedicated hazardous waste disposal facilities. In fact, in the U.S., municipal solid waste landfills comprise 16.5% of Superfund

⁵⁸ Naoko Tojo, "Analysis of EPR Policies and Legislation through Comparative Study Of Selected EPR Programmes for EEE - Based on the In-Depth Study of a Japanese EPR Regulation," International Institute for Industrial Environmental Economics, Lund University, Lund, Sweden; 1999. Available for download at the International Institute for Industrial Environmental Economics web site at: http://www.lu.se/IIIEE/publications/communications/2000/2000_10.pdf.

⁵⁹ Bill McCartney, "End-of- Life Management of Cellular Phones: An Industry Perspective and Response," presentation at the Second European Conference on Telecommunications and the Environment, Torino, Lingotto Fiere, November 19-20, 1998. PowerPoint presentation available at <http://www.etno.be/news/Environment_conference.html>. Site visited November 7, 2001.

National Priority List sites. (Superfund is a U.S. Government program to clean up sites "that pose the highest potential threat to human health and the environment in the United States.") The capital cost for clean ups at each of these sites has averaged over US\$20 million.⁶⁰

	Cost		
	Residents	Private sector	Government
Product take-backs	Source: Fees charged for take-backs. Could be paid at time of purchase or disposal. Amount: Incalculable. Depends on level of consumption of covered products and amount of fees.	Source: Program implementation and operation, potential savings from product redesign. Amount: Incalculable.	Source: Lower collection and disposal costs, reduced risk of site contamination and associated costs. Amount (2011): \$3.9 million savings in landfill costs assuming \$110 per tonne cost and diversion of 97 tonnes per day.

Disposal fees

Industry: The lack of disposal charges at Hong Kong landfills distorts markets for recycling and allows businesses to pass the costs of their wastefulness onto others. If businesses were required to pay the Government the full cost for landfill disposal of their wastes, many companies would find it cost effective to recycle. Assuming the cost of landfilling is \$110 per tonne, Hong Kong businesses were essentially subsidized by the EPD more than \$72 million in the year 2000.

Imposition of disposal charges will increase business expenses in direct proportion to the amount of waste produced. However, companies may reduce these costs by improving recycling efforts or adopting innovative business practices. For example, Target department stores, in the United States works with its vendors to reduce product packaging. The company also reuses 200 million clothing hangers and recycles more than 250,000 tons of materials annually. State Farm Mutual Automobile Insurance Company converted to electronic cameras, decreasing the use of instant film by 12% and the use of 35mm film by 26%, which saves more than 50 tons of film annually.⁶¹

Many companies that set out to reduce disposal find that their efforts pay off in other areas as well. For example, in 1999, Bell Atlantic expanded the use of electronic purchasing orders and invoices, reducing nearly 29 tons of paper and saving more than \$60,000 – much more than just the cost of disposal for 29 tons of materials.⁶² In 1998, Alcatel USA reused 10 tons of polystyrene shipping containers, saving \$550,000 in disposal and purchasing costs. By using CD-ROM-based rather than paper-based manuals, the company saved paper and an additional \$1.2 million.⁶³

⁶⁰ Mark Reisch and David Michael Bearden, *Superfund Fact Book*, Congressional Research Service, Environment and Natural Resources Policy Division, Washington, D.C., March 3, 1997.

⁶¹ United States Environmental Protection Agency Office of Solid Waste and Emergency Response, *Sixth-Year WasteWise Progress Report*, EPA report number EPA530-R-00-007, August 2000.

⁶² United States Environmental Protection Agency Office of Solid Waste and Emergency Response, *Sixth-Year WasteWise Progress Report*, EPA report number EPA530-R-00-007, August 2000.

⁶³ United States Environmental Protection Agency Office of Solid Waste and Emergency Response, *Fifth-Year WasteWise Progress Report*, EPA report number EPA530-R-99-035, August 1999.

Government: Levying fees at waste handling facilities will generate revenue to cover all or part of expenses formerly paid by the Government for commercial materials.

	Cost		
	Residents	Private sector	Government
Disposal fees	Not applicable. Fees would only be charged on commercial materials.	Source: Direct costs based on system usage. Amount: Incalculable. Depends on level of fees and amount of source reduction businesses achieve.	Source: Eliminates or reduces the costs for disposal of commercial discards, depending on level of fees. Amount (2011): \$11.4 million savings in landfill costs assuming imposition of fees results in 285 tonnes per day of additional commercial recycling. Also revenue from disposal fees. Assuming 2002 commercial disposal of 1800 tonnes per day, a \$30 per tonne fee would generate \$19.7 million in revenues. At \$110 per tonne, the fees would generate \$72 million in revenue.

Product charges

Consumers: Costs to consumers of imposing charges on difficult-to-recycle limited- or single-use products would depend on the level of fees and on their level of consumption of covered products. Furthermore, consumers could reduce the amount of charges they must pay by switching to durable products. Often durable products are cheaper in the long-term than their disposable equivalent, providing additional savings to those who make the switch.

Industry: As with consumers, the costs to businesses would depend on the level of fees and on their level of consumption of covered products.

Government: Every tonne of material removed from the waste stream saves the Government the cost of its collection and disposal. Assuming a disposal cost of \$110 per tonne and an 154 tonnes per day reduction in the use of disposable products, the Hong Kong Government could save more than \$6 million per year for disposal. Furthermore, reductions in litter should decrease Government costs for street and marine clean-ups.

	Cost		
	Residents	Private sector	Government
Disposal taxes	Source: Charges imposed on covered products. Amount: Incalculable. Depends on level of consumption of covered products and amount of fees.	Source: Charges imposed on covered products. Amount: Incalculable. Depends on level of consumption of covered products and amount of fees.	Source: Lower collection and disposal costs, reduced litter. Amount (2011): \$6.1 million savings in landfill costs assuming \$110 per tonne cost and diversion of 154 tonnes per day.

Restrictions on distribution of disposable products

Consumers: Costs to consumers of restrictions on distribution of disposable products would depend on the level of fees and on their level of consumption of covered products. Furthermore, consumers could reduce the amount of charges they must pay by switching to durable products. Because durable products are often cheaper in the long-term than their disposable equivalent, businesses may be able to pass savings onto their customers.

Industry: Costs to food service establishments of restrictions on the use of disposable products will depend on the extent to which the businesses rely on these products. Businesses that solely or predominantly used disposable products may have to make significant investments in purchasing durable goods and equipment, such as commercial dishwashing units. However, over the long-term, use of durable items may reduce business costs. Restricting the free distribution of some items may also save money by allowing businesses to charge for items customers are currently provided for free. Similarly, requiring lodging establishments to use bulk dispensers for liquid personal care products will require an initial investment for equipment, but result in long-term savings due to bulk purchasing and reduced waste disposal. For example, Unicoi State Park & Lodge in Helen, Georgia (United States), a 100-room lodge, switched from individual bars of soap and bottles of personal care products to dispensers at the sink for hand soap and lotion, and in the shower for shampoo, conditioner and body gel. The facility's General Manager, Scott Hudgins, estimates the lodge has cut bathroom amenities costs and waste stream by 60%.

Government: Every tonne of material removed from the waste stream saves the Government the cost of its collection and disposal. Furthermore, reductions in litter should decrease Government costs for street and marine cleanups.

	Cost		
	Residents	Private sector	Government
Restrictions on disposable products	Source: Fees paid on products currently distributed for free. Amount: Incalculable. Depends on level of consumption of covered products and amount of fees. Could be offset by businesses passing on savings to customers.	Source: Investment costs for purchasing new goods and equipment. Recoup costs of products currently provided for free. Amount: Incalculable. Depends on level of consumption of covered products and cost of alternatives.	Source: Lower collection and disposal costs, reduced litter. Amount: Included in estimated savings from implementation of product charges.

Reusable product business development

Government: The cost to Government for these programs is wholly dependent on the level of support provided. Forms of support could include direct grants for capital or operating expenses, low-interest loans, and/or technical assistance in developing business plans. The Government also will directly benefit through reduced collection and disposal costs.

	Cost		
	Residents	Private sector	Government
Business development (disposable product alternatives)	Not applicable	Not applicable	Source: Lower collection and disposal costs, reduced litter. Amount (2011): \$2.5 million savings in landfill costs assuming \$110 per tonne cost and diversion of 63 tonnes per day.

Separate collection program for bulky and reusable items

Government: Creating a separate collection system for bulky and reusable materials will most likely increase collection costs. However, these costs will be defrayed by reduced disposal costs in proportion to the quantity of material repaired, reused, and/or recycled. Furthermore, removal of many of the types of materials targeted by the program is critical to the success of a wet/dry collection system as many of the materials (bulky items and chemicals, for example) are not suited to processing at MRFs with the dry stream, or at composting facilities with the wet stream.

	Cost		
	Residents	Private sector	Government
Separate collection program for reusable items	Not applicable	Source: Lower waste collection costs since some materials will be collected in the new system. Amount: Assuming 48 tonnes per day and a collection cost of \$600 per ton, businesses would save \$10.5 million per year.	Source: Increased collection costs, decreased disposal costs. Amount (2011): \$28.3 million assuming collection costs will be 125% of current per tonne costs for MSW collection, 292 tonnes per day are collected, and half of the collected materials are not disposed.

Wet/dry collection

Industry: Introduction of a wet/dry system will require businesses and industry to modify their internal waste handling arrangements. Necessary changes could result in the need to purchase new trash bins, negotiate new trash collection and janitorial contracts, and conduct in-house education programs.

Government: Introduction of a wet/dry system will require the Government to modify their waste collection and transfer arrangements. However, these changes could be introduced using the same equipment used for bulk waste collection and disposal. For example, at housing estates that currently produce two truckloads of garbage a day, the collection would still use two trucks, one for wet materials and one for dry materials. As equipment is retired, the Government may want to investigate whether specialized vehicles, such as split compartment trucks, will improve collection efficiency.

	Cost		
	Residents	Private sector	Government
Wet/dry collection	Not applicable	Source: Modifications in waste management systems Amount: Incalculable. Will vary from business to business.	Source: Modifications in collection systems Amount: None. Can be achieved using existing equipment.

Increased recycling in public areas

Government: It is critical for the public waste receptacles to reflect the wet/dry collection scheme to be implemented in Hong Kong. Therefore, existing trash receptacles in public places must be converted to groups of bins suited to the new sorting regime.

	Cost		
	Residents	Private sector	Government
Require recycling be available at all public disposal sites	Not applicable	Not applicable	Source: Purchase of additional bins to implement wet/dry collection at all public trash receptacles Amount: \$15 million for the purchase of additional bins at public trash receptacles.

Source separation of C&D materials

Industry: The costs to industry of mandatory source separation of C&D materials can potentially include increased labor, container, and collection costs. However, reduced disposal fees and revenues from sales of recyclables can balance these costs. As discussed previously, these savings often surpass additional costs.

Government: The Government costs and/or savings are dependent on disposal reductions achieved and the amount of support it chooses to provide the C&D industry. Examples of support the Government could provide include technical assistance and development of a centralized sorting facility for C&D recycling.

	Cost		
	Residents	Private sector	Government
Require source separation of C&D materials	Not applicable	Source: Increased labor, container, and collection costs; reduced disposal fees and revenues from sales of recyclables Amount: Incalculable.	Source: Reduced landfill disposal costs Amount: Potential savings of approximately \$150 million annually assuming disposal reduction of 3,700 tonnes per day.

Incentives

Consumers: The system for rewarding recycling in public housing estates could take many forms. For example, the Government could simply allow cleaning staff in

public housing estates to sort and sell the dry stream of materials on the open market, retaining the revenue generated. Under this scenario, the benefit would accrue to individuals rather than all residents. Another option is for the Government to return a portion of revenues earned from sale of recyclables to individual housing estate governing bodies, perhaps based on volume or tonnage collected. This money could be earmarked for improvements in public areas or a similar activity that benefits everyone in the estate. The amount of incentives earned would depend on diversion levels and the level of incentives offered by the Government.

Industry: The benefits to businesses of incentives will be dependent on the level of incentives and the amount of reduction they achieve.

Government: The cost to the Government of these programs will, of course, be dependent on the types and levels of incentives and the level of participation in them. The costs, however, will be offset by avoided collection costs for domestic recyclables and avoided sorting and disposal costs for both domestic and commercial materials. These programs could be designed to be cost/revenue neutral.

	Cost		
	Residents	Private sector	Government
Redirect revenue from sale of recyclables as incentives	<i>Source:</i> Revenue from the sale of recyclables <i>Amount:</i> Dependent on market prices for materials, amount collected, and distribution of revenues.	Not applicable	<i>Source:</i> Loss of revenues from recyclables offset by avoided collection and sorting costs for recyclables and avoided disposal costs. <i>Amount:</i> Dependent on market prices for materials and the amount collected. However avoided collection and sorting costs for recyclables and avoided disposal costs should be greater than lost revenues.
Tax breaks for recyclables collection	Not applicable	<i>Source:</i> Reduced taxation <i>Amount:</i> Dependent on the level of waste reduction and incentives offered.	<i>Source:</i> Loss of tax revenue offset by avoided sorting costs for recyclables and avoided disposal costs. <i>Amount:</i> Dependent on the level of waste reduction and incentives offered.

Assist individuals, housing estates, and businesses purchase recycling equipment

Government: The amount of Government expenditures to purchase equipment would depend wholly on the level of funding the Government deems appropriate, the type of program implemented, and the level to which eligible parties take advantage of the programs. For example, the Government could decide to purchase

and distribute equipment directly to those who need it or offer grants to applicants to purchase equipment on the private market.

	Cost		
	Residents	Private sector	Government
Provide equipment to housing estates	Not applicable	Not applicable	Source: Equipment or funding Amount: Variable depending on specific implementation details.

Development of MRF facilities

Government: The costs of MRF facilities depend on the facility capacity and the technology used. Highly mechanized facilities typically have high capital costs but relatively low operating and labor costs compared to those that rely primarily on manual sorting. Based on typical U.S. MRF facilities, ILSR estimated typical capital costs of medium-level technology MRFs to be \$195,000 per tonne per day of processing capacity and processing costs to be between \$80 and \$150 per tonne. Revenues from material sales will offset the operating cost.

	Cost		
	Residents	Private sector	Government
Development of MRF facilities at transfer stations	Not applicable	Not applicable	Source: Capital and operation and maintenance costs, revenue from material sales. Amount: Estimated \$1.17 billion capital costs for development of two MRFs with daily capacity of 3,000 tonnes. Operation and maintenance costs may be up to \$150 per tonne, which corresponds to about \$165 million per year for 3,000 tonnes per day capacity. Possible revenues from material sales of more than \$1 billion per year.

Land allocation

Industry: The high value of land in Hong Kong can hinder the development of businesses, especially businesses such as recycling sorting and/or processing which often need relatively large land areas. Furthermore, the high variability in supply, demand, and value of recovered commodities can make investment in recycling businesses risky even when land is not expensive. Allocation of land to recycling businesses at reduced levels can help these businesses become financially viable.

Government: The Government cost of allocating land to recycling businesses depends on the alternative uses of the land. If the Government could rent or sell the

allocated parcels to other businesses at higher rates, the cost will be in direct proportion to the rates charged and the amount others would be willing to pay.

	Cost		
	Residents	Private sector	Government
Land allocation	Not applicable	<i>Source:</i> Reduced rents <i>Amount:</i> Depends on the market value of sites, rents charged, and the number of sites allocated.	<i>Source:</i> Opportunity costs of alternative uses of the land, revenue from rents paid. <i>Amount:</i> Depends on the market value of sites, rents charged, and the number of sites allocated.

Minimum recycled-content requirements for Government purchasing

Government: The cost of implementing minimum recycled-content requirements depends on the price of recycled-content materials and their virgin-content equivalent. In fact, recycled-content materials can sometimes save money. For example, at a former sports stadium in Seattle, Washington, management began using 100% recycled-content plastic lumber to replace treated wood channel boards that were used to hold down the Astroturf in a trench. While the two products had the same installation costs, removal of the plastic channel boards took less time, because they did not swell like treated wood and are easy to remove. The plastic boards helped the stadium save maintenance and wood replacement costs of approximately US\$8,600 per year.⁶⁴ Furthermore, in many countries domestically produced virgin-content products are cheaper than equivalent recycled-content products. However, Hong Kong currently has a small manufacturing base and imports many finished products. Development of domestic capacity for the production of recycled-content goods may result in these products being cheaper than imported goods.

	Cost		
	Residents	Private sector	Government
Minimum content requirement for Government purchasing	Not applicable	Not applicable	<i>Source:</i> Price preferences paid for recycled-content over virgin-content goods. <i>Amount:</i> Incalculable. Domestic recycled-content goods may eventually be cheaper than imported goods.

Minimum content requirements

Consumers, industry, and Government: The financial impact on consumers (whether individuals, businesses, or public agencies) of setting minimum-content requirements for certain products and packaging, such as newsprint or plastic bottles, is impossible to predict. The relative prices of recycled-content and virgin-content products are highly variable. Increased availability of recovered materials

⁶⁴ King County Environmental Purchasing Program, "King County Recycled Product Experience: Recycled Plastic Lumber Application at the Kingdome," case study on County web site at <<http://www.metrokc.gov/procure/green/stadlbr.htm>>.

may drive recovered material prices below those of virgin raw materials. The availability of manufacturing capacity able to use recycled feed stocks can also affect the relative prices of recycled versus virgin goods. Furthermore, in Hong Kong, as with Government recycled-content purchasing requirements, development of domestic industries using recycled feed stock may result in these products being cheaper than imported goods.

	Cost		
	Residents	Private sector	Government
Minimum content requirements	<p><i>Source:</i> Price differences for recycled-content and virgin-content goods. <i>Amount:</i> Depends on consumption of covered materials and price differentials, if any.</p>	<p><i>Source:</i> Price differences for recycled-content and virgin-content goods. <i>Amount:</i> Depends on consumption of covered materials and price differentials, if any.</p>	<p><i>Source:</i> Price differences for recycled-content and virgin-content goods. <i>Amount:</i> Depends on consumption of covered materials and price differentials, if any.</p>

Small-scale composting

Consumers: Worm composting is perhaps best suited for residential use in Hong Kong because it uses food scraps only and no yard waste. Furthermore, a successful worm bin composter will not smell, can be harvested every few months, and can be kept indoors or outdoors. In the U.S., many commercial enterprises manufacture and sell small worm bins, often constructed from recycled plastics. These bins typically retail for US\$35 to \$80. Increased interest in small-scale composting may result in the creation of a similar company in Hong Kong. Another option for composting domestic organic materials is use of an in-vessel composter sized to handle materials from individual buildings or entire housing estates. For composters on this scale, the composting process takes place entirely within an enclosed container in order to control both the composting process and prevent odors. A number of North American and European companies make in-vessel composting equipment. These systems vary in technological complexity and capacity, and hence cost.

Industry: Businesses implementing on-site composting will save on collection and disposal costs for organic materials.

Government: The Government may choose to support small-scale composting through the provision of technical assistance, equipment, or direct funding. Government demonstration projects such as the EPD's composter in its office at Kennedy Town provide valuable information for future development of small-scale composting.

	Cost		
	Residents	Private sector	Government
Promote small-scale composting	<p><i>Source:</i> Purchase of equipment, investment of time and effort</p> <p><i>Amount:</i> Small worm bins suitable for use in individual residences can be constructed at little cost and require little maintenance.</p>	<p><i>Source:</i> Depends on the level of technology chosen. Small worm bins suitable for use at small businesses can be constructed at little cost and require little maintenance. In-vessel systems generally have greater capital and operating costs, but can handle larger volumes of materials. On-site composting costs may be offset by reduced collection and disposal cost.</p> <p><i>Amount:</i> Depends on system chosen and amount of material diverted from disposal.</p>	<p><i>Source:</i> Discretionary expenditures for equipment and technical assistance, reduced collection and disposal costs for material composted.</p> <p><i>Amount:</i> Depends on level of investment Government makes assisting in implementation. Costs may be fully or partially offset by reduced collection and disposal costs.</p>

Centralized composting

Government: In order to implement fully the Greenpeace/ILSR waste reduction plan, the Government will need to develop six 600-tonne-per-day composting sites. These sites would need approximately 13 hectares each for a total land requirement of 78 hectares. The land for these facilities may be available at closed landfill sites in Hong Kong. These closed landfills occupy 300 hectares. ILSR estimates capital costs for the creation of these composting facilities to be \$470 per ton of annual capacity. Typical U.S. operation and maintenance costs of a 600 tonne per day facility are less than HK\$75 per tonne, or approximately \$99 million for 3,600 tonnes per day capacity. Final costs may vary, however, depending on technology, facility size, labor costs, and other local factors.

	Cost		
	Residents	Private sector	Government
Develop centralized composting	Not applicable	Not applicable	<p><i>Source:</i> Capital and operation and maintenance costs, revenue from compost sales.</p> <p><i>Amount:</i> Estimated \$618 million capital costs for development of six sites. Estimated operation costs of less than HK\$75 per tonne or approximately \$99 million for 3,600 tonnes per day capacity.</p>

Provide finished compost to other Government departments

Government: The proposed large-scale composting program will produce much more compost than is currently used by all Hong Kong Government activities. The use of this domestically produced compost will reduce expenditures on compost and fertilizer by numerous Government agencies including the Parks and Highway departments. Excess compost may be sold on the retail market in both Hong Kong and the Mainland, and sold or donated to Mainland governments. Even if the revenue from compost sales does not cover the entire processing cost to produce the material, the program may still be cost effective because it reduces disposal costs.

	Cost		
	Residents	Private sector	Government
Provide finished compost to other Government departments	Not applicable	Not applicable	<i>Source:</i> Avoided purchase cost for compost and fertilizers. <i>Amount:</i> Unclear.

Post-closure landfill monitoring

Government: The costs for post-closure monitoring of existing and closed landfills after the 30-year period required of contractors will necessarily be borne by the Government. Current science recognizes that landfill emissions are likely to continue well beyond 30 years. Monitoring must continue at least as long as emissions occur. In the absence of knowledge of the length of time that must elapse before emissions cease, the Government, to protect human health and the environment, must require all future landfill contractors to monitor closed landfills in perpetuity. These requirements will necessarily result in higher landfill costs, but the cost will reflect the “true” costs of landfill disposal more adequately than currently. The Greenpeace/ILSR proposal in this report should reduce Hong Kong's disposal requirements significantly, thereby extending currently landfill life, and delaying the need for a new, more expensive landfill contract.

	Cost		
	Residents	Private sector	Government
Require post-closure landfill monitoring in perpetuity	Not applicable	Not applicable	<i>Source:</i> More stringent monitoring requirements for future landfill development. <i>Amount:</i> Unclear

Comprehensive education programs

Implementation of the ambitious waste reduction proposal in this report will require the investment of significant resources in a comprehensive, on-going education program. The level of expenditure on this program cannot be too much, but it can easily be too little. In U.S. communities employing model education programs, typical costs average HK\$4 - \$20 per household per year, depending on program intensity and design. Using this figure as a benchmark, Hong Kong should expect to spend \$45 to \$50 million dollars annually, at a minimum. However, adapting existing educational materials and programs developed by other jurisdictions rather than creating new ones, partnering with other organizations, and using volunteers can minimize costs.

Costs summary

In order to develop cost comparisons of the Greenpeace/ILSR proposal, ILSR developed a model of costs based on EPD data and estimated costs for proposed programs. This model compared costs for four scenarios:

- Landfill disposal alone for all waste generated;
- Development of 6,000 tonnes per day incineration capacity with landfilling of the remaining waste stream and incineration residuals;
- Development of 6,000 tonnes per day incineration capacity, waste reduction of 20% by the year 2010, and landfilling of the remaining waste stream and incineration residuals; and
- Full implementation of the Greenpeace/ILSR program.

Operating costs

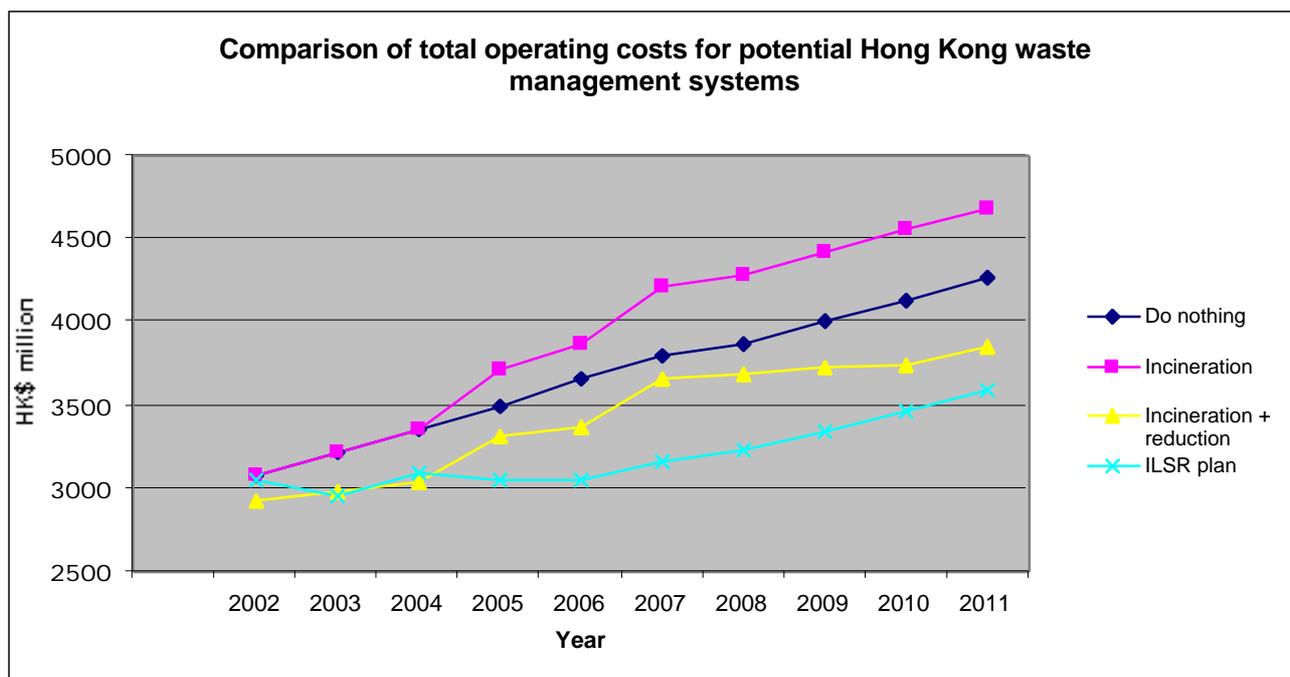
To develop these cost scenarios, ILSR had to make many assumptions. These include:

- Domestic waste generation will be 1.11 kg per person per day for the years 1999 through 2011;
- Commercial and industrial waste generation will be 0.53 tonnes per employee per day for the years 1999 through 2011;
- Population and employment will grow approximately 1% in the years 1999 through 2011;
- C&D waste requiring disposal or recycling will remain steady at the 1999 level of 7,475 tonnes per day for the years 1999 through 2011;
- Landfill disposal costs approximately \$110 per tonne;⁶⁵
- Waste collection costs were approximately \$890 per tonne in 1999, and will grow to \$1,280 per tonne in 2011;⁶⁶
- In scenarios 2 and 3, 3,000 tonnes per day of incineration capacity will come on-line in the years 2005 and 2007;
- Operation costs for incineration will be \$270 per tonne;
- The incinerators will only reduce this waste by a factor of 72% due to the need to by-pass the incinerators during maintenance and the amount of residual ash;⁶⁷
- Under scenario 3, new waste reduction will be achieved at no cost to the Government and will reach 6% in 2002, 8% in 2003, 10% in 2004, 12% in 2005, 14%

⁶⁵ This figure is from the *Waste Reduction Framework Plan*, Chapter 1. One difficulty in trying to assess costs is lack of information about Hong Kong's current landfill contracts. The contracts are not public. The Waste Reduction Framework Plan estimated landfill disposal costs the Government \$110 per tonne. However, this is an average figure. The actual terms of the contracts include guaranteed payments to the contractors which includes disposal of a set amount of waste, and a per ton tip fee for disposal above the base amount. If disposal is reduced below the base amount, the Government could find itself in a position of being unable to lower disposal costs. This analysis presents potential cost savings from avoided disposal based on \$110 per tonne of waste diverted from disposal. Unfortunately, the Government may not be able to reduce its actual disposal costs by \$110 per tonne because of its contractual structure.

⁶⁶ ILSR calculated these costs based on the total estimated cost of waste management as reported in the *Waste Reduction Framework Plan*. ILSR assumed disposal costs to be \$110 per tonne and collection to make up the remainder of the cost.

⁶⁷ ILSR believes 72% is conservative and that actual reduction may be much lower. Dr. Paul Connett, a U.S. waste management specialist reports, "The need for landfills is not reduced by 90% as incinerator advocates often claim; the actual reduction is about 40%." From *Waste Management as if the Future Mattered*, Work on Waste USA, Canton, NY, 1990. According to a consultant report for King County, Washington, USA, an incinerator project could need to landfill up to 50% of its design capacity, by volume.



in 2006; 15% in 2007, 16% in 2008, 18% in 2009, and 20% in 2010 and the years thereafter;⁶⁸

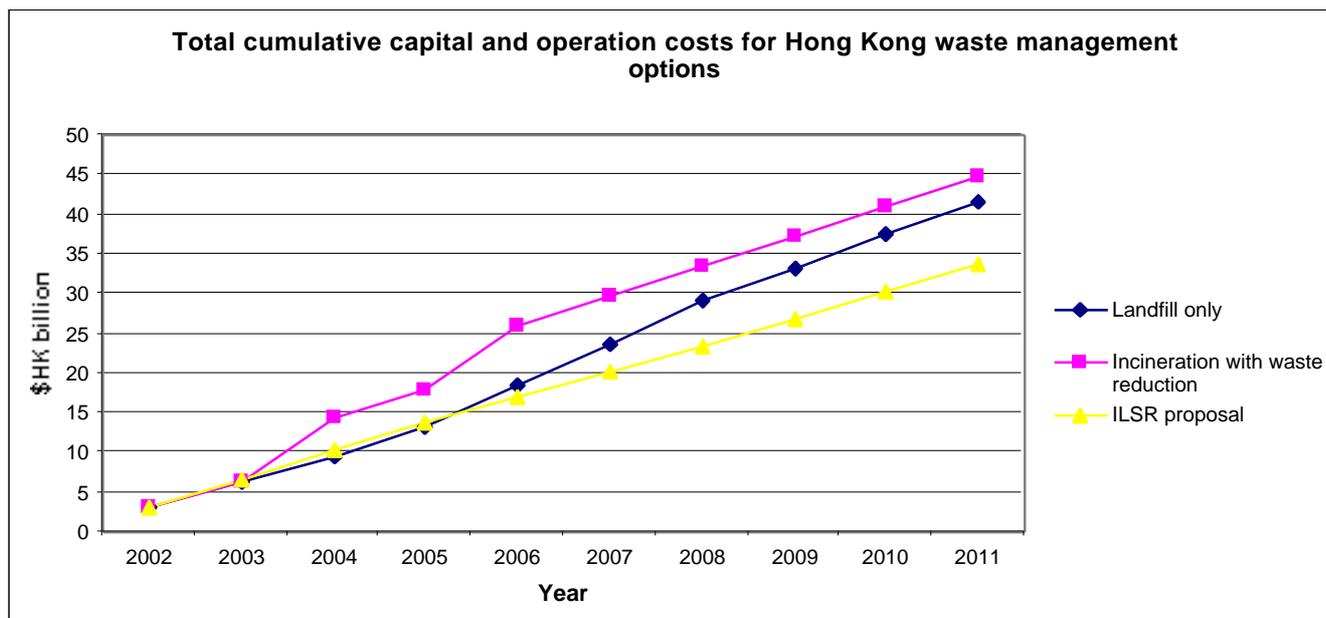
- Operating costs at composting facilities will be \$75 per tonne; and
- Operating costs at dry materials sorting facilities will be \$150 per tonne, offset by revenue from the sale of recyclables.⁶⁹

The figures on this and the next page show the estimated operating costs for disposal and the total programs under the four waste management scenarios as described above. Note that the disposal costs alone in the landfill-only scenario are the least expensive. However, under this scenario, collection costs, which far outweigh disposal costs, are not considered. Furthermore, under this scenario, the Government will run out of disposal capacity by 2015 or sooner. Under the ILSR scenario, total disposal will be reduced by more than 27 million tons from 2002 through 2011. This reduction could extend current landfill life by 20 years.

The comparison of total operating costs for the waste management scenarios shows that the Greenpeace/ILSR proposal has the lowest costs in the long-term. This cost does not drop below the cost for incineration with waste reduction until after 2005. It is interesting to note that 2005 is the first year incineration capacity is assumed to be on-line. Prior to that year, the incineration with waste reduction scenario is assumed to achieve waste reduction at no operating cost to the Government, however the Government would save from avoiding collection and disposal costs for any waste eliminated. Furthermore, this chart shows only operating costs. When capital costs are included, the Greenpeace/ILSR proposal is much less expensive than any proposal that includes incineration.

⁶⁸ These rates are based on the targets set in the Waste Reduction Framework Plan, however the dates for meeting the targets have been delayed.

⁶⁹ ILSR very conservatively estimated revenues at 25% of the average sale price of exported recyclables as reported in EPD's Monitoring of Solid Waste in Hong Kong: *Waste Statistics for 2000*.



Capital costs

The capital costs of the three strategic landfills currently in use in Hong Kong were more than \$4.8 billion. Continued reliance on landfilling only will require a similar or greater capital expenditure possibly by the end of the decade.

According to the Waste Reduction Framework Plan, the Government estimated capital costs for development of incinerator facilities, material recovery facilities, and expansion of the existing composting facility and construction of another to be greater than \$8.4 billion by 2007. Current estimates place this cost even higher. The Government has reserved \$9,780 million of its Capital Works Reserve Fund for the development of two waste-to-energy incinerators with an overall capacity of 6,000 tonnes per day. Assuming the costs of the materials recovery facilities and composting facilities will be the same as estimated in the Waste Reduction Framework Plan, the total capital costs of implementing its incineration proposal will, therefore, be greater than \$10 billion.

In contrast, the capital costs of implementing the Greenpeace/ILSR proposal will be much lower. The less than \$2 billion estimated capital costs for implementing this program include:

- \$5.1 million each year from 2002 to 2004 for purchase of additional bins in order to implement the new collection scheme;⁷⁰
- \$1.17 billion capital costs for development of MRFs with a daily capacity of 3,000 tonnes; and
- \$618 million capital costs for development of six composting sites with a daily capacity of 3,600 tonnes.

Government capital expenditures for implementation of the other programs proposed by Greenpeace and ILSR are largely discretionary. For example, the Government's level of support for small- and medium-scale composting may include all, or a portion of, the required capital investment for purchase of composting

⁷⁰ This figure is based on the purchase and placement of a second bin at each of the 17,000 public litter containers currently on the streets at a cost of \$900 per bin. The cost per bin is based on an article in "Next Message" that reported the cost for 8000 recycling bins was \$7.2 million.

equipment. However, businesses may invest their own money in order to reduce their disposal costs.

The chart, "Total cumulative capital and operation costs for Hong Kong waste management options," illustrates the potential savings of three waste management scenarios. Some assumptions used to generate this chart include:

- The landfill-only option will require development of new landfill capacity starting in the year 2006;
- The capital cost of new landfills will be \$4.8 billion spread out over three years;
- Capital costs for the Waste Reduction Framework Plan include \$200 million per year from 2002 through 2004 for development of material recovery facilities, \$11.1 million per year from 2002 through 2005 for development of composting facilities, and \$4.9 billion in 2004 and 2006 for development of two 3,000 tonne-per-day capacity incinerators; and
- The capital costs of the Greenpeace/ILSR proposal include bin costs as presented above and \$598 million a year from 2003 through 2005 for the development of composting and sorting capacity for materials collected in the wet/dry system.

At the bottom line, ILSR estimates cumulative expenditures for implementation of its proposal from the years 2002 through 2011, would be \$8 billion cheaper than a landfill-only waste management scenario and \$11 billion cheaper than implementation of the Waste Reduction Framework Plan. Furthermore, under this proposal, disposal needs for municipal solid waste and C&D materials would be reduced to approximately 7,000 tonnes per year, potentially extending the Region's remaining landfill capacity up to twenty years.

IMPACTS OF GREENPEACE/ILSR PROPOSAL

Environmental impacts

Air

Increased recycling and reuse will reduce the production of many air pollutants as compared to incineration or landfilling.

Removal of organic materials from Hong Kong's landfills for recycling and composting will reduce landfill gas production and, consequently, reduce air emissions resulting from the burning of this gas.

Most composting of organic material occurs in an aerobic environment, and, therefore, does not produce greenhouse gases. For example, landfilling 1,000 tonnes of food scraps, produces an average of 165 metric tonnes of carbon equivalent (MTCE) in greenhouse gases.⁷¹ Composting of the same material does not produce greenhouse gases.

Recycling also reduces net emissions of greenhouse gases as compared to landfilling or incineration. For example, when using the extraction of raw materials as a reference point, recycling of 1,000 tonnes of newsprint reduces greenhouse gas emissions by 418 MTCE, whereas incineration of the same newsprint increases greenhouse gases by 286 MTCE and landfilling produces 275 MTCE.⁷²

Fewer emissions originate at factories using recycled feedstock than at factories using virgin materials. Recycling paper reduces air pollution by about 75%. Substituting steel scrap for virgin ore reduces air emissions by 85% and water pollution by 76%.⁷³

Reuse and recycling avoids the creation of toxic emissions from incinerators. For example, dioxins, which are created when some chlorine compounds burn, are produced by incineration plants, but not during reuse and recycling processes. Total 1995 U.S. mercury emissions from all manmade sources were 144 tonnes. Of these emissions, fossil fuel combustion produced 76 tonnes, waste incineration produced 49 tonnes, and all other sources produced less than 20 tonnes. Clearly, the manufacturing of products, whether using virgin or recycled feed stocks, produces much less mercury emissions than the combustion of them.⁷⁴

Water

Increased recycling and reuse will also reduce the production of water pollution as compared to incineration or landfilling.

Thirty-five percent less water pollution is produced from the manufacturing of recycled paper compared to paper from virgin wood pulp. Recycling aluminum

⁷¹ United States Environmental Protection Agency Office of Solid Waste and Emergency Response, *Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste*, EPA report number EPA530-R-98-013, September 1998, p. ES-12.

⁷² United States Environmental Protection Agency Office of Solid Waste and Emergency Response, *Greenhouse Gas Emissions From Management of Selected Materials in Municipal Solid Waste*, EPA report number EPA530-R-98-013, September 1998, p. ES-13.

⁷³ Pennsylvania Department of Environmental Protection, "Recycling Saves Our Environment," available on the Department's web site at

<<http://www.dep.state.pa.us/dep/deputate/airwaste/wm/recycle/FACTS/benefits4.htm>>.

⁷⁴ National Electrical Manufacturers Association, *Environmental Impact Analysis: Spent Mercury-Containing Lamps, Fourth Edition*, January 2000, p. 3.

results in 97% less water pollution compared to producing new aluminum products from natural stocks.

Reducing landfill disposal reduces the potential for environmental contamination from landfill leachate. Furthermore, avoiding incineration avoids the creation of toxic ash that, when disposed in a landfill will eventually pollute groundwater.

When organic materials are buried in landfills, they produce weak acids during anaerobic decay. As these acids react with other garbage, the leachate can become toxic. Removal of organic materials from landfills, therefore, can reduce the toxicity of leachate.

Resources

Increased recycling and reuse will replace the need to extract raw materials for the production of products to replace those incinerated or landfilled.

Based on the proposal, more than 105,000 tonnes of glass, 91,000 tonnes of metals, 559,000 tonnes of paper, 365,000 tonnes of plastics, and thousands of tonnes of textiles and bulky products will become raw materials for the manufacturing of new products. A further one million tons of organic materials will be converted into compost.

If Hong Kong develops domestic industries that use their recovered materials, they will be able to reduce imports of finished products. The value of the plastics, metals, and paper alone on international markets is approximately HK\$1.25 billion per year.⁷⁵

On a global scale, the use of these recovered materials for manufacturing new products (as opposed to producing materials from virgin raw materials) will eliminate the need for the harvesting of 16 million trees, mining more than 100,000 tons of ores, and producing more than 3 million barrels of oil each year.

Recycling materials from recycled feed stocks also saves energy. It takes 60% less energy to manufacture paper from recycled stock than from virgin materials. It takes four times as much energy to make steel from virgin ore.

Aluminum can recycling saves 95% of the energy needed to make aluminum from bauxite ore. The electricity generated by waste-to-energy plants does not nearly equal the energy that could be saved by recycling.

Table 17: Energy savings of recycling

Material	Ratio of energy conserved by substituting secondary for virgin raw materials in manufacturing as compared with the amounts of energy yielded by a waste-to-energy facility (based on 15% efficiency).
Newspaper	2.6 times
Office paper	4.3 times
Glass containers	30 times
Tin cans	30 times
Aluminum cans	350 times
Plastic	3 - 5 times
Textiles	5 - 8 times

Source: Friends of the Earth, "Briefing: Greenhouse Gases and Waste Management Options," January 2000, p. 2.

⁷⁵ ILSR calculated this value based on \$2,234/tonne for plastics, \$1,055/tonne for ferrous metals, and \$601/tonne for paper. These figures represent the average value per unit weight of exported recyclable materials in 1999 as reported in "Monitoring of Solid Waste in Hong Kong 1999," by the Hong Kong Environmental Protection Department and assumes all metal disposed consisted of ferrous scrap.

Social impacts

Jobs

Recycling and composting creates and sustains many more jobs than handling the same amount of materials at traditional disposal facilities. For example, landfilling of 100,000 tonnes per year of materials at a typical landfill in the U.S. sustains only 2.4 full-time jobs on average. Incineration of the same amount would sustain 13.9 full-time jobs.

In contrast, processing 100,000 tonnes of mixed materials at a typical U.S. MRF sustains 119 jobs. Additional jobs are sustained by the subsequent manufacturing of new products using these materials as feed stock, and for the marketing, sales, and distribution of the new products.

ILSR estimated the jobs that would be created and sustained in recycling processing, manufacturing, and composting in Hong Kong if this proposal was implemented to be over 7,400. Additional jobs would likely be created in the retail sector or bottle redemption centers to support a deposit/refund system and in new service industries supporting reuse.

Employment gains as a result of bottle bills can be significant. In the U.S. State of Michigan (1980 population 9,262,078), a 1980 U.S. General Accounting Office (GAO) study determined that a total of 4,888 new jobs were created in Michigan as a direct result of the bottle bill. The gains in employment were offset by the loss of approximately 250 jobs in the container manufacturing, litter collection, and waste disposal sectors of the economy. However the net gain in the State was over 4,600 jobs.⁷⁶ Similarly, Iowa (2000 population, 2,926,324) Department of Natural Resources reported a gain of approximately 1,200 jobs in retailing and distribution as a result of the State's bottle bill.⁷⁷

Environmental justice

Implementation of the Greenpeace/ILSR proposal will increase the fairness of Hong Kong's waste management system in numerous ways.

For example, manufacturers and importers will become responsible for the wastes produced by their products and packaging. Under the current system, manufacturers can make product and packaging design decisions without bearing the costs these decisions impose on waste management systems. When these costs are shifted back to manufacturers, companies have a powerful incentive to design products with reuse and recycling in mind.

Table 18: Estimated jobs created in reuse, recycling, and composting industries in Hong Kong

	Jobs per 100,000 TPY	TPY	Jobs
Multi-material MRFs	108.5	1,090,000	1,300
Paper manufacturers	192.0	745,000	1,400
Plastics manufacturers	1,023.1	345,000	3,500
Metal manufacturers	260.7	57,000	150
Glass manufacturers	289.7	93,600	270
Reuse and re-manufacturing industries	560.8	72,000	400
Composting	44.1	975,000	430
Total			7,450

TPY = tonnes per year
Source: ILSR, 2001.

⁷⁶ Bottle Bill Resource Guide, " Bottle Bills at a Glance: Michigan." Available at <<http://www.bottlebill.org/USA/states- michigan.htm>>. Site visited November 11, 2001.

⁷⁷ Bottle Bill Resource Guide, " Bottle Bills at a Glance: Iowa." Available at <<http://www.bottlebill.org/USA/states- iowa.htm>>. Site visited November 11, 2001.

Health impacts

Implementation of the Greenpeace/ILSR proposal will reduce health impacts as a result of reducing air and water pollution from landfills, incinerators, and manufacturing from virgin materials. Furthermore, by formalizing the recycling sector, if current scavengers can be transitioned into jobs in recycling sorting and processing facilities, their risks of occupation injury and/or illness should be reduced.

Appendix A
Flow of materials in Greenpeace/ILSR proposed waste management
system, 2002-2011