For information
23 May 2005

Legislative Council Panel on Environmental Affairs

Technical Aspects of the Management of Municipal Solid Waste

Purpose

This paper provides Members with a summary of the efforts made in key aspects of municipal solid waste (MSW) management and a detailed analysis of the technical methods available for managing MSW.

MSW Management

2. A comprehensive waste management strategy comprises three key elements:

(a) waste avoidance and minimisation;
(b) recovery, recycling and reuse; and
(c) bulk reduction and disposal of unrecyclable waste.

3. The first and foremost element to effectively deal with MSW is to avoid the production of waste and to minimize it where it is not possible to avoid it altogether. Environmental education and public participation play an important role in waste avoidance and minimization. To this end, the Environmental Campaign Committee (ECC) and the Environmental Protection Department (EPD) have been promoting waste prevention and recovery through publicity and public education programmes. For example, under the Hong Kong Eco-Business Award organized by ECC, property management companies are commended for implementing effective waste management plans to reduce, reuse and recycle waste materials for the housing estates under their management.

4. Since 1999, EPD has administered a "Wastewi$e" Scheme to encourage businesses to adopt waste reduction measures. So far, over 770 companies and institutions have enrolled in the Scheme. EPD, in collaboration with the Hong

Kong Construction Association and the Real Estate Developers Association, has produced a set of publicity materials for promoting waste reduction in the construction industry. We have also developed education materials on waste separation and prevention for use by teachers in primary and secondary schools. Workshops have been organized for teachers to enhance their knowledge and teaching skills in waste issues. ECC organizes campaigns at public and private housing estates and schools to promote waste separation at source. In May 2002, we injected $100 million into the Environment and Conservation Fund (ECF) which provides funding for waste recovery projects undertaken by green groups and community organizations. Since 2002, a total of $19.6 million has been granted for such purpose.

5. In January 2005, the EPD rolled out a territory-wide programme to make it more convenient for households to separate domestic waste at source by encouraging and assisting property management companies to provide waste separation facilities on each floor of the buildings. The programme also aims to expand the types of recyclables to be collected such as plastic bags, metal containers, old clothing and used electrical appliances. So far, over 140 estates have signed up to join the programme. We aim to achieve 180 housing estates in 2005 and to cover 1 360 estates or 80% of the total population by 2012.

6. With better separation at source, the cost-effectiveness of the collection of recyclables will be highly improved, thus enabling more wastes to be reused and recycled. The same principle can be applied to all kinds of recyclable wastes such as expanded polystyrene, electronic goods, plastics, food wastes, beverage containers etc. The various collection activities will also enhance the educational aspects of the campaign, and households, having to separate waste at home, would be more conscious of the volume of waste they produced.

7. A summary of the extensive recovery and recycling programmes undertaken by the EPD in the past three years on the "3R" (reduction, reuse and recycle) campaign is at Annex A. Publicity and community education programmes will continue to highlight the importance of waste avoidance and minimization.

8. These educational efforts need to be complemented by economic incentives. We have been examining various economic tools that would help

share the responsibility of waste minimisation, recovery and recycling.

Financial Instruments

9. Product Responsibility Scheme (PRS) is a shared responsibility tool to enhance recovery, recycling and reuse of waste. Under PRS, a host of stakeholders (the manufacturers, importers, distributors, retailers and consumers) are responsible for the waste collection, treatment and disposal of the end-of-life products. The responsible parties have to assume financial responsibility to fund the collection and recycling of the used products.

10. EPD has completed a study on the introduction of PRS to manage vehicle tyres. We are assessing the costs and benefits of different options and their impacts on stakeholders and will consult the public on the feasible options in the second half of this year.

11. The study of the PRS on rechargeable batteries has recommended that a voluntary approach should be explored before considering mandatory measures. EPD launched a voluntary recovery programme for all types of rechargeable batteries in April 2005. 33 manufacturers and importers contributed to the scheme, and the used batteries collected at over 300 collection points are delivered to Korea for processing. The target is to achieve 10% recovery in two years, rising to 45% by 2011.

12. A study on the implementation of PRS on electrical and electronic appliances has commenced in March 2005, and a similar study on beverage containers will commence in late 2005. Recovery programmes for used electrical and electronic appliances and computers are organized by two charitable organizations in tandem to gather experience and to facilitate recovery and recycling. A regional collection centre for electrical and electronic appliances will be set up at the Kowloon Bay Transfer Station in the fourth quarter of 2005.

13. About 1 000 tonnes of plastic bags are disposed of in the landfills each day, and the wasteful use of plastic bags has generated much public concern. EPD and Environmental Campaign Committee (ECC) will continue to spread the message of "Use less plastic bags" through community education, and to encourage the source separation of plastic bags for recycling through the territory-wide separation of domestic waste at source programme. EPD is also

considering additional measures to reduce plastic bags by reference to the successful schemes adopted by overseas countries. We will promulgate an action plan and consult the public on the options shortly.

14. While the overall rate of MSW recovery and recycling is 40 %, the recovery rate for domestic waste is only 14 %. We target to achieve a recovery rate of 20 % for domestic waste by 2007 and an overall MSW recovery rate of 50% by 2014. Fiscal measures are crucial to the achievement of these targets. Since an MSW charging scheme will be more complicated and will directly affect the whole community, the operational arrangements and charging method of such a scheme will require careful study. Drawing on the experience of the construction waste charging scheme, we will study the feasibility of an MSW charging scheme. We will consult the public before introducing any scheme on MSW charging.

Promoting the Environmental Industry

15. We are developing a policy on promoting the environmental industry in Hong Kong. This will provide greater incentive to collect recyclable wastes locally.

16. The introduction of separation of waste at source would greatly increase the amount of recyclables that can be collected. We also plan to set up regional recycling centres for the collection and temporary storage of recyclable waste so as to enhance the collection network. The first regional centre would be set up at Kowloon Bay Transfer Station.

17. Apart from improving the collection network through separation of waste at source, availability of land at an affordable cost is very important to the environmental industry of Hong Kong. Under the land allocation policy set out in the Waste Reduction Framework Plan published in 1998, the allocation of suitable land through short-term tenancy (STT) was highlighted as one of the management tools to support the local waste recyclers.

18. As at May 2005, 29 STT sites with a total area of around 5.6 hectares have been leased for waste recovery and recycling operations since 1998. There were six new STT sites at the planning (pre-tender) stage which will provide some 2.6 hectares of additional land in the near future.

19. We have also earmarked 20 hectares of land for the development of an EcoPark in Tuen Mun Area 38. The EcoPark will be fully equipped with proper vehicular access, utilities, waste and water treatment, and other common facilities. The availability of 460 m of waterfront for berths can further reduce the operating cost of the recyclers. The provision of these facilities, together with long land tenure made available at reasonable prices, will greatly facilitate the development of the local environmental industry and encourage recycling operators to invest in the most up-to-date and efficient recycling technologies. The target is to commission first phase of the EcoPark in late 2006.

20. The development of local environmental industry cannot succeed without research and development. The Government has been supporting the research and development of the environmental industry. Apart from the $ 19.6 million granted for community recovery projects, the ECF has also granted $ 32 million to 96 research and development projects. The Innovation and Technology Fund (ITF) also contributes to the development of the environmental industry. Up to March 2005, a total of $ 63.1 million has been granted to 28 projects to promote the environmental industry.

Bulk Reduction of Unrecyclable Wastes

21. While waste reduction and recovery have been and will continue to be our main focus in the overall waste management strategy, there will still be large volumes of waste which cannot be recycled and need to be properly disposed of. Adopting landfill as the only waste disposal method is clearly not sustainable, and alternative waste treatment methods have to be adopted to reduce the volume of waste before final disposal.

22. In April 2002, the Government invited local and overseas companies to propose waste treatment technologies for the development of Integrated Waste Management Facilities (IWMF). 59 expressions of interest (EoI) were received from both overseas and local waste treatment technology suppliers and facility operators. An Advisory Group (AG), chaired by the Permanent Secretary (Environment) and made up of non-officials, including academics and professionals, has been set up to assist and advise the Government in selecting the most appropriate technologies based on environmental, technological, social, economical as well as consumer considerations. The AG members also visited waste management facilities in Japan and Korea in November 2004 to experience the various new technologies.

Strategy Options for waste treatment

23. Six major technology types that would have potential applications in Hong Kong were identified from the 59 submissions. They include composting, anaerobic digestion, mechanical-biological treatment (MBT), incineration, gasification, and co-combustion. Based on these technologies, the AG has further short-listed eight strategy options that appear to be suitable for Hong Kong. Some options comprise more than one technology, and they include -

Option 1 – Incineration with energy recovery

Incineration is a proven and reliable technology, and waste is combusted (typically over 850°C) to reduce its volume and hazardous properties, and to generate heat and/or electricity. The majority of MSW incinerators adopt the "mass burn" design which uses a large furnace with an inclined moving or roller grate system. The moving grate keeps the waste moving through the furnace during the combustion process.

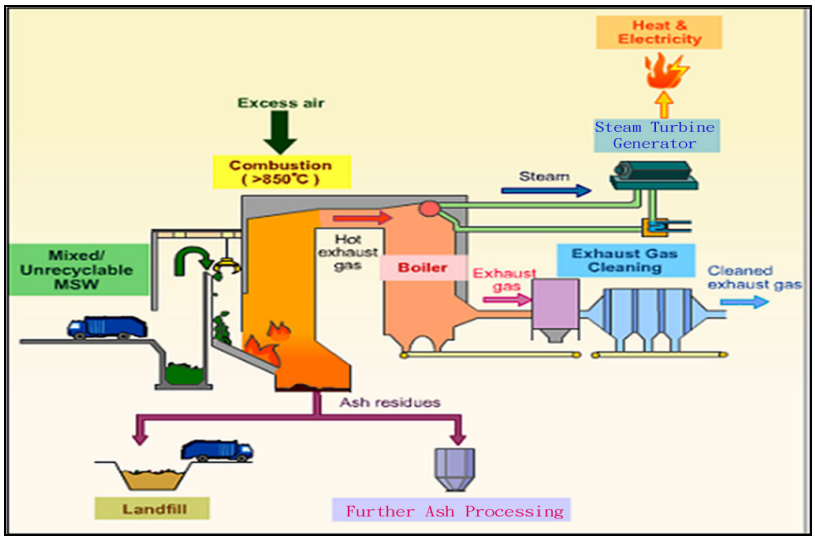


Fig.1 Process flow diagram of Mass-burn Incinerator with energy recovery

Modern incinerators adopt advanced process control measures to optimise the combustion at a temperature over 850°C with long residence time and high turbulence, so as to ensure complete destruction of organic pollutants. Coupled with advanced gas cleaning and pollution abatement equipment such as fabric filters, scrubbers and activated carbon powder injection system, modern incinerators can meet the most stringent emission standards adopted internationally.

Option 2 - Gasification

Waste is heated to a high temperature (typically over 1000˚C) which volatilises the organic fraction of the waste to produce a combustible gas called syngas. The syngas is in turn combusted to generate heat energy or used as a fuel after cleansing to generate electricity. Unlike incineration, gasification occurs in an oxygen-deficient atmosphere, and this reduces the opportunity for the formation of combustion by-products such as dioxins and furans. Gasification is a relatively new technology and there are concerns about its cost.

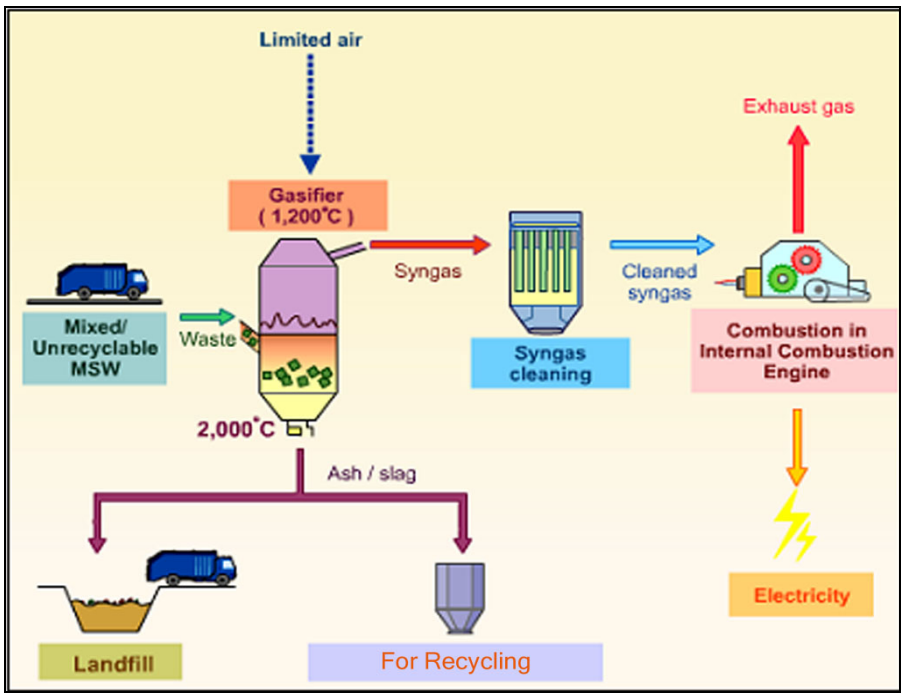


Fig.2 Process flow diagram of Gasification to produce syngas

Option 3 - Close-coupled gasification-combustion

Waste is heated to a relatively low temperature of 500 – 600˚C to produce syngas. The gas together with the ashes will then enter a furnace where the combustion of syngas raises the temperature to over 1300˚C and the ashes are melted to produce a residue which may be recycled as construction material.

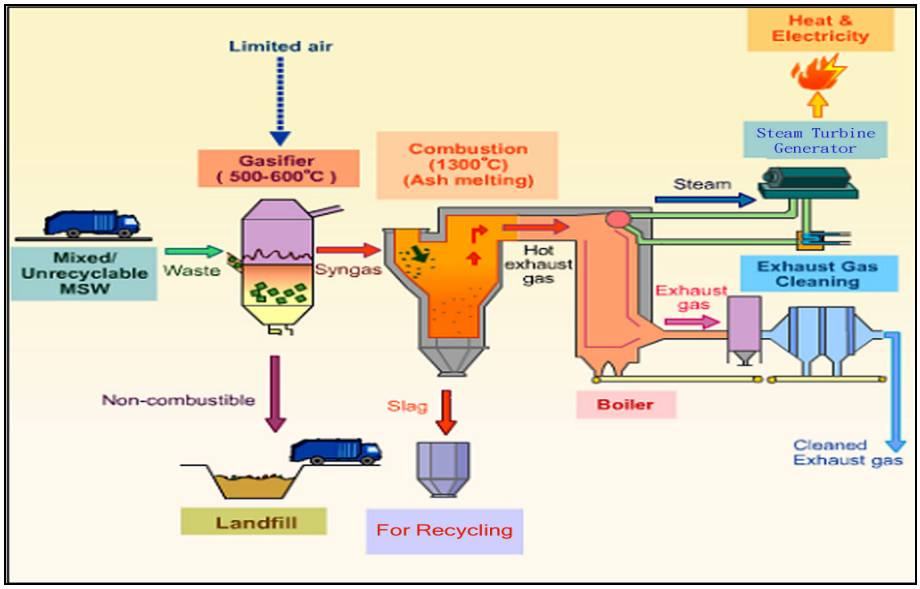


Fig.3 Process flow diagram of Close-coupled Gasification-combustion

Option 4 - Material Recovery and combustion of refuse derived fuel for cement production

Recyclable materials such as glass and metals are recovered from the waste using mechanical and manual sorting, and the non-recyclable materials are processed into refuse derived fuel (RDF[1]). The RDF is used as a fuel for co-combustion with coal for cement production.

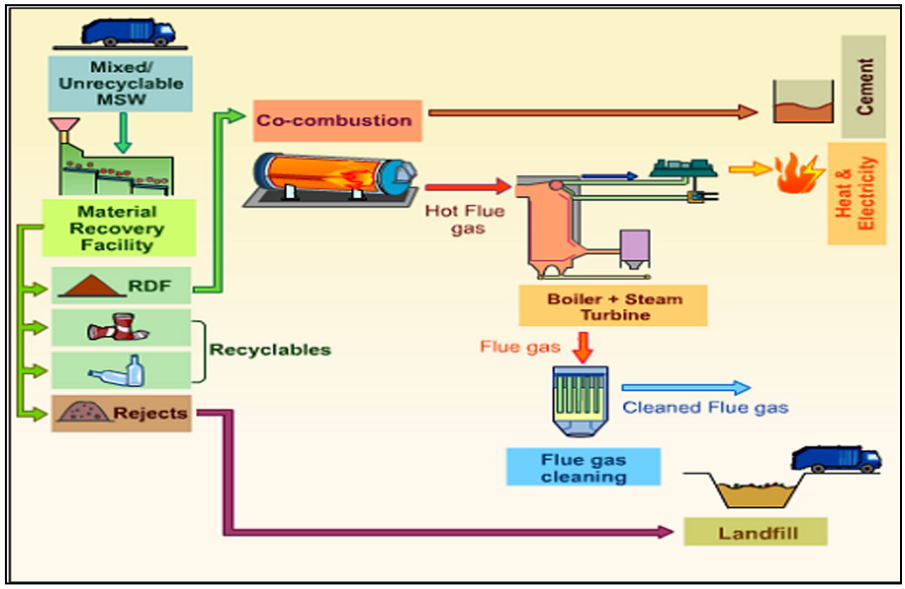


Fig.4 Process flow diagram of Material Recovery & combustion of RDF for cement production

[1] Refuse derived fuel consists of the combustible materials in MSW, for example paper and plastic, which are separated from the non-combustible fraction of mixed MSW. They are then shredded and pelletized to facilitate handling, transportation and storage.

Option 5 – Mechanical-Biological Treatment

Mixed waste is first treated through a series of mechanical operations separating them into recyclable materials such as metals and glass, and a biodegradable fraction which is treated and stabilized by a biological process such as composting or anaerobic digestion before application on land. However, the MBT process is only a separation process designed to recover recyclable materials and to treat the biodegradable fraction from mixed MSW. In term of waste reduction, it can only reduce the waste volume by about 50% but requires 2-3 times more land area than other technologies. Some MBT processes further convert the residues to RDF.

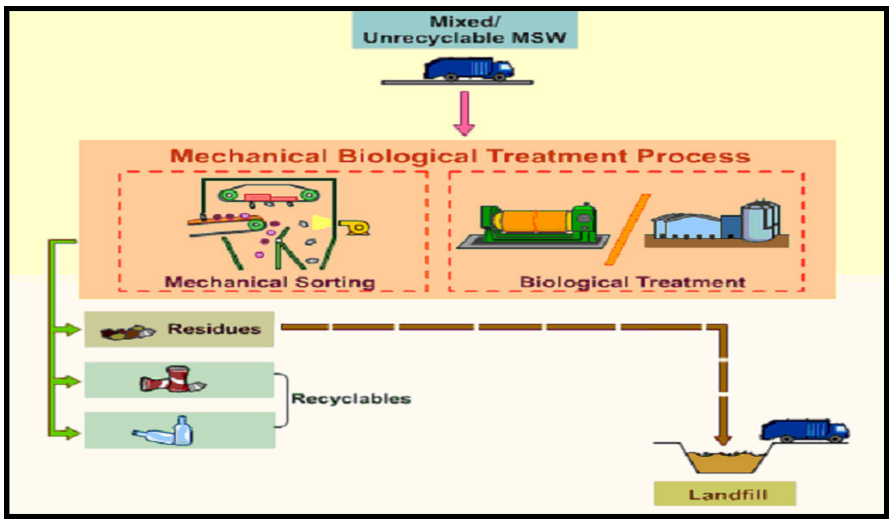


Fig.5 Process flow diagram of MBT

Option 6 – Composting and Incineration

Composting is a biological process to decompose organic matter to a residue that can be used as soil conditioner in the presence of oxygen through bacterial activity. The process will generate odour and gaseous emissions, and stringent control on the composting conditions and the emissions are exercised through "in-vessel" technology by total enclosure of the processing inside a drum. The volume of biodegradable waste which could be treated by composting depends on the available outlets for the compost, noting that the local market is limited and the Mainland has banned the import of compost produced from MSW due to public health concerns. Biodegradable waste such as food waste has to be separated at source prior to composting. The remaining mixed waste is treated by incineration.

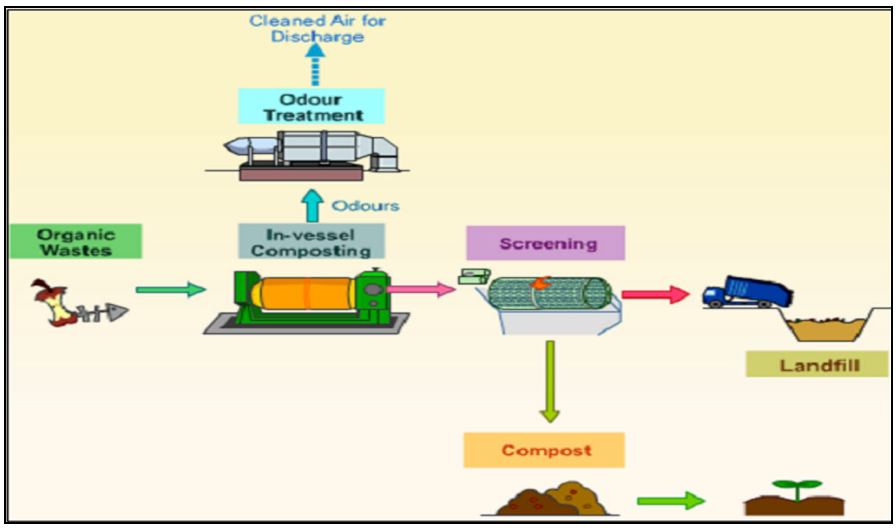


Fig.6 Process flow diagram of In-vessel Composting

Option 7 - Anaerobic Digestion and Incineration

Anaerobic digestion is a biological degradation process of organic materials by microbial activity in the absence of oxygen which produces biogas that can be used to generate heat or electricity, and organic residues that can be processed for use as soil conditioner. Compared with composting, anaerobic digestion requires less time for treatment but a higher level of technology and tighter process control on temperature and pH value. Biodegradable waste such as food waste has to be separated at source before anaerobic digestion. The remaining mixed waste is treated by incineration.

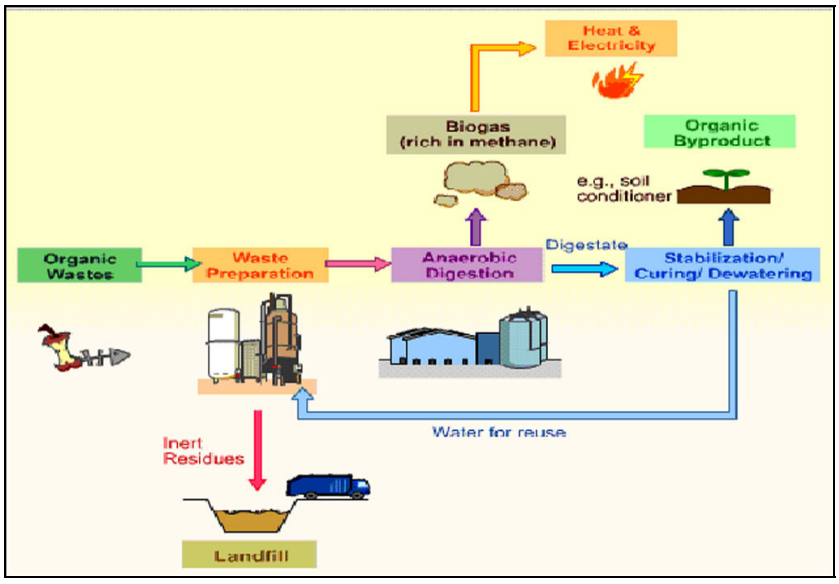


Fig.7 Process flow diagram of Anaerobic Digestion

Option 8 - MBT and Gasification

Mixed waste is first treated through a series of mechanical operations separating them into recyclable materials, non-recyclable materials that could be further processed to become RDF and a biodegradable fraction which is treated by anaerobic digestion to produce biogas. The RDF is then fed into a gasification process to produce syngas.

The Multi-technology Approach

24. These strategy options have been evaluated against a set of comprehensive criteria using a quantitative and qualitative approach as shown in Annex B. The criteria cover various important areas on environmental friendliness, reliability and operability of the technology, flexibility for expansion and variation, cost effectiveness, sustainability land requirements, and effects on public health etc.

25. The evaluation result indicates that each option has its strengths and weaknesses that need to be taken into account when formulating the strategic implementation plan. Some options have also proposed more than one technology. In the light of the heterogenous nature of our MSW, the AG recommended that the IWMF should adopt a multi-technology approach so that the most suitable technology could be applied to deal with different waste streams of MSW.

26. To illustrate the multi-technology approach, a schematic diagram is summarized in Figure 8.

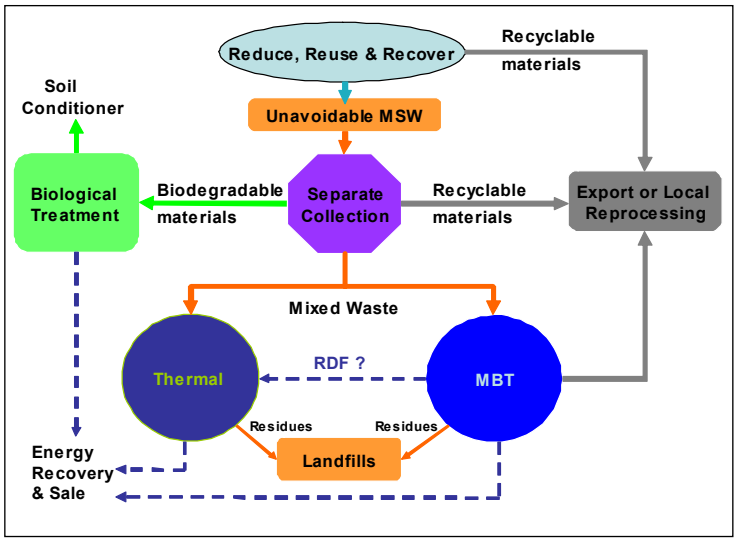


Figure 8 – Multi-technology Approach for the IWMF

27. The approach will be built upon and complement the existing efforts to promote waste reduction and recovery. Waste will be reduced as far as practicable through various measures such as community education and economic incentives. We aim at achieving 50% recovery rate (from 40% in 2004) by 2014. This is equivalent to about 7 200 tonnes of MSW per day that need to be treated in bulk. Through the separation of MSW at source, recyclable materials will be recovered for recycling. Biodegradable materials will be separately collected for biological treatment.

28. The remaining mixed MSW may then be treated by both MBT and one of the thermal technologies. Experience in Europe suggests that some 50 - 60% of the residues will need to be disposed of at landfills if MBT technology alone is adopted. Hence, for the future IWMF, MBT cannot be used as the only method to treat mixed MSW, and its scale would depend on the available outlets for its residues.

29. For the remaining portion of the mixed waste, which is not treated by MBT, thermal technology should be considered. Amongst various thermal technologies identified, namely, incineration, gasification and co-combustion, incineration is considered the preferred technology as it is a technologically well-proven method adopted by many advanced countries in Europe and Asia. It has a favourable treatment cost and is the most cost-effective technology to divert waste from the landfill amongst the options considered. Land requirement is also low as compared with the biological treatment option. Gasification is relatively more expensive and less cost effective than incineration at the present stage of technology development. As for co-combustion, its application will depend on the viability of a local cement manufacturing plant and the technical feasibility of the plant in accepting refuse derived fuel.

30. Given the problem of odour and land uptake, anaerobic digestion is preferred to composting. However, the volume of biodegradable waste to be biologically treated depends on the available outlet of the residues. We estimate that Hong Kong is able to take up soil conditioners produced from about 500 tonnes of biodegradable waste per day. As regards the thermal process, incineration is preferred as it is a mature technology and very high emission standards can be attained. The relatively high cost of gasification makes the technology comparatively less cost-effective. A small proportion of the mixed waste can be treated by MBT to recover recyclable materials not separated at source, subject to available outlets for the recovered materials in the separation

process. We estimate that the MBT plant should be able to handle 1 000 tonnes of waste per day. The remaining 5 700 tonnes will be treated by incineration. An IWMF of this scale could be housed within an area of 35 hectares.

Overseas Experience

31. Incineration, combustion of fuel derived from waste for cement production and MBT are proven technologies. About 130 million tonnes of MSW are combusted annually in over 600 waste-to-energy (mostly incineration) facilities worldwide. Most of these facilities are in the more advanced countries such as Japan, US and the EU countries.

	Approximate percentage of MSW treated by thermal method	Number of thermal treatment facilities
Japan	78%	1,715
Singapore	50%	4
Denmark	58%	32
The Netherlands	38%	11
The USA	15%	150

Table 1 – Thermal treatment facilities in overseas countries

32. Gasification is more costly at the present stage of technology development. Nonetheless, it8 has become more commercialized in Japan in recent years. There are over 100 sites operating in Europe using some form of MBT technology. MBT is more extensively used in Germany and Austria and increasingly so in Italy. UK is also exploring the application of the MBT technology. However, the Resource Recovery Forum's report issued by the consultant Fichtner in 2004 confirmed that although there are many assumed markets for RDF, the major useful product of MBT, the potential outlets are severely limited.

33. Many countries have adopted stringent standards for emissions from incinerators. As emission controls have become progressively more stringent across Europe in recent years, smaller scale incinerators are being phased out and

are replaced by fewer, but larger and more advanced incinerators capable of achieving the new emission limits. To meet the emission limits for dioxins and furans, most MSW incinerators now operate an air pollution control system based on the injection of materials such as activated carbon powder to absorb these pollutants, and a filter system to remove the injected materials with the trace contaminants. The emission standards for the main gaseous pollutants including dioxins and furans adopted by different countries are shown in Table 2. The emission standards to be adopted for the IWMF will be one of the most stringent standards among these technologically advanced countries.

Pollutants (mg/Nm^3)	Germany	The Netherlands	Singapore	Japan
Particulates	10/30[(a)]	5[(b)]	50	40
Organic Carbon	10/20[(a)]	10	---	---
HCl	10/60[(a)]	10[(b)]	60	700
HF	1/4[(a)]	1[(b)]	5	---
SO_x	50/200[(a)]	40[(b)]	200	#
CO	50/100[(a)]	50[(c)]	100	---
NO_x	200/400[(a)]	70[(b)]	400	250 (ppm)
Mercury	0.05	0.05	0.05	---
Cadmium	0.05	0.05	0.05	---
Total Heavy Metal	0.5	0.5	0.5	---
Dioxin/Furans (ng/Nm^3)	0.1	0.1	0.1	0.1

[(a)] (daily average)/(½ hour average) [(b)] Short-term average

[(c)] 1-hour average # depends on the area and stack height.

Table 2 – International emission standard for MSW incinerators

The Way Forward

34. In view of the urgency and seriousness of the waste problems that we face, a definitive and agreed way forward to resolve them is vital. The solution lies in a multifaceted plan that tackles the issues from all fronts. While we will continue to further our community education efforts to encourage the public to participate in the territory wide programme on separation of domestic waste at source and other waste reduction and recycling programmes, we would need to draw up an overall strategy for the management of municipal solid waste. We are working towards publishing the document in September.

Advice Sought

35. Members are invited to note the MSW management efforts and the recommendations of the AG on the multi-technology approach for the IWMF described above.

Environmental Protection Department
May 2005

Annex A

Waste Reduction, Recovery and Recycling Programmes

Period	Name of Programme	Characteristics of the Programme	Outlet	Result
2002-present	Wastewi$e scheme for commercial & industrial sectors	The scheme is a recognition program to promote voluntary waste reduction and recycling in commercial and industrial sectors.		Since 1999, over 770 companies and institutions have enrolled in the scheme. 244 have been awarded the "Wastewi$e" logo to commend their achievement of waste reduction targets
2002 – present	Packaging Expanded Polystyrene (EPS) Recycling Programme	Funded by Environment and Conservation Fund (ECF), Friends of the Earth (FoE) tested various modes of operation for recovery of EPS, including on-site compaction of EPS for large and regular producers and bulk collection service for ad-hoc producers.	The EPS collected is first compacted or melted and then sold to local recyclers for production of products such as photo frame.	About 1 tonne of EPS was collected every month. EPD plans to collaborate with FoE to extend the collection network by setting up more collection points.
2002 – present	Spent Mercury Lamp Recovery Programme	A set of equipment was installed at the Chemical Waste Treatment Centre to recover mercury from fluorescent tubes and energy-saving bulbs and street lamps from Government departments.	Mercury reclaimed will be sold as raw material.	By end 2004, the facility has taken in more than 250,000 of mercury lamps. Its effectiveness would be evaluated to see if the service could be extended to include commercial buildings and other waste with mercury content.
Aug 02 – present	Plastic Bags (Domestic) Recovery Trial	Collection bins are placed at 36 public/private housing estates and 24 supermarket stores to recover plastic bags.	Plastic bags recovered would be arranged for recycling by the collectors.	So far, 22 tonnes of plastic bags (equivalent to 3.9 million plastic bags) have been collected.

Period	Name of Programme	Characteristics of the Programme	Outlet	Result
Mid-02 – End-05	Recovery of waste electrical and electronic appliances at waste management facilities	Pilot recycling plant at North West New Territories Refuse Transfer Station was set up to recover discarded electronic and electrical appliances. This will be replaced by a recycling centre to be set up at the Kowloon Bay Transfer Station.	Appliances are dismantled to retrieve useful materials for recycling.	So far, about 5,000 appliances have been processed.
Jan 03 – Dec 05	Waste Electrical and Electronic Equipment (WEEE) Recovery Programme	St. James Settlement and Caritas were engaged to undertake the programme.	WEEE collected is refurbished for donation to the needy. The equipment that is beyond repair will be dismantled to retrieve useable components and materials for reuse and recycling.	25,000 and 40,000 units of appliances were collected in 2003 and 2004 respectively.
Apr 03 – Apr 05	Pilot Scheme in Recycling of Waste Tyres collected at Kowloon Bay Transfer Station	Recovery and recycling of waste tyres produced by the Government vehicle fleet and collected from the street by FEHD. A new contract will be awarded in the 3rd Quarter of 2005.	Rubber chips reclaimed were locally used in production of "RubberSoil" for application as slope fill and road base, etc; and steel reclaimed was sold as scrap.	By end 2004, about 4,600 tonnes of waste tyres were recovered.
Aug 04 – present	Pilot Programme on Separation of Domestic Waste at Source	Pilot programme is tried at 13 housing estates in the Eastern District aiming to facilitate residents to separate waste at source by providing waste separation facilities on each floor, and to broaden the types of recyclables. The programme is now expanded to the whole territory.	Paper, metals and plastics recovered are sold directly by participating estates to recyclers for recycling. Periodic programmes are also organized to recover other materials such as old clothing.	Preliminary data show that the amount of waste recovered has increased in various degree: metal – 15 times more than before (before the programme : 2 tonnes; after the programme : 30 tonnes); paper – up 40%; plastics – up 10%.

Period	Name of Programme	Characteristics of the Programme	Outlet	Result
Sep – Oct 04	Mooncake containers recovery programmes	EPD collaborated with property management companies, restaurant trade, and mooncake manufacturers to recover and recycler mooncake containers at shopping arcades. EPD also facilitated property management companies to organize their own collection programmes.	Mooncake containers collected were sold to recyclers for recycling	42,000 containers were collected during the nine-day period at the shopping arcades. 42,000 containers were collected from 170 estates.
Jan 05 – Jan 06	PET Beverage Bottle Recycling Programme	Launched and funded by Swire Coca-Cola and Vitasoy and co-organised by EPD. The programme provides reward to the public for returning plastic beverage containers of the organized beverage companies to designated community centre.	Plastic bottles were collected by local plastic recycler for recycling.	The programme commenced on 28 Jan 2005.
Apr 05 – present	Rechargeable Battery Recycling Programme	The first voluntary Product Responsibility Scheme (PRS) programme. This programme replaces the previous successful programme which only recovered batteries from mobile phones. This programme was supported by some 33 importers / producers. 300 Collection points were set up in the retail shops, service centers of the co-organizers, petrol stations, and MTRC stations.	Batteries collected were sorted and shipped to an overseas facility for recycling.	Since April 2002, about 8.6 tonnes of mobile phone batteries (about 172,000 pieces) have been collected. 7.5 tonnes of recovered batteries have been exported for recycling. The programme has been expanded to recover all types of rechargeable batteries in April 2005.

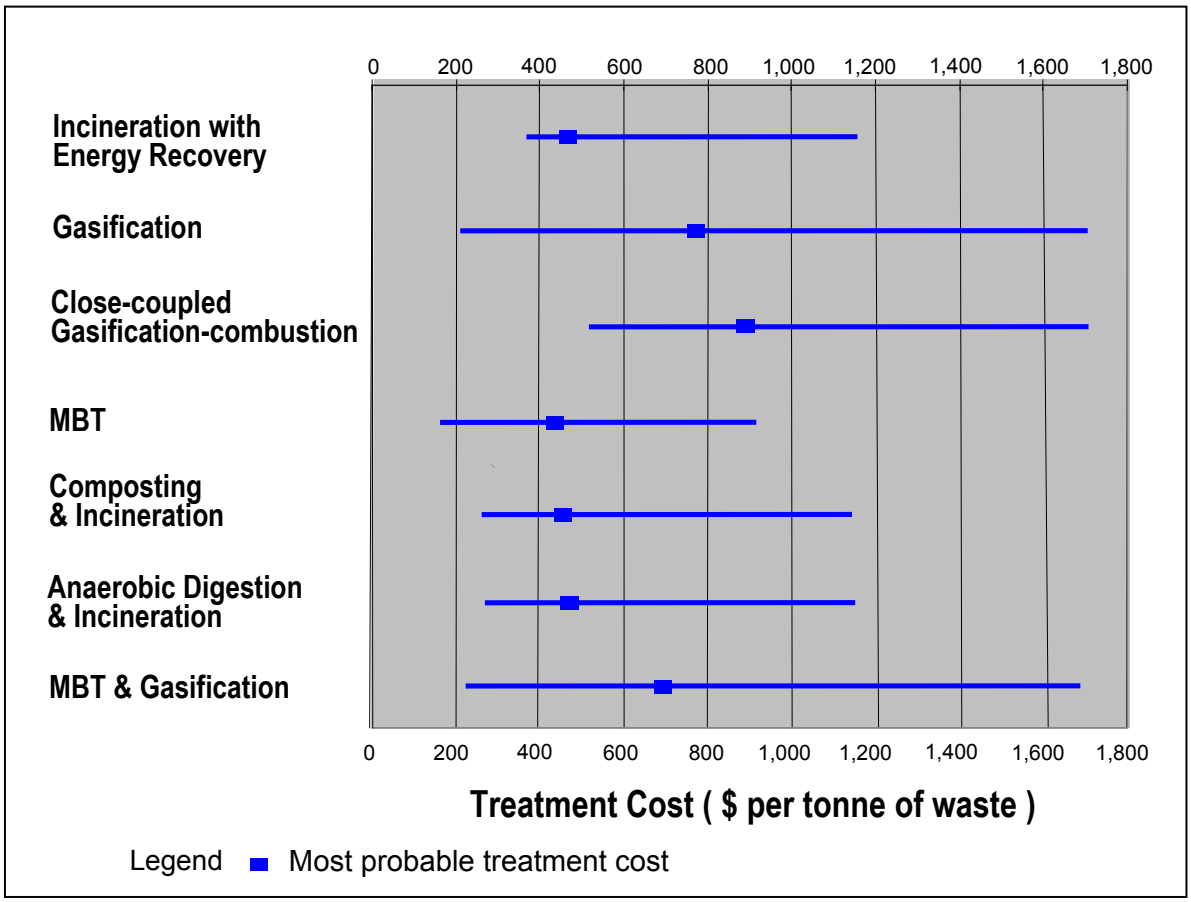
Annex B

Evaluation Result of the Strategy Options in the EoI

	Strategy Option							
Criterion	**1** Incineration with energy recovery	**2** Gasification	**3** Close-coupled Gasification-Combustion	**4** Material recovery & co-combustion[2]	**5** MBT	**6** Composting and Incineration	**7** Anaerobic Digestion and Incineration	**8** MBT and Gasification
Reliability	Excellent	Satisfactory	Satisfactory	to be demonstrated	Good	Good	Excellent	Satisfactory
Energy Recovery	19%	18%	8%	12%	0%	19%	19%	20%
Treatment Cost	See Figure I							
Flexibility	Satisfactory	Satisfactory	Satisfactory	Good	Good	Satisfactory	Satisfactory	Good
Product Outlets	Satisfactory	Poor	Poor	Good	Good	Poor/ Satisfactory	Poor/ Satisfactory	Poor
Monopoly Concerns	Satisfactory	Poor	Poor	Poor	Satisfactory	Satisfactory	Satisfactory	Poor
Climate Change[3]	2.17%	2.34%	1.93%	3.77%	3.7%	2.25%	2.19%	0.76%
Landfill diversion (by volume)	87%	89% - 96%	95% - 97%	to be demonstrated	48%	87%	87%	77% - 79%
Hazardous Solid Residues	Yes	No	No	No	No	Yes	Yes	No
Land Requirements	See Table A							
Air Emissions	See Figures II and III							
Liquid Emissions	See Figures IV and V							
Visual Impacts	Poor	Satisfactory	Poor	Good	Satisfactory	Poor	Poor	Satisfactory
Setup Timeframe	Satisfactory	Satisfactory	Satisfactory	Satisfactory	Good	Satisfactory	Satisfactory	Satisfactory
Employment	None of the options would provide significant new jobs (skilled and unskilled) relative to HK's overall employment situation.							
Public Health	All IWM strategy options would pose a very low or insignificant risk to public health.							

[2] Co-combustion of Refuse derived fuel (RDF) at cement plant

[3] Green House Gas emissions as % of HK total



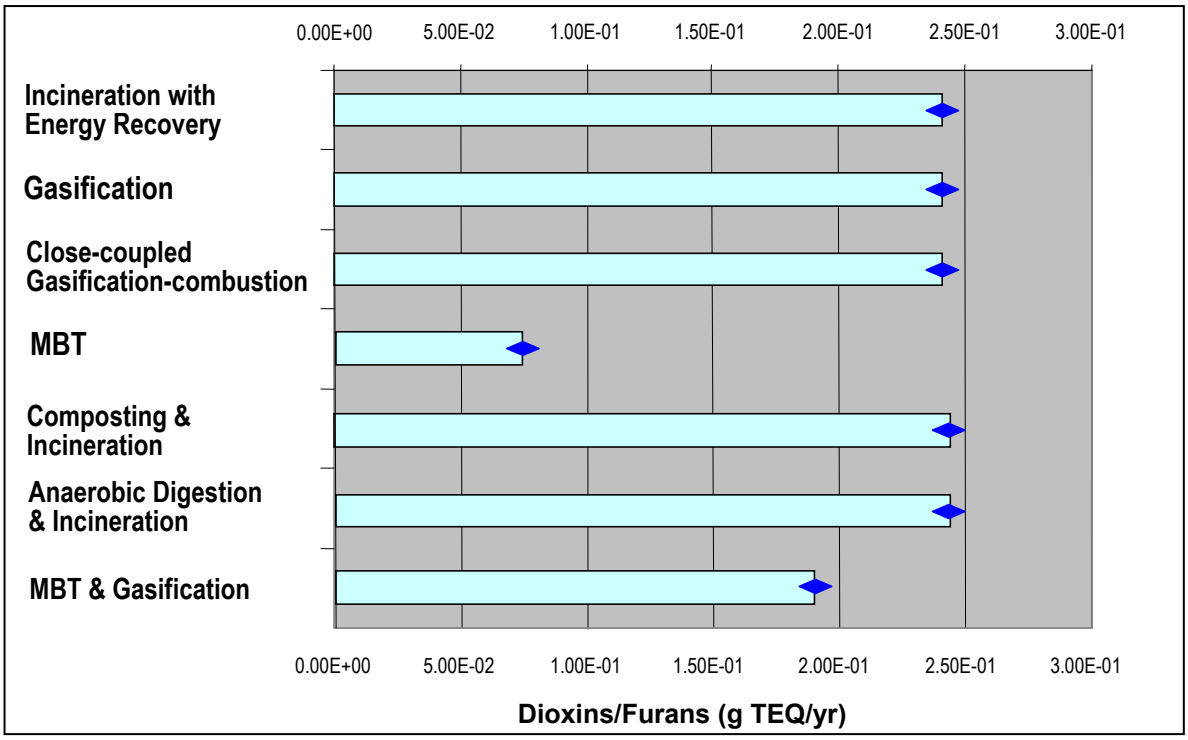
Treatment Cost for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Fig. I Range of treatment costs of the Strategy Options in the EoI

Strategy Option	Land uptake (m^2 per tpd of waste)
Incineration with energy recovery	28 – 30
Gasification	50 – 55
Close-coupled gasification-combustion	28 – 30
MBT	70 – 90
Composting and Incineration	34 – 37
Anaerobic digestion and Incineration	29 – 31
MBT and Gasification	67 – 76

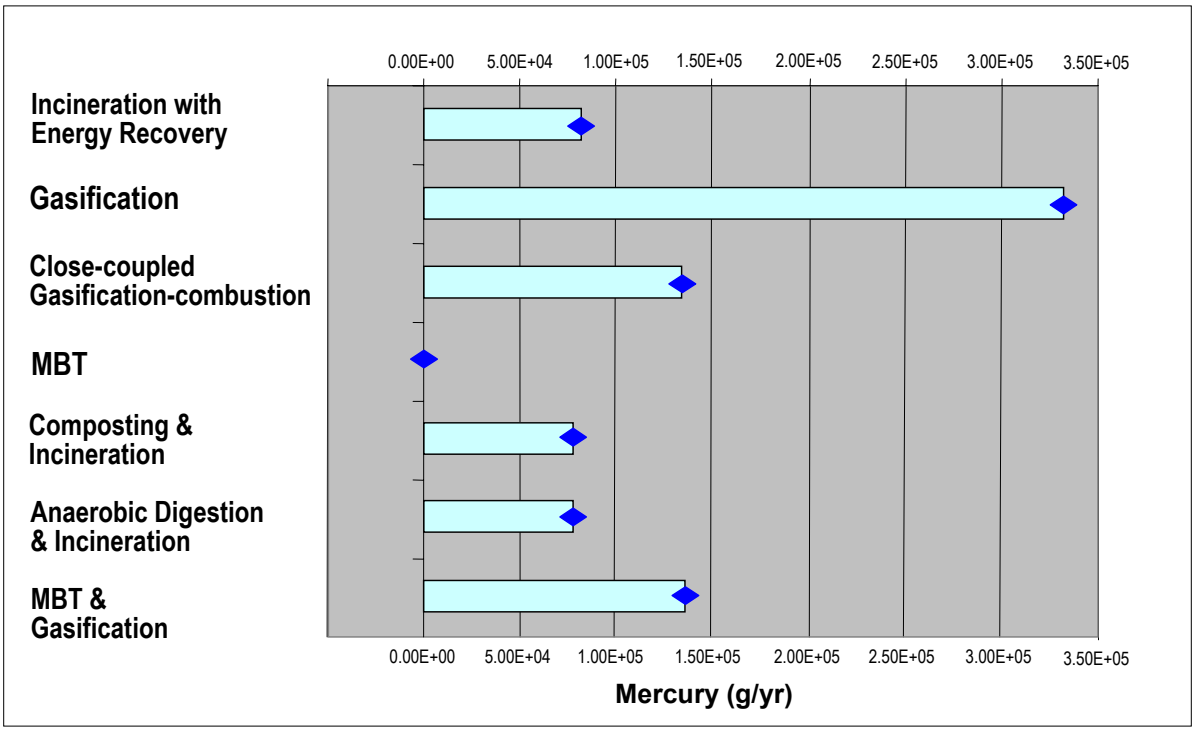
Land uptake for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Table A. Land uptake of the Strategy Options in the EoI



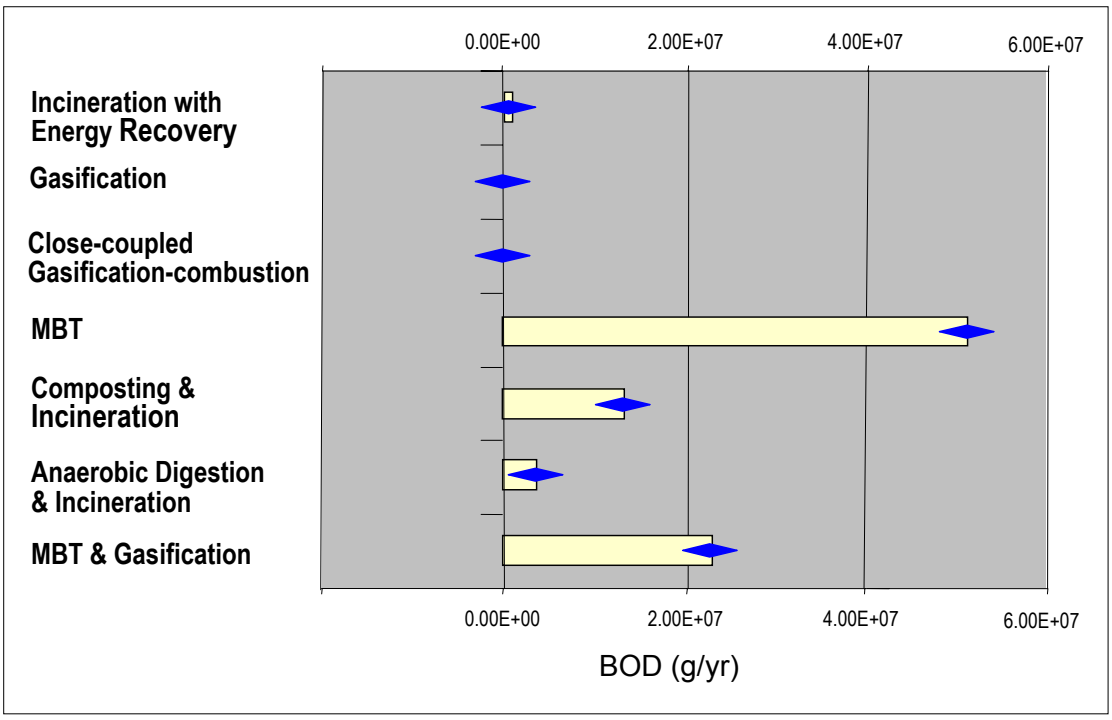
Data for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Fig. II Air Emissions (Dioxins in g TEQ/yr) of the Strategy Options in the EOI



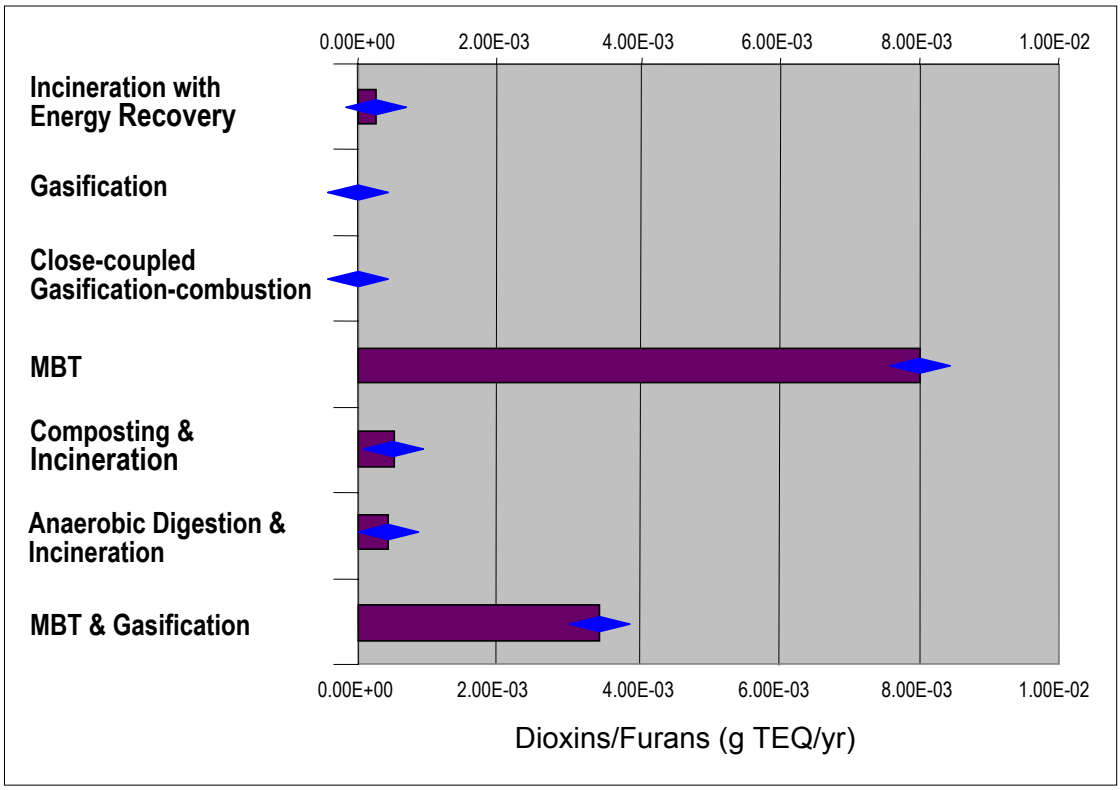
Data for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Fig. III Air Emissions (Mercury in g/yr) of the Strategy Options in the EOI



Data for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Fig IV Biochemical Oxygen Demand (BOD) loads to the water environment of the Strategy Options in the EOI



Data for Option 4 (co-combustion of RDF for cement production) is not shown due to limited data

Fig. V Liquid dioxin loads (in g TEQ/yr) to the water environment of the Strategy Options in the EOI.