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Integrated Waste Management Facilities
Technology Review and Associated Facilities

PURPOSE

This paper informs Members on the results of the technology review carried out under the Engineering Investigation and Environmental Impact Assessment Studies for the proposed development of the Integrated Waste Management Facilities (IWMF) and it also seeks Members' initial views on the associated facilities that might be incorporated in the IWMF.

BACKGROUND

2. In April 2002 the Environmental Protection Department (EPD) invited submissions of Expression of Interest (EOI) from local and overseas companies on proposal of treatment technologies for developing the IWMF. An Advisory Group (AG) comprising members from professional bodies, academia, green groups and business sectors, was set up to assist and advise in selecting the appropriate technologies. After evaluating the submissions, the AG recommended that the IWMF should adopt a multi-technology approach such that the most suitable technology could be applied to deal with different waste streams of municipal solid waste (MSW). The AG specifically advised that –

(i) Incineration be adopted as the major component of the IWMF strategy. Other thermal technologies (e.g. gasification or similar systems such as co-combustion in a cement plant) may be considered as the concerns over these technologies, cost, market competition and commercial viability etc. are resolved.

(ii) Application of mechanical and biological treatment (MBT) technologies could be considered at suitable scale under particular circumstances and as

a component of the overall IWMF strategy.

3. In December 2005, the Government promulgated "A Policy Framework for the Management of Municipal Solid Waste (2005-2014)" (Policy Framework). It sets out a comprehensive waste management strategy for the next ten years, encompassing targets and initiatives on waste avoidance reduction and recycling and the development of IWMF in mid 2010's for bulk reduction of waste.

4. A delegation of the Advisory Council on the Environment (ACE) visited some waste treatment facilities in the Netherlands and Germany in March 2006. Subsequent discussion of the ACE advised that thermal technology with waste to energy opportunity be adopted as the core treatment technology for treating the MSW. The ACE also advised that the treatment facility should be developed in phases, taking into account the progress and effectiveness of the various waste reduction and recycling initiatives.

5. Having considered the views of the AG and ACE, and the initiatives set out in the Policy Framework, EPD plans to develop the first phase of the IWMF with a treatment capacity of about 3,000 tonnes per day (tpd). This first phase of IWMF would adopt incineration with energy recovery as the core technology and it would also incorporate a demonstration scale sorting and recycling plant to recover resources from the MSW.

6. The Government has carried out a comprehensive site search exercise to identify suitable sites for developing the first phase of IWMF and following the completion of the site search exercise in early 2008, Shek Kwu Chau site and the Tuen Mun Tsang Tsui Ash Lagoons site are considered suitable as potential sites for development of the IWMF.

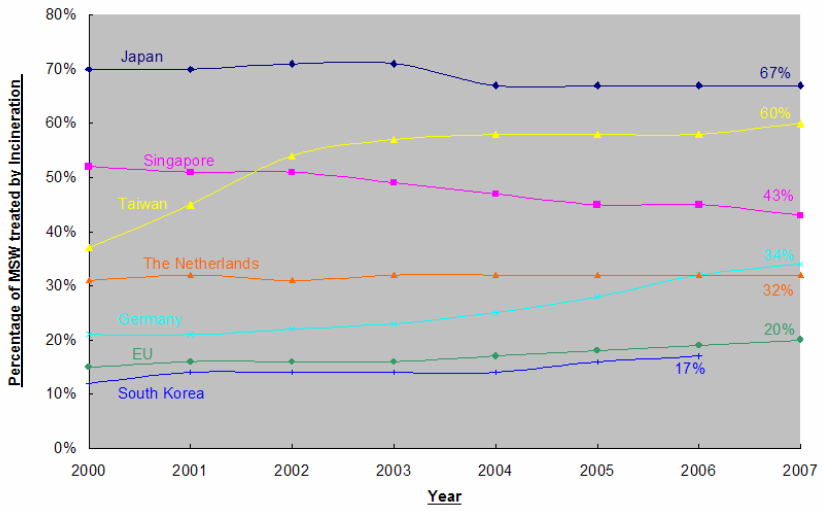
7. In order to ascertain the suitability of these two potential sites, EPD commissioned the detailed Engineering Investigation and Environmental Impact Assessment Studies for both sites in November 2008. The Studies are scheduled to be completed in the latter half of 2010, after which the Government would decide on the choice of site for the first phase of the IWMF and commence construction as soon as possible with a view to commissioning the IWMF in the mid-2010's.

TECHNOLOGY REVIEW

8. As a major part of the Engineering Investigation Study, the consultant has conducted a review of the latest development in waste treatment technology so as to ensure that advanced technology that might have become proven and suitable for the IWMF development since the EOI exercise would not be missed out. The review has found that thermal technology has remained to play a key role in waste treatment. In some jurisdictions such as Germany, South Korea, and Taiwan, the percentages of

MSW treated by thermal treatment technologies have increased in recent years. For Japan and Singapore, the thermal treatment percentages have, however, slightly decreased due to increases in recycling (**Figure** below). New large scale MSW incineration plants continued to be commissioned, for example, the 1,900 tpd plant commissioned in 2006 in Frankfurt, Germany; the 1,500 tpd plant commissioned in 2007 in Issy-les-Moulineau, France; and the 2,000 tpd plant commissioned in 2009 in Naples, Italy.

Figure 2 - Trend of thermal treatment of MSW in selected countries



9. In addition, the review has found that the trend of using MBT plants for mixed MSW treatment continued, particularly in Europe. This re-affirms AG's recommendation that MBT of MSW could be considered at a relatively small scale.

Thermal Technologies

10. The thermal technologies currently used for MSW treatment include incineration, gasification, plasma gasification, pyrolysis and co-combustion. A brief introduction of these technologies is in **Annex A** and an evaluation of these technologies is summarized as follows.

Incineration

11. Moving grate, fluidized bed and rotary kiln are the three known incineration technologies adopted for the treatment of mixed MSW. The review has indicated that fluidized bed incineration system is more commonly used for more homogenous waste such as sludge. If it is applied on mixed MSW, the waste needs to be pre-treated and shredded into small homogenous pieces prior to incineration. Currently, this technology is not commonly adopted for treatment of mixed MSW, and the waste facilities applying this technology are generally of small unit capacities less

than 60 tpd.

12. As for rotary kiln, the review has found that this technology is primarily used for treatment of hazardous waste. Its use for mixed MSW is quite rare and of limited capacity, with unit capacity ranges from 100 to 300 tpd.

13. In comparison with the above two forms of incineration technologies, the unit and plant capacities of the moving grate system are the highest, with capacities reaching 800 tpd and 4,300 tpd respectively. Moreover, it is found to be the only technology that is proven to treat waste in large capacity (i.e. over 3,000 tpd) mixed MSW.

14. Given the above and the very limited track record of fluidized bed and rotary kiln incineration in treating mixed MSW, the review has recommended that moving grate incineration be considered for the IWMF Phase 1 development. In addition to its proven track record for large scale application, the moving grate incineration technology also has the following advantages -

(i) currently, there are over 10 major suppliers with good track records for the provision of this technology. This may enable adequate tender competition at the tender selection stage;

(ii) it has the highest capability to treat different sizes and qualities of the mixed MSW;

(iii) this technology possesses the least operational complexity; and

(iv) this technology requires the least capital and operating costs, and land space for development.

Gasification

15. The review has found that up to 2008, only some 90 gasification plants have been installed all over the world for MSW treatment. This number is very small when compared with over 900 moving grate incineration plants that have been installed worldwide. For gasification applications, pretreatment of MSW to fine granules is generally required as this technology, when compared with incineration, is less robust in treating mixed MSW with different sizes and qualities. So far, this technology is only adopted for relatively small scale MSW treatment (less than 400 tpd).

16. The review has also found that some key gasification suppliers have

recently withdrawn from the international market. In view of its limited track record for large scale MSW treatment, the incapability of treating MSW with varying sizes and qualities, and the limited number of suppliers (less than five major suppliers internationally), the review considers that gasification technology is not suitable for the proposed IWMF development.

Plasma Gasification

17. Plasma gasification is mainly adopted for treating specific wastes such as hazardous wastes or even low-level radioactive wastes. For MSW, application of this technology entails pre-treatment of the mixed waste to a more homogeneous feedstock. The review has found that since the EOI exercise, there has been no noticeable major development of this technology for MSW treatment. So far, this technology is only adopted for relatively small scale MSW treatment (less than 300 tpd). Therefore, the review considers that the plasma gasification technology is not suitable for the proposed IWMF development.

Pyrolysis

18. Up to 2008, there were some 30 pyrolysis plants for MSW treatment in various parts of the world. The typical unit capacity and plant capacity fall within the ranges of 60 to 80 tpd and 130 to 160 tpd respectively. Application of pyrolysis for mixed MSW treatment is limited and this technology is not suitable for large scale uses. If applied, pre-processing of mixed MSW is usually required. In general, pyrolysis system requires higher capital cost than the incineration systems.

19. The review has also found that a key pyrolysis supplier in Japan has recently withdrawn from providing new pyrolysis system for waste treatment. Having considered this, and the limited number of such plants and its small-scale of application, our review considers that the pyrolysis technology is not suitable for application in the proposed IWMF.

Co-combustion

20. As regards the technology of an Eco-co-combustion system proposed earlier by a local cement production company to EPD for treatment of MSW, the review however has found that it is considerably different from the conventional

co-combustion process adopted worldwide[1]. The proposed system burns the MSW in a separate rotary kiln system and the waste heat so generated is utilized in the "front-end" cement making calcination process (i.e. conversion of limestone to lime in the pre-calciners). The pre-calcinerated materials hence produced is then used for cement production in the existing rotary kiln of the cement plant. The ash residues generated from MSW burning in the rotary kiln is to be re-used as feed materials into the cement making process. A schematic diagram of the proposed Eco-co-combustion system is at **Annex A**.

21. While a pilot plant trial run at a scale of several tonnes per day of mixed MSW operated for some two months was conducted in 2005, it did not test out the full process of the proposed Eco-co-combustion system. The review found that so far, all over the world, there has not been any application of similar system for treatment of MSW. In addition, the company proposed that four rotary kilns, each with a unit capacity of 1,000 tpd, be used in their Eco-co-combustion system for mixed MSW combustion. The consultant advised that no rotary kiln of such scale has ever been built and used for MSW combustion. According to the review, the largest rotary kiln adopted for MSW combustion is one operating at a capacity of some 450 tpd. This rotary kiln was supplied by a company which has already retreated from the rotary kiln incineration market. The review hence considers that it would be too risky and unscientific to simply scaling up the findings of the pilot plant to predict the operational practicability of the proposed Eco-co-combustion system.

22. In addition, the consultant advises that as MSW is proposed to be treated as fuel for cement production under the proposed Eco-co-combustion system, should there be any reductions/fluctuations in the demand for cement production, there would have a knock-on effect on the treatment capacity of the plant. This would inevitably cause serious adverse impact on Hong Kong's ability of MSW treatment.

23. Given the technology and market risks concerned, the review does not recommend the applicability of the Eco-co-combustion system for MSW treatment.

24. In conclusion, the review recommends that the moving grate incineration technology be adopted as the core technology for the development of the IWMF Phase 1.

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[1] It is not uncommon to find use of wastes as a supplementary fuel to substitute normally 10% to 20% of the fossil fuels for the cement kiln. In this conventional usage, certain waste with high heating value (e.g. waste oil, animal meal, used tyres and rubber) or refuse derived fuel (RDF)[2] produced from MBT Plants elsewhere outside the cement plant is used as fuel for direct feeding to the existing cement kiln and be burnt together with the cement raw materials. The waste however needs to be specially prepared so as to act as a supplementary fuel.

[2] RDF can be produced from mixed MSW through a number of different processes including sorting or mechanical separation, size reduction (shredding, chipping and milling), separation and screening, blending, dry stabilization or biological treatment, and pelletising.

Sorting and Recycling Technologies

25. The review has also identified that for sorting and recycling of MSW, the technologies available include mechanical treatment alone (MT), mechanical and biological treatment (MBT), biological and mechanical treatment (BMT) and mechanical heat treatment (MHT). A brief introduction of these technologies is in **Annex B**.

26. Of the various sorting and recycling technologies, it is noted that application of MHT for MSW treatment has not found to be commercially proven. As for MT, the technology could only recover recyclables without stabilizing the waste residues. Both MBT and BMT technologies could recover materials and energy from the MSW and produce a more stable waste residue. Considering that MBT normally requires smaller land intake than BMT, MBT is proposed to be adopted for the sorting and recycling plant as a component of the IWMF.

27. The review has noted that currently, there are over 200 MBT plants for MSW treatment worldwide and the biological treatment stage of the MBT could be either composting (aerobic) or anaerobic digestion. After evaluation, the review has recommended adoption of the anaerobic digestion process because it can produce biogas for energy generation and achieve a comparatively higher waste volume reduction with less land requirements than the composting process.

ASSOCIATED FACILITIES

28. In reviewing the development of MSW incineration plants elsewhere, the consultant finds that some plants have incorporated social, recreational and educational facilities to enhance their social acceptance. These associated facilities are generally well received by the public. It is therefore considered worthy to consider the possibility of incorporating some associated facilities in the proposed IWMF development.

29. Both of the two potential sites for the IWMF phase 1 development are located adjacent to the sea and in quite remote location. Considering these site characteristics, common social and recreational facilities such as community halls, swimming pools, tennis courts etc. may not be suitable. Instead, the associated facilities may be used to demonstrate the waste-to-energy concept and advanced waste treatment technologies to the public. The following preliminary options that could make use of part of the surplus energy generated by the IWMF and build in situ or adjacent to the IWMF may worth exploring -

(i) Educational centre cum Waste Technology Museum – It could focus on themes relating to waste treatment and education. The facility could comprise exhibition hall, interactive (computer) game gallery, lecture

theatre and round site touring route via visitor corridor cum electric trolley;

(ii) Eco-tourism Park – It could comprise greenhouse and botanic garden with a wide collection of flora species; an ecology centre displaying information on the local faunal species and providing venues for environmental activities. A good example is the Yumenoshima Tropical Greenhouse Dome in Japan which utilizes the heat energy from the adjacent Shin Koto Incineration Plant; and

(iii) Recreational facilities such as heated swimming pools which can utilize part of the energy generated by the IWMF.

30. In addition, as the Shek Kwu Chau site is surrounded by marine environment with diverse ecology and the surrounding water is a major habitat for marine life such as finless porpoises, consideration could be given to build a facility in or adjacent to the IWMF to promote marine ecology education and conservation.

ADVICE SOUGHT

31. Members are invited to note the results of the technology review carried out under the Engineering Investigation and Environmental Impact Assessment Studies for the development of the IWMF Phase 1 and to comment on the potential associated facilities that could be considered for incorporation in the IWMF development.

Environmental Protection Department
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