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REVIEW ARTICLE

Sustainable strategy for municipal solid waste disposal in Hong Kong: current practices and future perspectives

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Abstract
Hong Kong (HK) is confronted by increasing problems of solid waste disposal, as it is an overpopulated city with limited land resources. Currently, solid waste disposal mainly relies on three landfills located in the New Territories. However, the current waste treatment facilities and policies cannot appropriately control and manage increments of solid waste. The primary reason is the increased amount of municipal solid waste (MSW) caused by the growth of the population and the economy, with food waste accounting for the largest proportion of MSW in HK. The secondary reason is that the capacity of existing landfills will be exhausted in the near future as the level of waste generated continues to grow. To deal with these problems, in this paper, we propose five approaches with the aim of identifying the most sustainable strategy for efficient solid waste disposal in HK: a food waste recycling program; an MSW charging scheme; the implementation of incineration plants (i.e., waste to energy); black soldier fly bioconversion and a waste trading scheme; and black soldier fly bioconversion and a hybrid anaerobic digestion system. This is followed by a detailed demonstration of each approach, particularly focusing on the benefits, limitations, and implementation of each in the case of HK. The results of this study may shed light on how to effectively and sustainably manage the increasing amount of solid waste in HK.

Keywords Food waste · Hybrid anaerobic digestion system · Municipal solid waste · Waste recycling

Introduction

Hong Kong (HK) is a special administrative region of China with limited natural resources and space available for waste disposal. Since the generation of food waste has substantially increased with the sharp growth of the population and the economy in recent decades, HK is pursuing appropriate methods of food waste disposal, which are a pressing need. Over the past decade, HK's population has grown by more than one million and the amount of solid waste has increased by more than 20% (1.12 million tons) during the same period. Among the 9000 tons of municipal solid waste (MSW) disposed to landfills, approximately 3600 tons is food waste, accounting for the largest proportion of MSW in HK (Woon and Lo 2016). The generation of this ever-increasing amount of food waste and the scarcity of landfills result in tremendous pressure on the HK government. At present, HK relies solely on landfills for MSW disposal (Woon and Lo 2013), and thus, HK is experiencing a serious shortage of food waste disposal sites. If the quantity of food waste continues to increase at the current speed, the landfill sites in HK will run out far earlier than expected. According to the HK Environmental Protection Department (HKEPD), all existing landfills in the South East New Territories, North East New Territories, and West New Territories could be exhausted by 2014, 2016, and 2018, respectively (Woon and Lo 2016). As a result, there is an urgent need for the HKEPD to develop and implement a practical

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Table 1 Disposal of MSW at landfills in 2011(unit: tpd) (Hong Kong Environmental Protection Department 2013)

Composition of MSW	Domestic	Commercial	Industrial	Total	Percent
Glass	189	78	10	278	3.1%
Metals	129	36	17	182	2.0%
Paper	1259	569	103	1931	21.5%
Plastics	1107	464	123	1694	18.8%
Food waste	2868	1014	113	3994	44.4%
Textiles	141	56	20	217	2.4%
Wood/Rattan	91	40	187	318	3.5%
Household hazardous wastes	64	14	51	83	0.9%
Others	122	90	86	298	3.3%
Total	5973	2360	663	8996	100%

strategy of food waste disposal to address this emerging issue of food waste deposal.

During recent decades, MSW has tremendously increased, largely due to rapid population growth, urbanization, industrialization, and economic growth (Suocheng et al. 2001). The HKEPD has listed waste reduction and management policies as an intractable environmental issue to be addressed. In 1998, the Waste Reduction Framework Plan (WRFP) established various initiatives for solid waste reduction. In 2005, the HKEPD published "A Policy Framework for the Management of MSW in HK (2005–2014)", which proposed strategies and measures to address the municipal solid waste (MSW) problems in HK in the next decade (Cohen et al. 2015). However, due to the marginal success of these policy frameworks and disposal programs, the disposal of food waste is still a major challenge in HK (Chung and Lo 2003). Therefore, the objective of this paper is to propose a potentially comprehensive strategy to control and manage food waste in HK. Several technologies for food waste reduction, including a waste recycling scheme, incineration plants, bioconversion, and waste trading scheme, are also reviewed and discussed in this paper. We aim to provide some suggestions for HK's food waste disposal.

Current food waste disposal and challenges in HK

Food waste in HK

HK generates a large amount of MSW, of which food waste is the major component in HK. According to the HKEPD, in 2005, 6.4 million tons of waste was generated and disposed to a landfill in HK. Most of HK's food waste is disposed to landfills with other MSW. From 2000 to 2010, MSW production increased by 30% from 5.33 to 6.93 million tons. In 2011, the total amount of MSW disposed to landfills was 8996 tons per day according to Table 1, and food waste accounted for 44% (i.e., 3994 tons) and ranked first (Hong Kong Environmental Protection Department 2013). In 2012, 3337 tons of food waste was disposed to landfills each day, accounting for 36% of total MSW (Hong Kong Environmental Protection Department 2013). In 2016, according to the solid waste statistics of HK Waste, this number increased to 3600 tons (35% of total MSW) (Woon and Lo 2016), representing an increase of 6.5% compared to the 2015 level (Hong Kong Environmental Protection Department 2017). On average, the food waste generated in HK is far more than that in other areas of Asia. In 2012, the food waste generated in HK was 1.45 kg per person per day (Hong Kong Environmental Protection Department 2017). In contrast, in the same period, the food waste generated in Taipei, Seoul, and Singapore was only 1.00, 0.95, and 0.87 kg, respectively.

In addition, the multiple sources of food waste lead to difficulty in collecting and separating the food waste in HK. Currently, the food waste in HK mainly consists of waste derived from food production, processing, wholesale, retail, and preparation, in addition to that from meal leftovers and expired food. This waste could be anaerobically biodegradable, and in this process, approximately 125 m^3 landfill gas from every ton of landfilled food waste could be recovered (Hoornweg and Bhada-Tata 2012). Moreover, this biodegradable waste may generally result in environmental issues, for instance, methane gas emissions, which may increase the fire risk if such emissions are simply disposed of at landfills (Lauby-Secretan et al. 2016; Li et al. 2009). MSW anaerobic digestion has also been reported as an appropriate alternative in MSW disposal along with possible energy recovery (Khoshand et al. 2018).

Food waste disposal in HK

Over the past few decades, the waste management policy in HK has developed as a model with an increased focus on sustainability. Landfill disposal has been selected as the main food waste disposal approach. In 1989, the Waste Disposal Plan was proposed by HKEPD, and a strategy for MSW disposal in HK was established. The HKEPD has changed waste disposal by replacing old waste facilities with new, cost-effective facilities to meet higher environmental standards. First, waste went from being collected in disposal bins to being collected in refuse transfer stations (RTS). After being compacted in containers, it is delivered to disposal lands or recycling centers. Hundreds of waste collectors were located in the territory before transferring to refuse transfer stations. These refuse transfer stations serve as the collection stations for transferring waste to the landfills. Therefore, the waste collection model in HK includes a comprehensive system of refuse transfer facilities covering the area of outlying islands and 6 refuse transfer stations. The strategic landfills were operated by the HKEPD. Three strategic landfills and a network of refuse transfer stations were developed as facilities for waste disposal in HK. The total capacity of these three landfills is approximately 140 million m^3. However, with the large quantity of waste being generated every day, the capacity of the three existing landfill sites is still expected to be exceeded by 2020. Considering HK's current situation, the construction of a new landfill to treat the waste produced is not practical due to land limitations. Furthermore, the extension of the three landfills is restricted to a limited scale due to the high cost of available space. Therefore, solid waste disposal has become an imminent social problem for the HK government.

Putrescibility is one of the main parameters for most of the food waste in MSW. As a result, food waste may not be suitable for landfill disposal with other solid waste, as it leads to a rapid depletion of the limited landfill space, the formation of methane, and the generation of wastewater. On the other hand, the classification of waste being disposed of can accelerate the recovery of waste. Accordingly, it is also important to measure and separate food waste from the source and dispose of it separately from other waste.

As a result, a multipronged approach to tackling food waste problems has been adopted and implemented in HK. This strategy emphasizes the avoidance and reduction of food waste. It seeks to recover food waste and make it a valuable resource. The waste reduction campaign aims to awaken public awareness of the food waste problems in HK and to result in practical actions in various sectors of the community. To treat and recycle food waste that cannot be separated at the source, a pilot-scale solid waste treatment plant (the Pilot Composting Plant) at the Kowloon Bay Recycling Centre was demonstrated in 2008. The Pilot Composting Plant has a treatment capacity of approximately 500 tons per year, and approximately 100 tons of compost are recovered as fertilizer or soil conditioners in planting, landscaping, and agriculture. In addition to the efforts in food waste reduction, the control strategy for grease trap waste disposal is noteworthy. Wastewater can be generated from restaurants and food processing industries. Wastewater contains a large amount of organic carbon, which requires high biochemical and chemical oxygen demands. In addition, it contains high concentrations of oil, grease, and food solids, which can potentially cause problems for both sewage systems and public sewer systems (Amha et al. 2017). Therefore, wastewater needs to be treated due to its high level of biochemical and chemical oxygen demands when it is released to a downstream water body. Generally, wastewater should be separated by means of grease traps before it is discharged from polluted sources. The HKEPD published Grease Traps for Restaurants and Food Processors for the maintenance of grease traps. A new Grease Trap Waste Treatment Facility (GTWTF), located in the West Kowloon Transfer Station, is now being operated. It is recommended that grease trap waste collectors should use the GTWTF.

Potential approaches for future food waste disposal in HK

Implementation of incineration plants

Incineration is a thermal treatment technology involving the combustion of the organic substances contained in waste before final disposal. After incineration, the volume of waste can be reduced by more than 90%. In addition, the heat generated from combustion can be recovered for electricity generation. The combination of incineration with landfilling is the most popular approach for solid waste treatment worldwide. An incineration system can maximize the benefits of renewable energy, and the generated electricity and heat can neutralize the energy demanded by the plant. Meanwhile, HK has set a target according to which by 2020, 1 to 2% of electricity demand should be provided by renewable energy. At present, however, HK relies solely on landfills for MSW disposal, and the three strategic landfills currently being operated, namely those in the South East New Territories (SENT), North East New Territories (NET), and West New Territories (WENT), will be exhausted by 2019, making incineration worthy of consideration.

In the long-term debate on the implementation of incineration technology, the core obstacle that postpones progress is the public fear of gas emissions from combustion, represented by dioxins. In Japan, a successful case has proven that the introduction of incineration can make a contribution to waste disposal and that it is also environmentally friendly to humans and nature. Currently, the main obstacle is attributed to the public's lack of confidence and psychological acceptance. Therefore, the HK government should make greater efforts in education and publicity, which will be beneficial to spreading the correct cognition regarding incineration among the public and overcome the obstacles to it.

Food waste recycling program

Compared with incineration plants, food waste recycling programs have an edge in economic efficiency and lower exhaust emissions. In 2002, the Food Recycling Law went into force in Japan and led to significant efficiency (Ogushi and Kandlikar 2007). Thus, the law asks food industries to purchase agricultural products that are produced using food waste compost or food waste-converted animal feed. To operate the recycling system, the initial step is to establish a separation and collection hierarchy. However, regarding this issue, there are inadequate laws and rules, and waste collection points and food waste charging schemes are absent. As a result, food waste separation and recycling are still far from sufficient in HK. Local residents generally dump food waste with general waste (e.g., electric and electronic waste); thus, the recycling and reuse of containers, paper, and plastic are not efficient. It is never easy to find a way for this type of recycling program to work in practice. The results of a survey conducted with approximately 100 communities in Shanghai, another metropolis in China, revealed that their food waste recycling scheme had diversion rates of only 28% on average (Huang et al. 2014). In addition to financial support and necessary facilities, public awareness and some mandatory regulations are indispensable.

The HK government could encourage local residents to collect and separate the waste generated by community households with some economic incentive. Following waste collection and separation, waste charging is used, and each community household is required to pay charging fees, which depend on the amount of waste generated. This approach can encourage communities to avoid waste generation and to reuse recyclable items. Moreover, the recyclable items collected by community organizations can be sold to recyclers and collectors, while food waste can be recovered for fertilizers and fish food. The fees charged by community organizations are used to finance the establishment and daily operations of waste collection facilities. On the other hand, the government may also promote reward schemes for residents who practice waste recycling behavior (Yau 2010). The waste dumped at municipal collection points must be separated into recyclable (e.g., container, electrical, and electronic equipment), non-recyclable, and organic waste (e.g., food waste). Then, the HK government can charge residents who deposited their waste at municipal collection points. Non-recyclable items will be delivered to incineration plants for power generation and finally be disposed of by landfilling. Moreover, organic waste will be collected and reused to produce fertilizers for farming or for conversion into animal feed. Waste cooking oil can also be utilized to produce biodiesel as a costly feedstock, which is an alternative energy source to fossil fuel (Karmee 2016).

Optic bag system for food waste separation and collection

Currently, in HK, most food waste from domestic households is not sorted out from daily MSW before it is disposed to landfills, as discussed above (Woon and Lo 2016). To address this problem, how to separate and collect food waste from sources with less behavioral change from the public is key. Woon and Lo (2016) proposed an optic bag system to efficiently separate food waste and other types of MSW. Optic technology was first employed to select bottles with high recycling value. Regarding such optic technology, it has been said that it "can be used to identify and sort recyclable materials in a way that makes efficient use of available natural resources" (Nordbryhn 2012). The Haraldrud Plant, the world's largest optical sorting plant, which is located in Oslo, Norway, has a treatment capacity as high as approximately 0.15 million tons of waste every year. Therefore, applying optic technology for sorting food waste is feasible and practical.

In this suggested system, the food waste is packed in a green optic bag because the color green can allow the optic bags to be identified and sorted from the other plastic bags in a sorting plant using an optical camera. Optic bags can be provided by the HK government. In contrast, residual domestic MSW will be packed in a common plastic bag. Food waste will be further placed in a receiving pit after it is transferred to the refuse transfer stations. Then, the collected bags will be sent to a conveyor belt, and an optic sensor will be applied to detect green bags, with these bags being pushed off the conveyor belt. The food waste in optic bags will be broken into small pieces of 35 to 50 mm (Woon and Lo, 2016). Eventually, the food waste will be compacted and transported to recycling facilities for further treatment. The food waste collected after this sorting process can be recovered as a valuable material or as a source of renewable energy. As a source of valuable material, food waste can be further processed into animal feed, such as swine feed and fish feed (Woon and Lo 2016). Moreover, food waste can be a potential source of renewable energy that can be converted into electricity and biogas fuel for vehicles.

Black soldier fly bioconversion

In recent decades, studies on insect bioconversion as a measure to treat organic waste have been conducted in many regions worldwide (Cickova et al. 2015). Some species of flies have now been successfully utilized to reclaim energy in animal manure, food waste, and restaurant scraps, especially houseflies and black soldier flies (*Hermetia illucens*) (Wang and Shelomi 2017). Meanwhile, the increasing prices of fishery products and the growing demands for fish feed have stimulated interest in research to find alternatives, one of which is insects as well as larvae. Combining these two considerations, using fly bioconversion to convert food waste into fish feed turns out to be a feasible, sustainable, and low-cost approach. Previous studies on houseflies mainly utilized them to biodegrade the manure of livestock, while black soldier flies were found to be much more suitable for food waste disposal (Hussein et al. 2017).

Given that houseflies are infamous transmitters of diseases, black soldier flies are considered a better alternative since they can also be widely found in HK and, more importantly, there are no concerns about black soldier flies with regard to disease transmission. Once their eggs hatch, their larvae begin to feed on food waste, which will be consumed too rapidly to allow the growth of bacteria due to their gluttonous appetite. These flies can be used to feed to a variety of fish species by feeding alone or with other materials with the type of whole larvae, chopped or dry larvae powder (Henry et al. 2015). This alternative fish feed has the adequate protein that most fish species require for growth. According to a study by Sánchez-Muros et al. (2014), insect powder is required to have a protein level of at least 50% in South Africa. In addition to being used in the local fishery industry, the final product can be sold to other countries or cities, which can cover some of the cost spent on this waste treatment (Cheng and Lo 2016). However, this method requires more complicated technical support for feeding black soldier flies than other waste treatment techniques, such as landfills and incineration. Adult flies and larvae need to be separated in different areas with different conditions, which may consume a large amount of labor during the whole hatching, eclosion, and growing process of the fly. Black soldier flies prefer a warmer environment; thus, the temperature must be maintained at approximately 27–30 °C; otherwise, the maturation period will increase from 2 or 3 weeks to 2–3 months and have an adverse effect on the food waste depletion rate (Tomberlin and Sheppard 2002). Hence, there is an emerging need for a new insect farming approach associated with a highly automated control model.

Food waste trading scheme

Figure 1 shows the principle of the waste trading scheme. The marginal abatement cost represents the cost of abating one additional unit of contaminant, while the marginal damage represents the damage of one additional unit of solid waste generated. To achieve the minimum solid waste generation rate, the marginal abatement cost must be equal to the marginal social damage of the solid waste generated. The waste trading scheme can be applied in HK, as shown in the following suggestions.

HK is geographically separated into 18 districts, and each district has an administrative council. Every year, the HK government assigns a "waste credit" to each district according to its population and waste generation rate. Each district can be considered an entity involved in the trading scheme, and the administrative council is responsible for calculating the abatement target and regulating mitigation plans. If a district exceeds its abatement target, the extra waste credit can be sold to other districts. The profit gained from trading can be used to financially support environmental education and to improve waste treatment facilities. If a district does not meet its abatement target, the insufficient credit should be obtained from other districts. The charge can be regarded as a penalty to encourage the districts to reduce the solid waste that they produce.

The following illustrative example explains how the waste trading scheme applies to each district. Figure 1 (1) shows a curve between the entity where Q reductions are needed to comply with the emission objective and the domestic reduction using new technology, which incurs marginal cost P. Figure 1 (2) shows another entity where the marginal cost of reduction is lower than the tradable permit (P*). There are two districts (e.g., District A and District B) with different populations and solid waste generation rates. Figure 1 (1) shows that for District A, the target is to reduce solid waste by 300 tons. If the reduction is undertaken domestically, it will incur marginal cost P. However, if price P* is higher than marginal abatement cost P, District A could be motivated to reduce an extra amount of carbon emissions (400 tons) and to sell these credits to other districts. The area of region A in Fig. 1 (1) represents the revenue earned by District A. In contrast, District B intends to reduce its solid waste by 1000 tons. Figure 1 (2) shows that a domestic reduction of 1000 tons incurs a higher marginal abatement cost P' than tradable permit P*. Therefore, District B should reduce its emissions by 600 tons and purchase the remaining 400 tons from other districts (e.g., District A). District A reduces its waste generation to earn an extra refund, while District B reduces its waste production rate to save money. Consequently, the scheme induces the administration councils to encourage the public to reduce waste.

Hybrid anaerobic digestion system

Food waste possesses a bulk density and water content of 1.0 ton/m^3 and 80–85%, respectively, and it is mainly composed of biodegradable organic waste (Lim et al. 2012). Therefore, an alternative for food waste disposal is anaerobic digestion by certain groups of microorganisms that are widely applied for municipal organic-rich wastewater treatment (Chiu and Lo 2016). As increasing attention has been paid to biogas generation for energy recovery in anaerobic digestion (van Lier et al. 2001), anaerobic digestion that converts food waste into biogas has been developed and utilized as a mature energy technology throughout the world (Pham et al. 2015; Yang et al. 2013). This process, known as biomethanogenesis, occurs naturally in wetlands, rice fields, the intestines of animals,

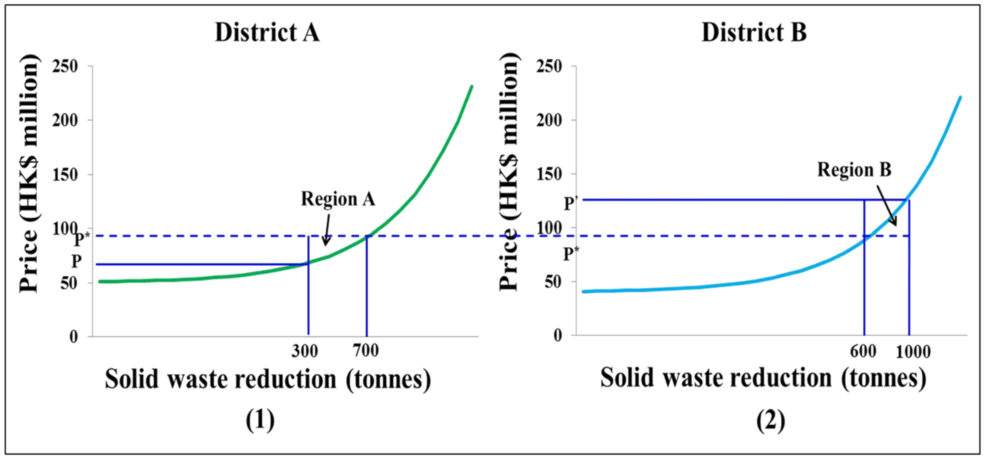

Fig. 1 Principle of waste trading scheme for solid waste reduction

manures, and aquatic sediments, and it is the major component in the carbon cycle in ecosystems (Farhat et al. 2018). In a traditional anaerobic digestion system (as shown in Fig. 2), a digester, which is an airtight chamber where manure, biosolids, food waste, other organic wastewater streams, or combinations of these feedstocks decompose, can be employed. Biogas (a blend of methane, carbon dioxide, digestate, etc.) can be generated in the process. However, anaerobic digestion is very time consuming and is mainly attributed to low methanogenesis (Hu et al. 2019). In addition, the anaerobic digestion of organic polymeric materials is a complex process. To improve process efficiency, a two-phase anaerobic digestion including a first reactor for acidification and a second reactor for methanogenesis has been studied (Li et al. 2010; Oliveira and Doelle 2015).

This paper proposed a novel lab-scale anaerobic digestion system for energy recovery. This system consists of an acidification reactor, followed by a methanogenic reactor, as shown in Fig. 3. Food waste digestion and biogas production are achieved by these two independent reactors. Fresh food waste is fed into the acidification reactor, and hydrolytic bacteria, fermenting bacteria, and acetogenic bacteria synergistically catalyze the hydrolysis reaction by extracellular hydrolytic enzymes (Hu et al. 2019). The resulting monomers after hydrolysis undergo fermentation either directly to acetate or through the pathway of volatile fatty acids and alcohols facilitated by the so-called secondary fermenters or obligate proton reducers. These bacteria convert their substrates into acetate, carbon dioxide, hydrogen, and formate, which are subsequently utilized by methanogenic bacteria/archaea. Methanogenesis

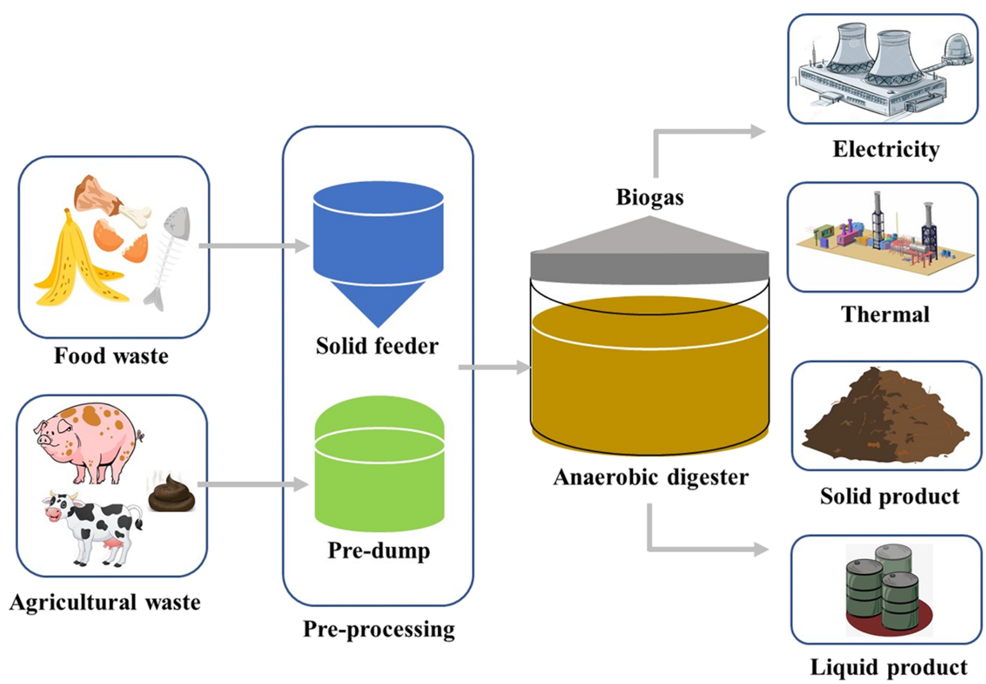

Fig. 2 The configuration of a typical anaerobic digester system

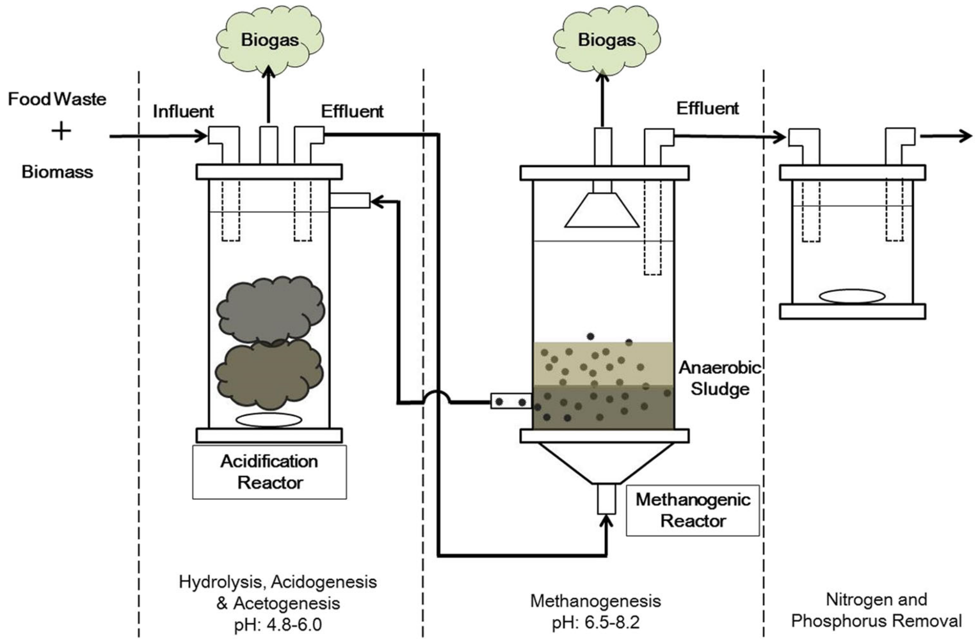

Fig. 3 Schematic diagram of the lab-scale anaerobic digestion system

can effectively proceed in a methanogenic reactor with a high solid retention time (SRT), where methanogenic bacteria/archaea can be dominant in the microbial community structures by controlling the reactor's operating parameters (e.g., pH and temperature). The waste sludge in the methanogenic reactor after thickening can be further treated for energy and nutrient recovery.

This system may be highly applicable for dealing with slurry-type food waste, such as residual fruits, vegetables, eggshell, and spoiled noodles. Since this system is used for the influent of the acidification reactor, food waste combined with water will be shredded into particles with an average size of 6 mm. To guarantee the efficiency of the acidification and methanogenesis process, some factors should be adjusted to a certain level, as shown in Table 2 (Usack et al. 2012). The final product, methane, as a clean energy, can substitute for traditional fossil fuels in terms of both heat and power generation (Hu et al. 2019; Loizia et al. 2019).

Comparison of the potential approaches for food waste disposal in HK

A successful approach to food waste disposal that is specific to HK depends on environmental burdens, costs, and time duration. Therefore, in this study, three criteria, including the construction and operation costs, time duration, and environmental burdens, are used to compare the different strategies for food waste disposal in HK. As shown in Table 3, incineration plants have a high remediation efficiency and can reduce more than 90% of the waste volume with a rapid reaction time. However, the generated byproducts, such as dioxins, from the incineration process are major drawbacks that could have

Table 2 Operation parameters for the anaerobic digestion system in this system (Usack et al. 2012)

Monitoring Parameters	Acidification reactor		Methanogenic reactor	
	Mesophilic	Thermophilic	Mesophilic	Thermophilic
pH	4.8–6	4.8–6	6.5–8.2	6.5–8.2
Loading rate (mg VS/L/day)	800–6400[a]	100–7500[a]	400–3200[b]	50–3750[b]
Solid retention time (days)	7–10	7–10	15–20	15–20
Temperature (°C)	25–40	50–65	25–40	50–65
COD (mg/L)	3500–5000	5000–6400	1600–1700[c]	1600–1700[c]
Carbon to Nitrogen ratio	20–30	20–30	–	–
Alkalinity (mg $CaCO_3$/L)	0	0	110–800	110–800

[a] Usack et al. 2012

[b] Loading rate of the proposed methanogenic reactor is deduced based on loading rate of the acidification reactor

[c] Hai-Lou et al. 2002

Table 3 Comparison of the potential approaches for the food waste management in HK

	Environmental burdens	Construction and operation costs	Time duration
Incineration plant	High impact	High	Low
Food waste recycling program	Low impact	Medium	Long
Optic bag system	Low impact	High	Medium
Black soldier fly bioconversion	Medium impact	Medium	Long
Food waste trading scheme	Low impact	Low	Long
Hybrid anaerobic digestion system	Medium impact	Medium	Medium

negative impacts when they are released into the environment. The food waste recycling program, optic bag system, and food waste trading scheme do not generate toxic byproducts. It should be noted that these technologies generally require additional costs. Therefore, the implementation of commercial operations related to these approaches for food waste disposal in HK will certainly be challenging. In addition, these approaches cannot immediately be applied for food waste disposal in HK due to the long operational and monitoring time. The hybrid anaerobic digestion system and black soldier fly bioconversion could potentially generate byproducts such as methane and carbon dioxide during the remediation process. Their major advantages are the relatively high treatment efficiency and low implementation costs. A promising approach to food waste disposal in HK could be a comprehensive treatment based on a combination of the hybrid anaerobic digestion system and black soldier fly bioconversion due to their low cost and relatively high treatment efficiency.

Discussion of the potential policies for helping food waste disposal

The HKEPD is currently charged with food waste management in HK, and the HKEPD should focus not only on environmental effects but also on long-term economic effects such as food waste recycling and power generation. In addition, the HKEPD committee members for each district should update environmental standards and implement laws and regulations under the guidance of the HKEPD. Moreover, non-governmental organizations (NGOs) play a significant role in food waste disposal. Most of the proposed food waste disposal strategies, such as the food waste recycling program and food waste trading scheme, need to be promoted to the public by NGOs. Meanwhile, NGOs could appeal to the public to spread awareness about the social acceptance of the techniques for food waste disposal that are suggested. In addition, NGOs can play a significant role in third-party auditing to achieve efficient food waste management and disposal. The implementation of the food waste program and the construction of infrastructure should be based on regular inspections by committee members provided by NGOs. Cooperation between the HKEPD and NGO auditors could be the most cost-effective approach against unexpected quality incidents.

Conclusion

HK is a densely populated city with very scarce land resources. Therefore, an efficient food waste disposal plan will play a significant role in good municipal administration. In HK, the MSW generated by households is collected on a daily basis and delivered to three strategic landfills located in the New Territories. Waste is also managed through legislation. For example, the Waste Disposal Ordinance enforces the control of waste collection and disposal. It is generally believed that the existing waste treatment facilities and policies are insufficient to address the food waste generated. First, the increased population in HK results in an increased amount of food waste disposed to landfills. Second, HK will exhaust its landfill capacity earlier than expected, and the new landfill will be exhausted by 2020 if the level of waste generated continues to increase. Thus, this paper proposes several environmentally friendly measures for controlling food waste. It is expected that the implementation of the optic bag system can encourage people in HK to implement food waste separation at the source. In addition, this paper discusses the potential application of the optic bag system with subsequent black soldier fly bioconversion. The implementation of these potential approaches for future food waste disposal can hopefully provide an effective method of food waste separation at the source and promote the sustainable use of food waste in HK. Furthermore, these approaches hold significant value not only for producing renewable energy (e.g., methane, compost, and electricity) but also for gaining extra profits.

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