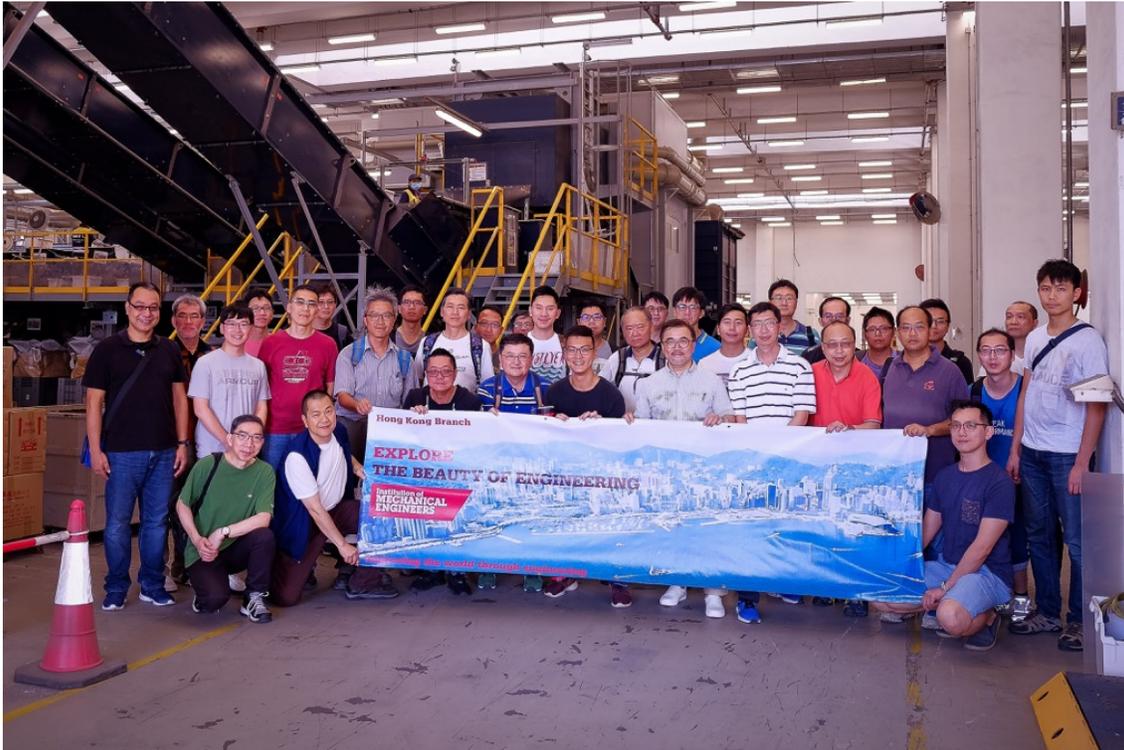


INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH
TECHNICAL VISIT TO WEEE-PARK ON 30/6/2018



Institution of Mechanical Engineers Hong Kong Branch visited WEEE-Park on 30/6/2018

Hong Kong produces 15,300 tonnes per day (tpd) of solid waste. About 67 %, or 10,345 tpd, is municipal solid waste (MSW), while 29 % and 4 % are construction waste and special waste, such as sludge produced in the sewage treatment process, respectively. Plastic and paper occupy total 40 % of the total MSW.

Although currently newspaper, office paper and carton boxes and Classes 1 and 2 plastic are permitted to import to China for recycle, it is not possible after 2022. In fact, half of the globally consumed plastic bottles are recycled in China, and Japan can handle only 20 % of the total amount, while the remaining 80 % is sent to China. The upcoming import ban of China has prompted the used plastic bottle exporting countries to handle their own used plastic bottles. The same has come into effect for the wasted electrical and electronic equipment (WEEE) which export to China has been banned. Export is no longer a solution for Hong Kong to deal with its wastes, including WEEE, and they must be duly treated locally.

In parallel, the government department responsible for waste management, Environmental Protection Department (EPD), has migrated its focus on MSW from disposal of to prevention from the source over the past two (2) decades, resulting in the introduction of the producer responsibility scheme (PRS) and WEEE treating facilities.

Groundwork for Waste Solutions

To enable Hong Kong to properly resolve its waste problem, the right waste management infrastructure must be in place to convert waste into resources. The conversion is possible only with the effective source separation, effective collection, proper separation and reuse or recycle outlet. Such coherent cycle is prerequisite for the conversion to become commercially viable and sustainable, and the viability and sustainability is facilitated by PRS, the “polluter pays” principle, whereby the manufacturer, importer, retailer, consumer and government share the eco-responsibility for the collection, treatment and disposal of the end-of-life product.

PRS was given its legal foundation with the enactment of Product Eco-Responsibility Ordinance (Hong Kong Law Chapter 603) (PERO) in July 2008. PERO is an “umbrella” legislation which provided the shared core elements of all PRS and the fundamental regulatory requirements in respect of the individual types of products, with operational details to be established in the legislation and its subsidiaries.

The first PRS introduced under PERO is on plastic bags, which has aimed at reducing the excessive use of plastic shopping bags through a direct economic disincentive. Phase 1 was enacted on 7/7/2010 and following the implementation of the amended legislation on 1/4/2015, which reduced 90 % of the plastic bag consumption and disposal before the enactment. Although the mandatory levy of 50 Hong Kong cent per plastic bag has successfully steered behavioural change in the use of plastic bags, it has been observed that the disposal of plastic bags has begun to increase according to the recent landfill surveys. To continue disincentivising the use of plastic bags, the levy is going to increase by 50 % higher to HK\$1 and the range of exemption will also be reduced. For instance, currently the issuance of plastic bags for containing the condensate formed on the chilled beverage containers is exempted from the levy. Soon, the exemption will be lifted and plastic bags for such application will be charged.

Waste Treatment “DIY”

The second phase of PRS governs WEEE. Hong Kong has generated more WEEE than before in light of the reduced retail price of the electrical appliances. For instance, the general retail price reduction of television sets by 90 % over the past ten years has incentivised more frequent replacement of the appliance. Out of the 70,000 tones of WEEE generated per year, 75 % is large household appliances which are air-conditioning units, refrigerators, television sets and washing machines. 10 % is computer products, and the remaining 15 % is small household appliances such as fans, cookers, toasters and alike.

Currently, the majority of WEEE in Hong Kong is treated by export to China and the less developed countries such as Cambodia and Vietnam in southeast Asia and Kenya in Africa. However, following the upcoming ban of importing WEEE of these countries, Hong Kong can no longer rely on export to dispose of WEEE, whereas it must treat it locally. The existing recycling industry in the territory, nevertheless, has remained in the low value chain by means of packing and exporting WEEE and is insufficient to meet the demand of treating WEEE properly and sustainably. The breakthrough has fallen on the shoulders of the government.

The public consultation on waste management in 2010 affirmed the development of a WEEE treatment and recycling facility and the introduction of a mandatory PRS for WEEE. Then in 2017, the subsidiary legislation was enacted that in effect of 1/8/2018, the following eight (8)

electrical and electronic appliances are classified Registered Electrical Equipment (REE) and are subject to a recycling levy according to their class:-

Class	Levy [HK\$]	Remark
Computer (desk-top, lap-top and tablet inclusive)	15	
Printer (30 kg in weight or less)	15	
Scanner (30 kg in weight or less)	15	
Monitor [between 5.5 inch (140 cm) and 100 inch (2,540 mm) in length]	45	
Air-conditioner (air-cooled and/or air-heated inclusive)	125	Mandatory Energy Efficiency Labelling Scheme applied
Washing machine (10 kg capacity or less)	125	ditto
Refrigerator (not exceeding 500 litres)	165	ditto
Television set [100 inch (2,540 mm) or less in length]	165	

Also, the subsidiary legislation will regulate REE by means of upstream and downstream control. The key regulatory measures are tabled below.

Effective Date and Scope	Stakeholder(s)	Mandatory Duties
1/8/2018: upstream control on the new REE products	Supplier (manufacturer and importer inclusive)	<ul style="list-style-type: none"> • Be registered with EPD • Submit return and audit report • Pay recycling levy for REE distributed in Hong Kong • Provide recycling label to the distributee
	Retailer	<ul style="list-style-type: none"> • Have an EPD-endorsed removal service plan • Arrange removal services as requested by the consumer free of charge and deliver the unwanted equipment to a licenced recycler • Provide recycling label and receipt with the prescribed wording to the consumer
31/12/2018: downstream control on the abandoned REE	Recycler	Obtain a waste disposal licence for the storage, treatment, reprocessing or recycling of the abandoned REE
	Importer and Exporter	Obtain permit for the abandoned REE import and export

	Government	Ban acceptance of the abandoned REE in the designated waste disposal facilities (e.g. refuse transfer stations) and landfill disposal of the abandoned REE
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In parallel, an open tender was called in September 2013 to design, build and operate (DBO) a WEEE treatment complex, as well as actively collect REE and provide free take-back services of WEEE for the retailers for ten (10) years. The contract was awarded to the ALBA-IWS joint venture in March 2015 for the approved project estimate and annual operational expenditure of HK\$548.6 million and HK\$200 million respectively. ALBA Group is a specialist of recovering waste to resources in Germany, while IWS, or Integrated Waste Solutions (Hong Kong) Ltd., is a local logistic company specialised in treating confidential documents. The contractor is paid by the weight of the abandoned REE processed.

After the ground-breaking ceremony held in January 2016, the three (3) hectares WEEE treatment complex in EcoPark in Tuen Mun Area 38 of New Territories, WEEE-Park, is fully commissioned in March 2018 with the treatment capacity of 30,000 tonnes per annum. The maximum capacity can reach 57,600 tonnes per annum. WEEE-Park features use of rainwater and solar energy, embedment green architecture to maximise the use of natural lighting and ventilation, 30 % of green coverage ratio and BEAM Plus Gold rating.

The objectives of WEEE-Park are to bring Hong Kong align with the overseas developments on WEEE management, construct a circular economy, aligns with the “polluter pays principle”, for promoting the recycling and proper disposal of WEEE, ensure the abandoned REE is properly treated and reduce the landfill burden. The difference of 40,000 tonnes per year between the annual WEEE generation and the WEEE-Park capacity of 70,000 tonnes per annum and 30,000 tonnes per annum respectively is pending the private sector to fill.

Engineer Wastes to Resources

As the government contractor, the ALBA-IWS joint venture establishes four (4) Regional Collection Centres in Sheung Shui and Kwai Chung of New Territories, Kwun Tong of Kowloon and Wong Chuk Hang on Hong Kong Island to collect WEEE directly. Alternatively, it receives WEEE from the Community Green Stations, which are operated by the non-government organisation to collect low value recyclables.



Upon arrival at WEEE-Park, WEEE is first screened for its class and condition. If the appliances can return to fully functional after refurbishment and they are the classes on the requested list for the under-privileged referred by the social worker, they are duly repaired

and tested by the experienced electricians in the Refurbishment Workshop before distributed to the families in need.



Buffer Storage in WEEE-Park

The WEEE collected which is not given a second life is then stored in the Buffer Storage according to its class, pending process. It is tagged for identification in the treatment process and its image is taken for EPD record.

According to the class, WEEE is processed in one of the following process lines for the eventual recovery of aluminium, copper, iron and plastics:-

Process Line	Process Class(es)
1	Refrigerator
2	Air-conditioning unit
3	Computer, washing machine and other WEEE
4	Television sets and monitors

Process Line 1: Refrigerator

The abandoned refrigerators first have their cables, plugs and other fittings removed, and then have their refrigerant extracted. The refrigerant can be in the form of chlorofluorocarbons (CFC), hydro-chlorofluorocarbons (HCFC) and volatile organic compounds (VOC), which are harmful to the ozone layer and flammable. In spite of the refrigerant type is unknown in the recovery, the refrigerant is duly collected, stored in dedicated gas cylinders and sent to Chemical Waste Treatment Centre of EPD on Tsing Yi Island of New Territories (CWTC) for the proper disposal.

After the recovery of the refrigerant, the compressor is removed using a hydraulic cutter. The lubricating oil in the reception tank in the removed compressor is drained and the recovered lubricating oil is sent to CWTC for the proper disposal.

The remaining casing is then shedded into mixed pallets of various materials. Since the casing is often wrapped by the flammable VOC-made foam-type insulation, to avoid fire, the shedding process is purged by nitrogen to suppress ignition.

The shedded casing contains a mix of aluminium, copper, iron and plastics. The pallets first undergo magnetic sorting whereby the ferrous metals are extracted. Second is density sorting, whereby air jets blow the mixed pallets to travel upwards along a zig-sag separator, and the non-ferrous copper and aluminium and plastics of higher density are collected at the lower elevation of the air jets. They are further sorted by passing eddy current, whereby the conductive copper and aluminium are temporarily magnetised by the electromagnetic field generated by the eddy current and separated from the non-conductive plastics.

In density sorting, the polyurethane (PUR) foam of the lowest density is blown to the top of air current and is channelled to the final stage of treatment. Since the PUR foam used as insulation in the refrigerators contains refrigerants which require extraction, the PUR foam undergoes de-gassing whereby, with the help of the injection of steam generated diesel-fired steam generator, the refrigerants are extracted from the PUR foam and, after cooling, are collected and temporarily stored in the dedicated cylinders. Same as Process Line 1, the collected refrigerants are sent to CWTC for proper disposal.

The de-gassed and purified PUR foam is compressed into cubes. Given the PUR foam contains calorific value and is combustible, the cubes have the potential for cement production as fuel.

Process Line 2: Air-conditioning Unit



Sorted aluminium at the end of the process

Upon arrival, the cables, plugs and covering panels are removed for recycling or further treatments. Same as the refrigerators, the air-conditioning units have their refrigerants such as CFC, HCFC and VOC, recovered for proper disposal. The compressor lubricating oil is drained and the compressors are removed. After the capacitors are removed, the remainders are then transferred to Process Line 3 for further material sorting.

Process Line 3: Electrical Scraps

Computers and washing machines first have their detachable parts and components, such as circuit boards, rechargeable batteries, drain hoses, glass doors and stabilising concrete blocks, salvaged manually. Then joined by the processed air-conditioning units transferred from Process Line 2 and the detoxified television sets and monitors transferred from Process Line 4, the appliances are shredded and milled into pallets of 150 mm in size or less to facilitate sorting.

The pallets first pass through magnetic sorting to extract the ferrous metals. The remainder pallets are then manually sorted, whereby easily identifiable materials such as large pieces of metal, plastics and cables are collected and separated from the conveyor belt.

The manually sorted mixture of metal and plastic pallets then passes through an electromagnetic metal sensor. Upon the detection of metal, the sensor triggers an air blast to carry the non-ferrous metal such as aluminium and copper, separating metal from the assorted plastic. Leveraging the near-infrared technology, the remaining mixed plastic pallets are eventually identified and sorted.

The mixed non-ferrous metal and plastic residues then pass through an eddy current. The conductive non-ferrous copper and aluminium are temporarily magnetised by the

electromagnetic field generated by the eddy current and separated from the non-conductive plastics.

The mixed non-ferrous metals in various sizes, free of residual plastics, are sorted by their size. After passing the rounding mill, they pass through three (3) layers of vibrating mesh panels and the sizes of over 8 mm, between 4 mm and 8 mm and below 4 mm are filtered and separately extracted.

Finally, the mixed non-ferrous metal residues in similar sizes are discharged onto the air floatation table, where the copper pallets are separated from the aluminium pallets due to the difference in density.

Process Line 4A: Cathode Ray Tube Monitors

Cathode ray tube (CRT) type television sets contain lead in the funnel glass and fluorescent powder on the inner side of the glass panel. Lead, for blocking radiation, is poisonous to the human health in terms of damage to the brain development and nerve system of young children, kidneys, circulatory system and respiratory system, while the fluorescent powder may cause kidney damage and osteoporosis if inhaled.

The cases, cables and plugs, circuit boards, capacitors and speakers are first removed for recycling or further treatment. Next the glass panels and the funnel glasses are separated using hot wires. The lead-contained funnel glasses are transferred to dedicated facilities where they are treated in an environmentally-sound manner. Afterwards, a vacuum tube extracts the fluorescent powder from the glass panels and transfers the extracted powder to the collection barrels.

The detoxified television sets are sent to Process Line 3 for further material sorting.

Process Line 4B: Flat Screen Displays

Modern flat screen monitors, such as liquid crystal displays, contain mercury in the fluorescent lamps behind the screen. Mercury is highly toxic and poisonous to the human health.

Same as Process Line 4A, the detachable accessories are first removed for recycling or further treatment. Then the flat screen monitors are sent to a robot arm station to have their screen cut automatically. The mercury-containing fluorescent lamps are exposed and accessible for manual



Flat screen displayed under manual handling for dismantlement

removal. They are disposed of properly in CWTC. The remainder of the monitors is transferred to Process Line 3 for further dismantling.

Remarks

Affluent cities like Hong Kong inevitably generate much WEEE, of which responsible and proper disposal is essential for sustainability. Championed by EPD, Hong Kong has leveraged engineering and technologies offered by the private sector to process its own WEEE to the least practical impact to the environment in a commercially viable way. The residents of Hong Kong can be rest assured that their WEEE will not be causing harm to the environment at home and abroad, whereas be transformed into useful resources for the benefit of the society. As the WEEE treatment processes are built on the fundamentals of mechanical engineering and their applications, WEEE-Park is yet another show-case of mechanical engineering solutions can bring Hong Kong to become a more eco-friendly and sustainable city, of which all Institution of Mechanical Engineers (IMEchE) members in Hong Kong can be proud.



The activity convener, Mr. Jimmy Lee, presented a certificate of appreciation to Dr. Alain Lam, Environmental Protection Department Principle Environmental Protection Officer, in recognition of his offer of the activity.

IMEchE Hong Kong Branch thanks Dr. Alain Lam, EPD Principal Environmental Protection Officer, for his detailed explanation and facilitation of the WEEE-Park tour on 30/6/2018.

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