LC Paper No. CB(1)336/14-15(07)

Legislative Council

of the

Hong Kong Special Administrative Region

Delegation of the Panel on Environmental Affairs

Report on the duty visit to the United Kingdom, the Netherlands, Denmark and Sweden to study these countries' experience on thermal waste treatment facilities

2 to 8 March 2014

TABLE OF CONTENTS

Chapter 1 — Introduction

1.1 Purpose of the report

1.1.1 A delegation of the Panel on Environmental Affairs ("the Panel") of the Legislative Council visited the United Kingdom ("the UK"), the Netherlands, Denmark and Sweden from 2 to 8 March 2014 to study these countries' experience on the development and operation of thermal waste treatment facilities. This report presents the main findings and observations of the delegation.

1.2 Background of the visit

1.2.1 To tackle Hong Kong's imminent waste challenge, the Environment Bureau released the "Hong Kong Blueprint for Sustainable Use of Resources 2013-2022" ("the Action Blueprint") on 20 May 2013. The Action Blueprint maps out a waste management strategy, with targets, policies and action plans for the coming 10 years. It has set a target to reduce Hong Kong's per capita disposal rate of municipal solid waste ("MSW") by 40% by 2022.

1.2.2 The Action Blueprint also sets out the goal of transforming Hong Kong's waste management structure to 55% recycling, 23% incineration and 22% landfilling by 2022. The integrated waste management facilities ("IWMF") Phase 1, which can significantly reduce the volume of 3 000 tonnes MSW each day, is an essential infrastructure set out in the Action Blueprint for achieving this transformation. It is an essential tool to help Hong Kong reduce reliance on landfills.

1.2.3 At its meeting on 16 December 2013, the Panel was advised that the Administration planned to visit Europe, including the UK, the Netherlands, Denmark and Sweden in early March 2014 to keep abreast of the latest development and operation of the following thermal waste treatment technologies –

(a) Moving-grate incineration technology;

(b) Plasma gasification technology; and

(c) Gasification and Pyrolysis technologies.

1.2.4 As the relevant knowledge and updates could benefit the planning for waste management in Hong Kong beyond 2022, the Administration invited the Panel to consider whether to conduct a similar visit.

1.2.5 Taking into consideration the importance of IWMF in the Administration's waste management strategy and in achieving the goal of transforming Hong Kong's waste management structure by 2022, the Panel agreed to undertake a duty visit from 2 to 8 March 2014 to the four countries to obtain first-hand information on their experience in planning and operating thermal waste treatment facilities, so as to enable members to grasp the latest development on the subject and facilitate their deliberations on the issues concerned in examining the waste management infrastructure projects to be proposed by the Administration.

1.2.6 On 24 January 2014, the Panel obtained the House Committee's permission to undertake the duty visit.

1.3 Objectives of the visit

1.3.1 The duty visit aimed to study the following areas –

(a) the development of mainstream incineration technology in Europe over the past decades, in terms of technology reliability, emission control, environmental impacts, public acceptance, etc;

(b) the advantages and disadvantages of the above thermal waste treatment technologies and their potential of application in Hong Kong;

(c) the four countries' policies and measures on waste management and their experience in developing waste management infrastructure as well as their plans for the future;

(d) the response of non-governmental organizations and the public to waste treatment facilities, with focus on thermal waste treatment facilities; and

(e) the latest development and experience of alternative MSW treatment technologies and their potential of application in Hong Kong in future.

1.4 Membership of the delegation

1.4.1 The delegation comprised the following nine members –

Panel members

Hon Cyd HO Sau-lan, JP
(Chairman of the Panel for the 2013-2014 session and leader of the delegation)
Hon James TO Kun-sun
Hon WONG Ting-kwong, SBS, JP
Hon Kenneth LEUNG
(only joined the UK, the Netherlands and Denmark legs)
Hon Dennis KWOK
(only joined the UK and the Netherlands legs)
Dr Hon Elizabeth QUAT, JP
Ir Dr Hon LO Wai-kwok, BBS, MH, JP

Non-Panel members

Hon Paul TSE Wai-chun, JP
Hon TANG Ka-piu, JP

1.4.2 Ms Miranda HON, Clerk to the Panel, Miss Lilian MOK, Senior Council Secretary, and Ms Shirley TAM, Council Secretary (Information Service), accompanied the delegation on the visit.

1.5 Visit programme

1.5.1 The visit programme of the delegation commenced on 2 March 2014 and ended on 7 March 2014. The delegation departed for Hong Kong on 7 March 2014. The Panel delegation had the same visit programme as the delegation of the Hong Kong Government. The detailed visit programme and a list of the organizations and persons met by the delegation are in **Appendices I and II** respectively. The list of the Hong Kong Government delegation is in **Appendix III**.

Chapter 2 — Thermal waste treatment in the European Union

2.1 Overview

2.1.1 In Europe, the restriction of constructing new landfill sites by the European Union ("EU") and the implementation of EU's *Landfill Directive*[1] in 1999 have expedited the enactment of environmental legislation and the development of thermal waste treatment technologies. Some European countries have adopted different thermal waste treatment technologies as part of their waste management strategies to reduce the volume of waste delivered to landfills and recover energy, mineral and/or chemical content from waste.

2.2 Thermal waste treatment technologies

2.2.1 Thermal waste treatment is a term given to any waste treatment technology that involves high temperature in the processing of waste feedstock. It includes incineration and other treatments, such as Advanced Thermal Treatments ("ATT") which principally include pyrolysis, gasification and plasma gasification. The general objectives of adopting thermal waste treatment are to –

(a) reduce the bulk size of waste requiring final disposal at landfills;

(b) turn waste into energy;

(c) stabilize waste to reduce the potential environmental impacts arising from its final disposal; and

(d) sanitize waste to reduce hygiene hazard.

Incineration

2.2.2 Incineration is a thermal waste treatment technology used to reduce the volume of waste requiring final disposal. It can reduce the waste volume by over 90% and is one of the widely used technologies for treating MSW. Most modern incineration plants incorporate heat recovery as well as power generation facilities to recover energy from waste.

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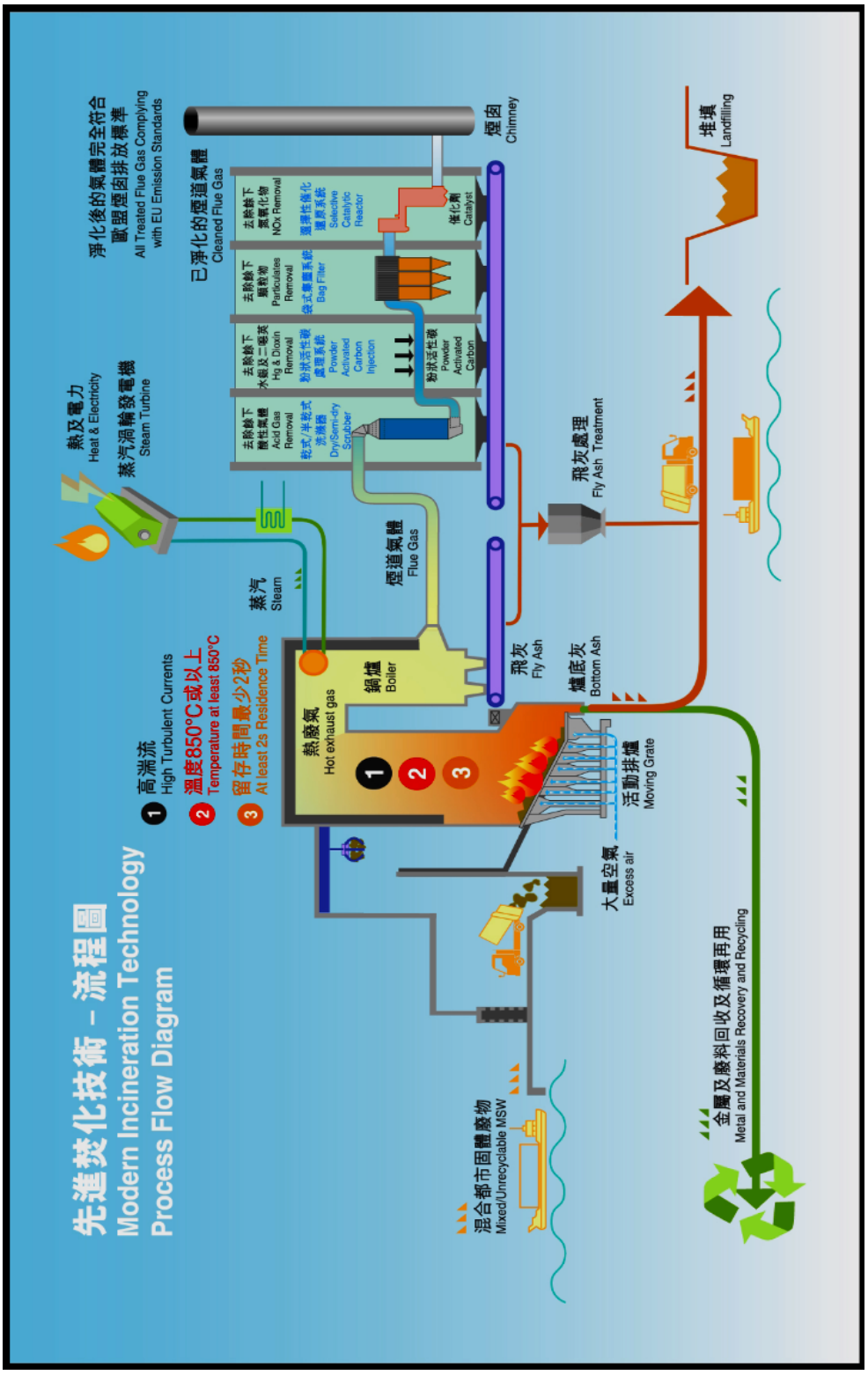
[1] Under the amended Council Directive 1999/31/EC of 26 April 1999, for example, all EU member states are required to reduce the total amount of biodegradable municipal waste sent to landfills to 75% of the quantity generated in 1995 by 2006, 50% by 2009 and 35% by 2016. The target aims to achieve the progressive diversion of biodegradable municipal waste from landfills.

2.2.3 The modern incineration process is shown below –



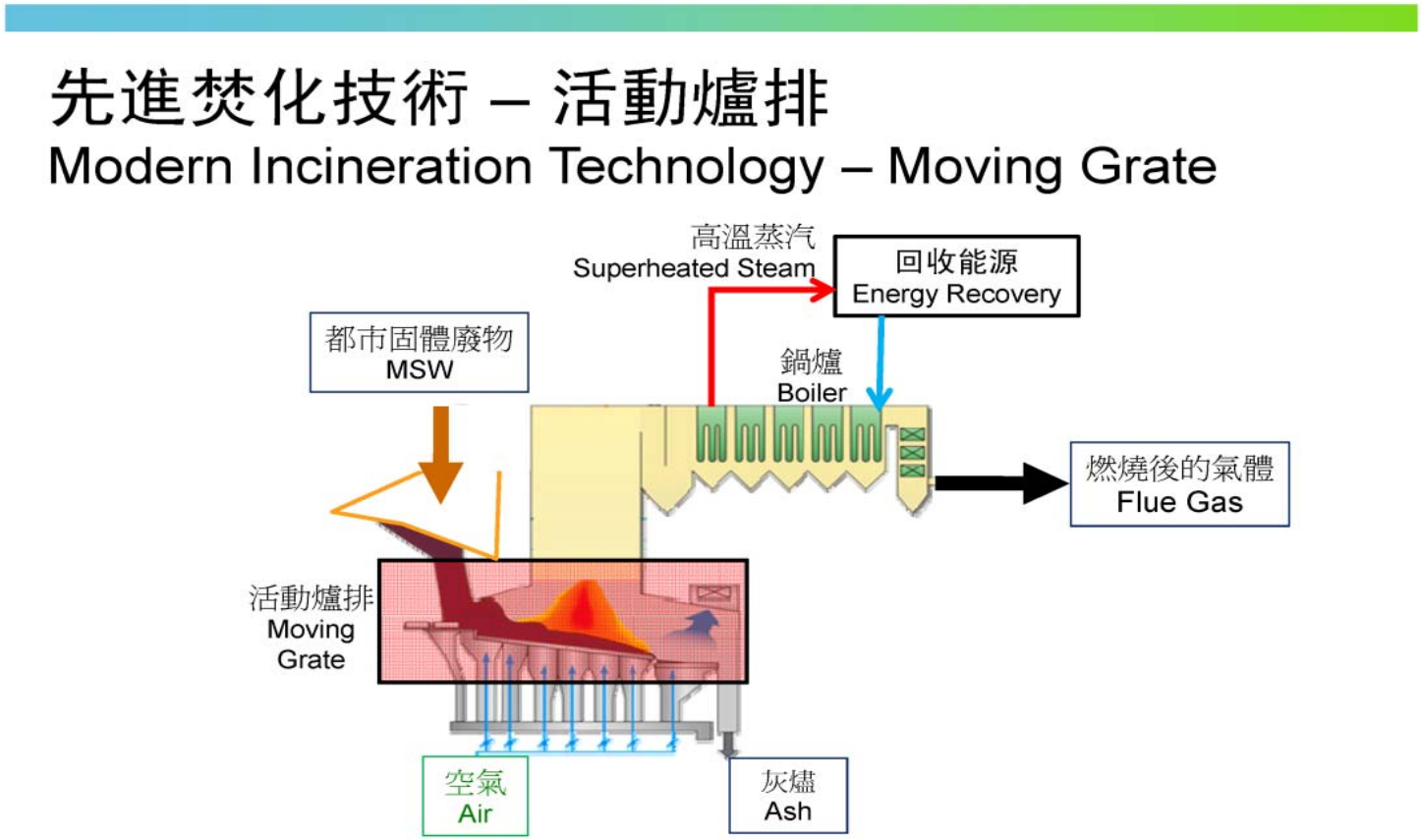
Source: Environmental Protection Department

2.2.4 Incineration usually involves the combustion of raw residual waste in a specially designed furnace at high temperature of over 850°C for more than two seconds with sufficient supply of air so as to ensure complete burning of waste and prevent the formation of dioxins and carbon monoxide ("CO"). When waste is burnt, the heat from the combustion process can be used to produce high pressure steam in a boiler, which is used to generate electricity via a steam turbine and/or used for heating purpose. The exhaust gas, or flue gas, from the boiler is first cleaned for eradication of pollutants before going into the atmosphere.

2.2.5 The ash residues from incineration generally include bottom ash from a furnace and fly ash from exhaust gas cleaning units. The bottom ash is either reused as construction material or disposed of at landfills. Fly ash is typically stabilized and solidified by reagents (e.g. cement) and disposed of at dedicated landfills with continuous environmental monitoring.

Moving-grate incineration technology

2.2.6 The moving-grate incineration technology is commonly adopted by incineration plants for waste management. Most MSW incinerators that adopt moving-grate design accept feeding of mixed MSW into a furnace without pre-processing. The furnace is equipped with an inclined moving grate system which keeps the waste moving through the furnace during the combustion process. Modern incinerators adopt advanced process control to optimize waste combustion at a temperature over 850^{o}C with long residence time and high turbulence so as to ensure complete destruction of organic pollutants.



Source: Environmental Protection Department

Moving-grate incineration technology

Advanced Thermal Treatments

2.2.7 ATT primarily comprises pyrolysis, gasification and plasma gasification. Unlike incineration, ATT technologies require pre-processing to remove oversize items, non-combustible materials (such as metals and glass) and excess moisture. The waste is then shredded to ensure that it will degrade evenly during the treatment process. The pre-treatment is commonly conducted by Mechanical Biological Treatment processes with the production of Refuse Derived Fuels. Refuse Derived Fuels are then used as the feeding stock for gasification, pyrolysis or plasma gasification.

2.2.8 ATT creates a mixture of products from the thermal step, which have a lot of chemical energy stored in them (e.g. gases and oils). These products can be burnt and used to raise steam. They also have the potential to be cleaned and burnt directly in gas engines or gas turbines, or converted to transport fuels or synthetic natural gas. The latter routes can convert the energy from waste more efficiently. However, ATT is technically difficult and some of the generated energy is used to power the process, thus reducing the overall benefits. The pollution control strategies for ATT are usually on a smaller scale due to the reduction in the volume of process air required.

Pyrolysis

2.2.9 Pyrolysis is commonly used in the chemical industry (e.g. to produce charcoal, activated carbon and methanol from wood). It thermally degrades the waste in the absence of air or oxygen to produce pyrolysis oil, char and syngas. An external source of heat is required to drive the pyrolysis reactions which occur at temperature range of 400^{o}C to 800^{o}C. The oil produced can be used directly in fuel applications and solid char may be used as a solid fuel, carbon black or upgraded to activated carbon.

Gasification

2.2.10 Gasification takes place at high temperatures (typically 600^{o}C to 1 400^{o}C) in an oxygen deficient environment, where combustion cannot occur. The carbon content in the material is converted into syngas comprising CO, hydrogen and methane, and various hydrocarbons.

Syngas can be combusted in a boiler and steam turbine system to generate electricity. The syngas can also be cleaned to remove particulates, hydrocarbons, and soluble matter before being used in gas engines to generate electricity or heat, or it can be further processed into fuels for use in vehicles and aeroplanes or chemical feedstock for producing plastics.

2.2.11 In Europe, the development of gasification technology is in its infancy as the technology tends to have higher operating and capital costs in comparison with incineration facilities, given the requirement for waste pre-processing and the added complexity of the technology.

Plasma gasification

2.2.12 Plasma gasification is the application of a high temperature plasma arc under an oxygen-starved environment to break down waste to produce syngas for energy recovery. The operating temperature of plasma gasification can be as high as 5 000^{o}C to 7 000^{o}C. At these temperatures, waste is broken into basic elemental components in a gaseous form (i.e. syngas) and inorganic residues are transformed into a vitrified slag.

2.2.13 Plasma gasification is mainly adopted for treating industrial and special wastes such as ash, contaminated soils, military waste, used activated carbon or radioactive wastes. Application for MSW is rare and mainly limited to Refuse Derived Fuels treatment. The primary reason appears to be the high capital and operational costs for adopting the technology. Since plasma gasification requires significant amount of energy input, the overall energy recovery rate tends to be low.

2.3 European Union legislative framework on thermal waste treatment

2.3.1 Thermal treatment of waste is covered by the *Industrial Emission Directive*, which is issued by EU to recast the *Waste Incineration Directive* and six other Directives related to industrial emissions in a single directive. The *Industrial Emission Directive* aims to reduce emission into air, soil, water and land and prevent the generation

of waste, thereby achieving a high level of protection of the environment taken as a whole.

2.3.2 To minimize pollution from industrial sources, the *Industrial Emission Directive* defines the obligations to be met by industrial activities with major pollution potential[2], including waste incineration. The *Industrial Emission Directive* also requires the establishment of a Europe-wide register, namely, the European Pollutant Release and Transfer Register, to provide the public with detailed information on the emissions from waste incineration plants and other industrial facilities across EU. The register adds transparency to waste incineration activities and enhances public participation in environmental decision-making.

2.3.3 There are also specific requirements in the *Industrial Emission Directive* governing waste incineration, including the scope of regulated facilities, permit applications and conditions, operating conditions, control and monitoring of emissions, delivery and reception of waste, residues, and reporting and public information.

2.3.4 The *Industrial Emission Directive* applies to waste incineration plants and waste co-incineration plants which incinerate or co-incinerate solid or liquid waste. For pyrolysis or gasification plants, they will be exempted if the gases resulting from the thermal treatment of waste are purified to such an extent that they are no longer a waste prior to their incineration and they can cause emissions no higher than those resulting from the burning of natural gas.

[2] The list of industrial activities covered under the *Industrial Emission Directive* includes waste management, energy industries, production and processing of metals, mineral industry, chemical industry, and rearing of animals.

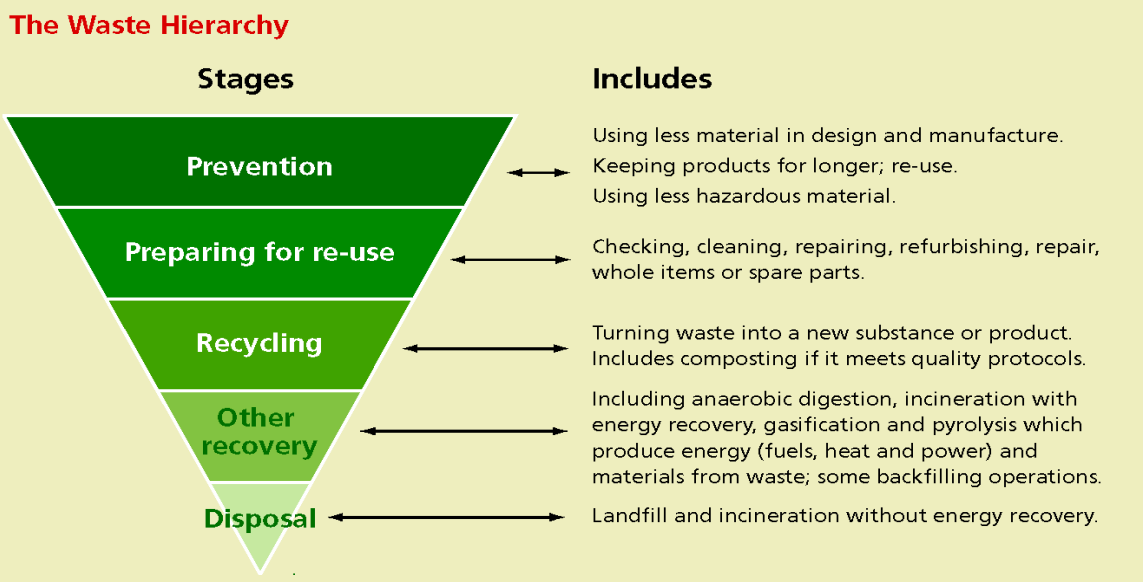
Chapter 3 — Waste management in the United Kingdom

3.1 Overview of the waste management policies in the United Kingdom

3.1.1 In the UK, a vast majority of MSW was handled by landfilling in the last century due to its low handling cost. This situation started to change in the 1990s when EU imposed a number of obligatory requirements on its member states to reduce their reliance on landfilling. The UK saw a marked reduction in the proportion of MSW sent to landfills from 86% in 1996 to 49% in 2011. Over the same period, the proportion of recycling/composting increased from 7% to 39%, and that of incineration rose from 7% to 12%.

3.1.2 The Department for Environment, Food and Rural Affairs ("Defra") is an UK Government department responsible for formulating policy and regulations on areas such as environmental, food and rural issues. Defra administers the environmental policy in England through the Environment Agency, a non-departmental public body.

3.1.3 In the UK, waste management is primarily governed by EU's *Waste Framework Directive*. The waste hierarchy introduced in *Waste Framework Directive* is the main policy framework for UK's waste management. The hierarchy as shown below gives top priority to waste prevention, followed by reuse, recycling, other types of recovery (including energy recovery), and last of all disposal (e.g. landfill).



Source: Defra

3.1.4 The UK Government uses various instruments to stimulate prevention and recycling. These include financial instruments (e.g. landfill tax), promotion of high quality recycling (e.g. mandatory separate collection of waste such as waste paper, metal, plastic and glass from 2015 onwards), separate collection of bio-waste with a view to composting and digesting bio-waste, and reuse and repair policies alongside the development of the Waste Prevention Programme formulated by Defra.

3.1.5 The landfill tax was implemented in the UK in 1996 and was levied at £7 (about HK$85) for active waste (mainly biodegradable) and £2 (about HK$24) for inert waste[3]. The subsequent implementation of the EU's *Landfill Directive* in 1999 also requires all EU member states, including the UK, to reduce the use of landfill and develop alternative disposal methods. The targets for the UK are to reduce the biodegradable MSW going to landfill to 75% of the amount generated in 1995 by 2010, 50% by 2013 and 35% by 2020. The first two targets have been met accordingly. The *Landfill Directive* has set the stage for the implementation for Landfill Allowances Trading Scheme and the escalation of landfill tax. The UK Government increased the landfill tax for active waste in 1999 to drive the diversion of waste from landfilling. The level of such tax has been on the increase since then. The landfill tax was set at £72 (HK$873) per tonne of active waste in 2013/14 and raised by £8 per annum, to £80 by 2014/15. The escalation of landfill tax has given a strong economic incentive to divert biodegradable waste from landfill, resulting in a substantial reduction of the use of landfilling for processing MSW. To date, the landfill tax remains the key driver to divert waste from landfills.

Waste prevention, reuse and recycling

3.1.6 The UK Government is committed to moving towards a "zero waste economy" in which material resources are reused, recycled or recovered wherever possible, and only disposed of as the option of very last resort. Defra has published the Waste Prevention Programme for England to encourage the business sector and individuals to contribute to

[3] The amount of tax is calculated according to the weight of the material disposed of and whether it is active or inactive waste.

a more sustainable economy by reducing waste as well as reusing and recycling products.

Producer responsibility schemes and voluntary responsibility deals

3.1.7 In the UK, there is a range of statutory producer responsibility schemes covering waste electrical and electronic equipment, vehicles, batteries and packaging. These schemes aim to ensure that those who make products are responsible for the costs of dealing with their products in an environmentally sound manner once the products have reached the end of their life.

3.1.8 The UK Government is also working closely with the business sector to develop new voluntary responsibility deals under which businesses will take responsibility for ensuring that a proportion of the products they produce are recycled, thereby reducing waste.

Mandatory charge for single-use plastic carrier bags

3.1.9 To reduce the use of plastic bags, a five-pence mandatory charge on all single-use plastic carrier bags will be introduced in England in October 2015. It is expected that the charge will reduce the number of plastic bags used in England and increase their reuse.

Thermal waste treatment

3.1.10 Since the implementation of EU's *Landfill Directive* and the increase in landfill costs, there has been a wider application of waste incineration in the UK. It is the UK Government policy that efficiently recovering energy from residual waste has a valuable role to play in both diverting waste from landfill and in energy generation. When selecting thermal waste treatment technologies, carbon emission will be considered in terms of the composition of the residual waste stream, the type of energy produced (heat and/or power) and the overall generating efficiency of the facility.

3.1.11 There are over 50 waste-to-energy plants in the UK and incineration is the most common thermal waste treatment method adopted. In 2011, incineration accounted for about 3.8 million tonnes or 12% of MSW treated in the UK. However, the figure is still lagging behind its European neighbouring countries such as Denmark, Sweden and the Netherlands.

Emission control and monitoring

3.1.12 In the UK, all waste incineration plants must comply with the *Waste Incineration Directive 2000*[4] which sets the most stringent emissions controls for any thermal processes regulated in the EU. The plants are also governed by the *Industrial Emission Directive* which specifies strict requirements for the operation of an incineration plant area. The enforcement of the *Industrial Emission Directive* is undertaken by the Environment Agency through the Environmental Permitting regime.

Environmental impact assessment and licensing

3.1.13 Under the Environmental Permitting Regulations, all commercial-scale incineration facilities require a permit issued by the Environment Agency. Permits will only be issued if the plant concerned will be operated in an environmentally friendly way and meet all legal requirements. The process of obtaining the permit is an initial step in an on-going management process for the delivery of the requirements of the permit and ensuring the compliance and use of Best Available Techniques.

Power and heat export

3.1.14 The use of thermal waste treatments allows the recovery of energy from waste in the form of electricity and/or heat. In the UK, many treatment plants produce electricity as it can be easily distributed and sold via the national grid. In contrast, there are few facilities solely producing heat as the users need to be local to the facilities and a dedicated distribution system/network is required.

[4] Directive 2000/76/EC on the Incineration of Waste.

Gate fees

3.1.15 The gate fees charged by different waste-to-energy facilities vary substantially in the UK. The factors which determine specific gate fees at a facility are complex, ranging from the size of a facility, the nature and duration of contracts, financing arrangements, the age of the facility, the level of revenues generated from the sale of recovered materials and other outputs (such as energy and compost), and charges for the management of process residues. Notwithstanding these variations, according to the UK Waste & Resources Action Programme's Gate Fees Report 2012, the cost of disposal to landfill (including the landfill tax) continues to increase. Non-hazardous landfill gate fees (including the landfill tax) remain broadly comparable to gate fees charged by waste-to-energy facilities.

3.1.16 The median gate fees charged by the thermal waste treatment facilities in the UK in 2011 are as follows, showing that the gate fees charged by newer facilities are generally more expensive than those of existing older facilities due to the fact that newer plants are facing higher construction, financing and operating costs –

Pre-2000 facilities	£64 per tonne (£32 – £75 range)
Post-2000 facilities	£82 per tonne (£44 – £101 range)

Renewables Obligation

3.1.17 The UK Government introduced the Renewables Obligation ("RO") in 2002 to provide incentives for the deployment of large-scale renewable electricity in the country. RO requires licensed electricity suppliers in the UK to source a specified proportion of the electricity they provide to customers from eligible renewable sources. This proportion which is known as the "obligation" is set each year and has increased annually. Under RO, eligible renewable electricity generators are required to report the amount of renewable electricity they generate on a monthly basis to the Office of the Gas and Electricity Markets ("Ofgem"). Ofgem will issue Renewables Obligation Certificates ("ROCs") to electricity generators according to the amount of eligible renewable electricity they generate. Electricity generators can sell their ROCs to suppliers or traders, which allows them to receive a premium in addition

to the wholesale electricity price. Suppliers then present the ROCs purchased from electricity generators to Ofgem to demonstrate their compliance with RO. Suppliers who do not present enough ROCs to meet their obligation must pay a penalty (known as the "buy-out price"). The money Ofgem collects in the buy-out and late payment funds is re-distributed on a pro-rata basis to suppliers who presented ROCs. As such, ROCs themselves have a market value that can add significantly to the income of electricity supplier. The electricity generated from the biomass (renewable) fraction of waste in an incineration plant provides an important additional revenue stream for the plant.

3.2 Visit to Advanced Plasma Power ("APP")'s pilot plasma gasification plant in Swindon

3.2.1 To better understand the application of ATT technologies for waste treatment in the UK, the delegation visited APP's pilot plasma gasification plant in Swindon. Established in 2005, APP is a UK-based waste-to-energy and fuels technology provider which is committed to maximizing the value derived from waste as an energy and materials resource while minimizing its impact on the environment. APP has developed the Gasplasma® technology which is an internationally-patented technology that converts waste and/or the outputs from any waste gasification process into the two products below –

(a) a clean, hydrogen-rich synthesis gas (i.e. syngas), which can be used to generate electricity and converted into substitute natural gas, hydrogen or liquid fuels; and

(b) a strong, inert product called Plasmarok® which can be used as a construction material.

Plasmarok®

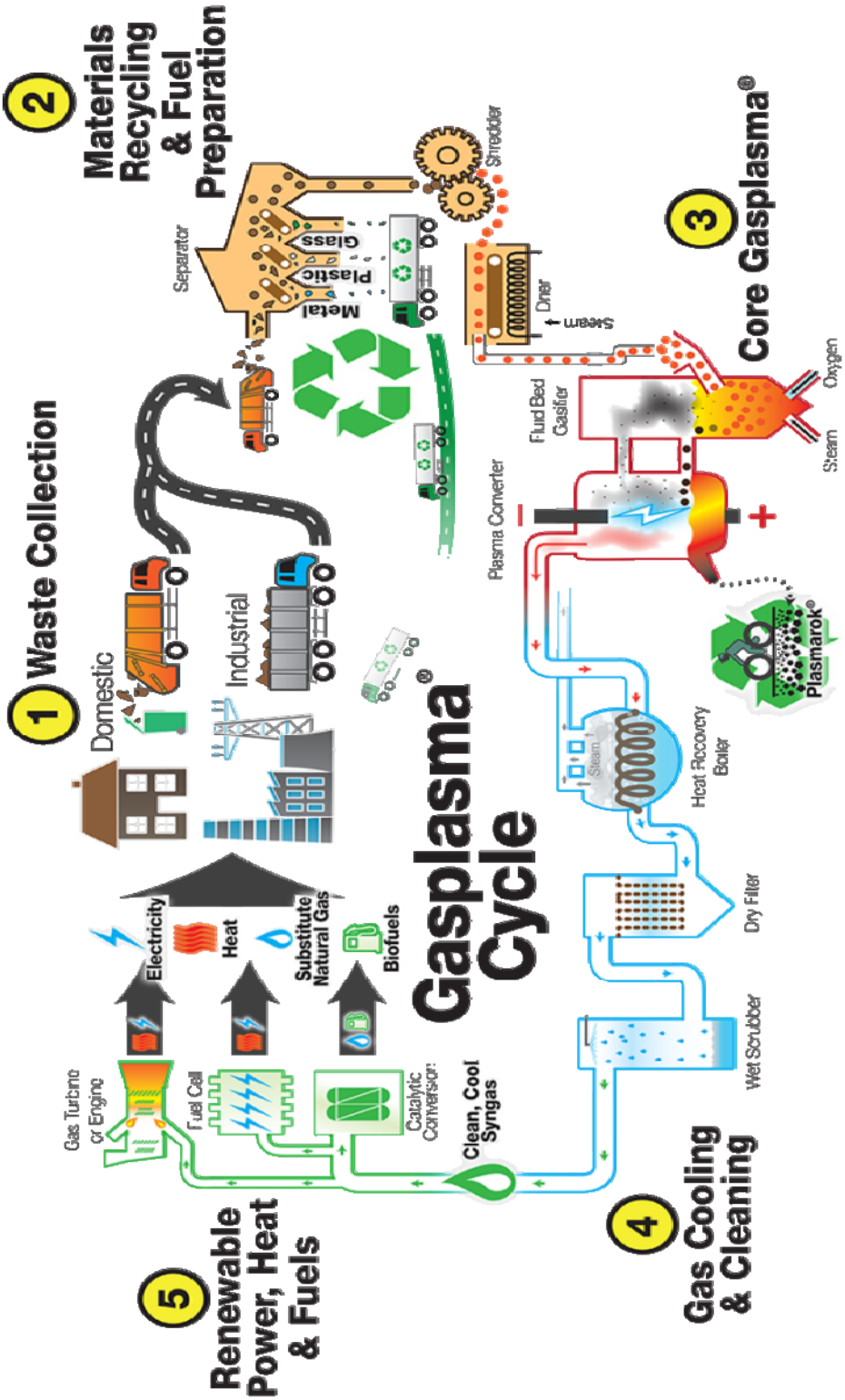
3.2.2 The benefits and potential of the Gasplasma® technology are being demonstrated by APP at a pilot plasma gasification plant located in Swindon. The plant has been in operation since 2008 with a capacity of about two tonnes of waste per day. It functions as a test plant for its clients to test their pre-sorted waste feedstocks or Refuse Derived Fuels and provides detailed analysis of the test output.

APP's pilot plasma gasification plant

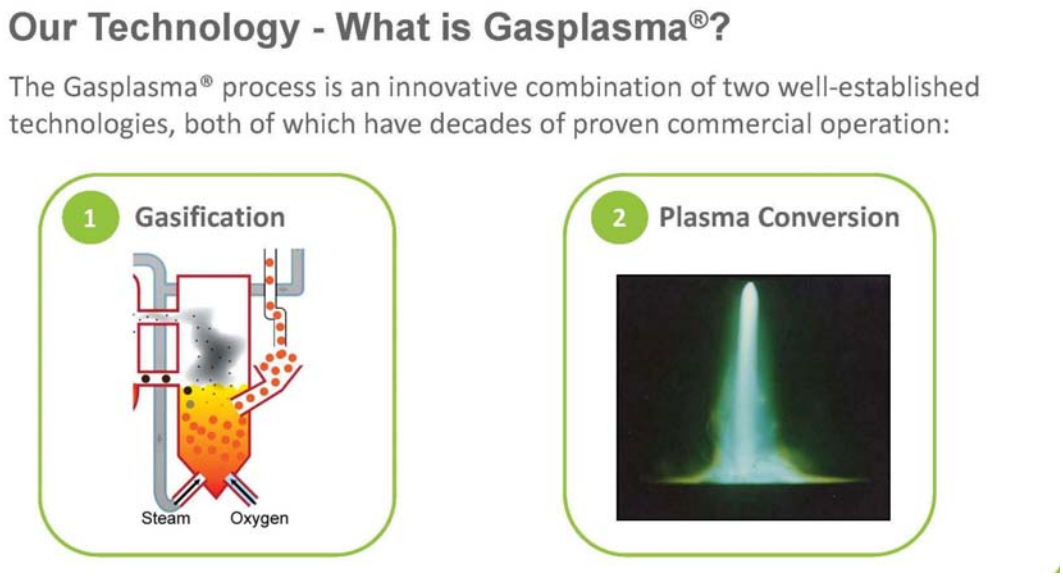
3.2.3 The delegation received a briefing on the operation of the pilot plant and the Gasplasma® process by the representatives of APP and Tetronics International, a sister company based in Faringdon. Members note that the Gasplasma® process is a combination of two technologies, namely, gasification and plasma treatment, in a unique configuration to convert waste into syngas. The Gasplasma® process will see waste sifted to remove any over-sized objects. The remainder is then processed in a Materials Recycling Facility to recover any metals, glass and hard plastics, before the residue is shredded and dried to make Refuse Derived Fuels. The next stage comprises a fluidized bed gasifier operating at 850^{o}C which transforms the organic materials in Refuse Derived Fuels into

crude syngas containing tars and chars. The crude syngas is then passed into a separate, secondary plasma converter. The intense heat at 1 500^{o}C from the plasma arc and the strong ultraviolet light of the plasma "cracks" the crude syngas. The cracking creates clean syngas while the bottom ash from the fluidized bed gasifier is vitrified into Plasmarok®. The clean syngas can be used to generate renewable power, or be used as a feedstock to liquid fuel or other chemical processes.

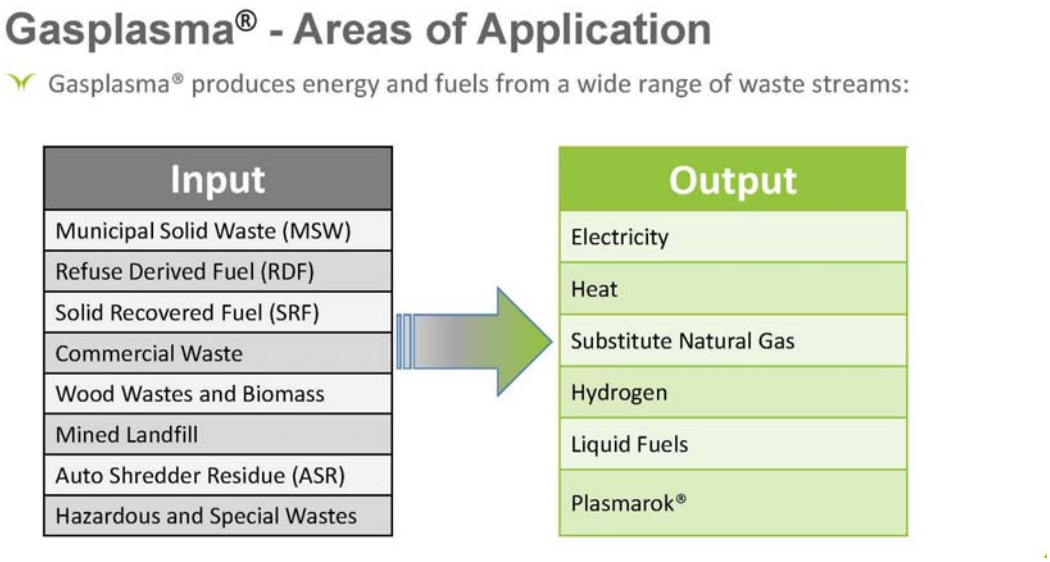
The delegation received a briefing by the representative of APP on the operation of the pilot plasma gasification plant



Gasplasma® Cycle – the process of transforming waste to energy by applying the Gasplasma® technology



The Gasplasma® process



Energy and fuels are recovered from a wide range of waste streams through the Gasplasma® process

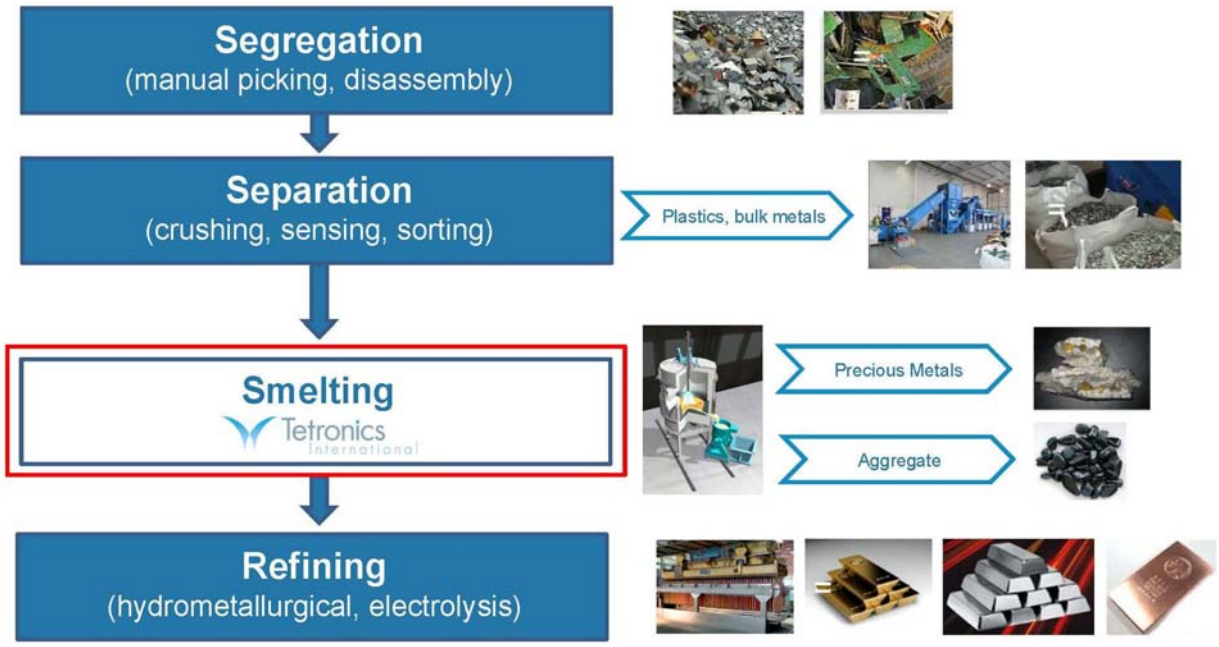
3.2.4 After the briefing, the delegation toured around the pilot plant. Members learned that application of plasma gasification entailed pre-treatment of mixed waste to a more homogenous feedstock. Non-recyclable materials would be converted into Refuse Derived Fuels through Mechanical Biological Treatment processes. Refuse Derived Fuels consist 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.

Members of the delegation received a briefing on the operation of APP's pilot plasma gasification plant

Members were briefed on the making of Refuse Derived Fuels which consisted of the combustible materials in MSW

3.2.5 The delegation has been advised that Tetronics International uses its patented plasma arc technology as the core driver for metal recovery. Such technology provides the highest technical metal recovery rates as compared to alternative technologies, while treating any hazardous material that may be contained within the waste. Applications include, but are not limited to, electrical and electronic wastes, catalyst wastes, mining wastes and steel plant wastes. Over 98% of precious metal such as gold, silver and copper could be recovered from the processing of waste electronic equipment like printed circuit boards. The following diagram illustrate the precious metal recovery process by Tetronics International –



3.2.6 The delegation also notes that a typical Gasplasma® facility accepts about 150 000 tonnes of MSW (including commercial and industrial ("C&I") waste) a year, which are enough to produce around 90 000 tonnes of Refuse Derived Fuels a year and generate renewable power for around 17 500 households and residual heat for an additional 700. Members of the delegation have enquired whether the pilot plant would be financially sustainable in the long run as the Gasplasma® technology is a new technology without proven records of effectiveness in waste management. However, APP staff did not provide the capital and operating costs of a typical Gasplasma® facility as they are

commercially sensitive information. The staff also did not disclose the financial model of its new Gasplasma® facility which has a treatment capacity of 60 000 tonnes of MSW per annum to be constructed in Birmingham.

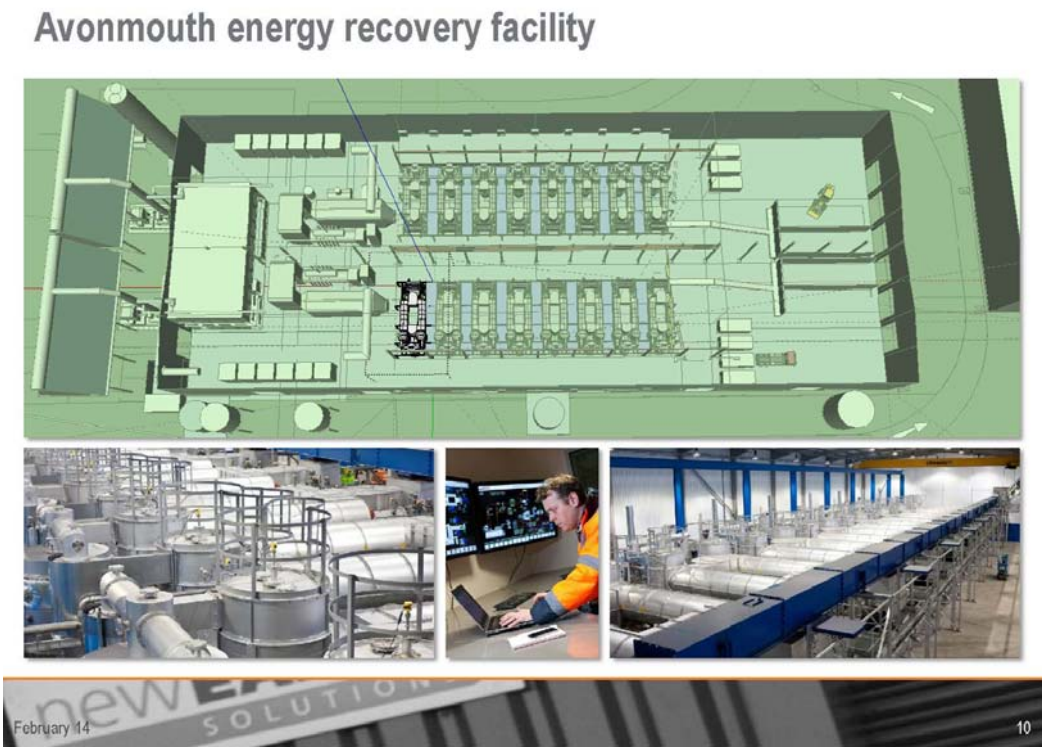
3.2.7 According to APP staff, the Gasplasma® technology is an advanced, globally patented waste-to-energy and fuels technology which offers numerous unique benefits over conventional thermal treatment technologies. The technology converts waste to syngas to generate electricity directly in gas engines, gas turbines or fuel cells which significantly improves energy conversion efficiency and maximizes electrical output. The gas is capable of being converted to liquid fuels, hydrogen or to substitute natural gas for distribution to homes and businesses in existing gas grids. Plasmarok®, a high value construction material, will also be produced during the Gasplasma® process. With the above advantages, APP considers the Gasplasma® technology clean, modular and scalable, delivering high efficiencies and maximizing landfill diversion while minimizing any visual and environmental impact.

3.3 Visit to New Earth Solutions' pyrolysis and gasification plant in Avonmouth, Bristol

3.3.1 After touring APP's pilot plasma gasification plant, the delegation visited New Earth Solutions' pyrolysis and gasification plant in Avonmouth, Bristol. Commissioned in February 2013, the first phase of the plant employs the pyrolysis and gasification technologies to turn Refuse Derived Fuels from its adjacent Mechanical Biological Treatment facility into electricity and heat. The operation capacity of the plant is about 350 tonnes of waste per day and some 13MW of electricity is generated annually. Phase 2 of the plant is under construction and will be generating power at a later stage.

New Earth Solutions' pyrolysis and gasification plant

3.3.2 The delegation received a briefing on the operation of the plant and then toured the energy hall. Members have been informed that the plant uses New Earth Solutions' own Advanced Conversion Technology which is called "NEAT". NEAT utilizes pyrolysis and gasification processes to recover energy from prepared Refuse Derived Fuels. The prepared Refuse Derived Fuels from the adjacent Mechanical Biological Treatment facility is fed to the NEAT units mechanically. The pyrolysis stage involves heating the incoming Refuse Derived Fuels in the absence of oxygen and converting it into syngas and carbon rich char. The char is then gasified using high-temperature steam with the controlled addition of oxygen. This converts the char into further gases, with a remaining particulate ash to be safely disposed. The gas produced from both the pyrolysis and gasification processes is combined and fed through a thermal oxidizer operating at around 1 200^{o}C.



The energy recovery facility in the New Earth Solutions' pyrolysis and gasification plant

The delegation received a briefing by Mr Robert ASQUITH,
Communications Director of New Earth Solutions

Members of the delegation, accompanied by Mr Mark SCOBIE, Chief Executive of New Earth Solutions, toured around the pyrolysis and gasification plant

Refuse Derived Fuels were shredded and pelletized to facilitate handling, transportation and storage

3.3.3 According to the staff of New Earth Solutions, the plant is a private investment project and there was no government funding of capital investment. While the plant is located approximately one kilometer away from the nearest local residence, there is no objection from the community and no betterment measures or compensation is given to residents. The plant is currently serving approximately 750 000 to 1 million people in the west of England region (including Bath and North East Somerset, Bristol City, North Somerset and South Gloucestershire). The major revenues of the plant include the gate fees, the wholesales of electricity, private electricity sales and ROCs. Despite the delegation's enquiry, New Earth Solutions did not reveal the capital and operating costs of the plant but claimed that the costs of the plant were competitive as compared to incineration and landfilling in the UK. The current gate fee charged to waste generators is about £95 to £115 per tonne of waste. The fee is competitive vis-à-vis the UK landfill tax which is £80 per tonne of waste in 2014/15.

3.3.4 The delegation also notes that around 85% of the waste processed by the plant is MSW and the remaining 15% is C&I waste which is more variable and better for the production of Refuse Derived Fuels. New Earth Solutions is now exploring other applications of Refuse Derived Fuels besides electricity and heat generation, such as road fuel, heating fuel, hydrogen, char and industrial gases. Given the limited operation capacity of the plant (which is about 350 tonnes of waste per day), some of the prepared Refuse Derived Fuels from the adjacent Mechanical Biological Treatment facility not yet processed by the plant will be exported to other European countries, such as the Netherlands, for further treatment. Since Refuse Derived Fuels are flammable, standard precautions against fire are taken in the plant.

Refuse Derived Fuels not yet processed by the New Earth Solutions' pyrolysis and gasification plant will be exported to other European countries for further treatment

3.3.5 New Earth Solutions' staff have further told the delegation that as compared with landfilling and other waste treatment plants adopting conventional energy-from-waste technologies, the operation of the plant is more flexible and community friendly. Public exhibitions have been held to engage local residents in different development phases of the plant. The plant has contributed towards the sub-regional and regional targets for renewable energy generation and the transition to a low-carbon economy. The construction and operation of the plant also lead to job creation and over 100 jobs have so far been created in Bristol.

3.4 Meetings with Air Products' waste-to-energy facilities in Teesside, Lakeside Energy-from-Waste Plant, Mayor of London's Office, Department for Environment, Food and Rural Affairs, Institution of Mechanical Engineers and United Kingdom Without Incineration Network

3.4.1 During its stay in the UK, the delegation met with representatives of Air Products' waste-to-energy facilities in Teesside and the Lakeside Energy-from-Waste Plant, officials of the Mayor of

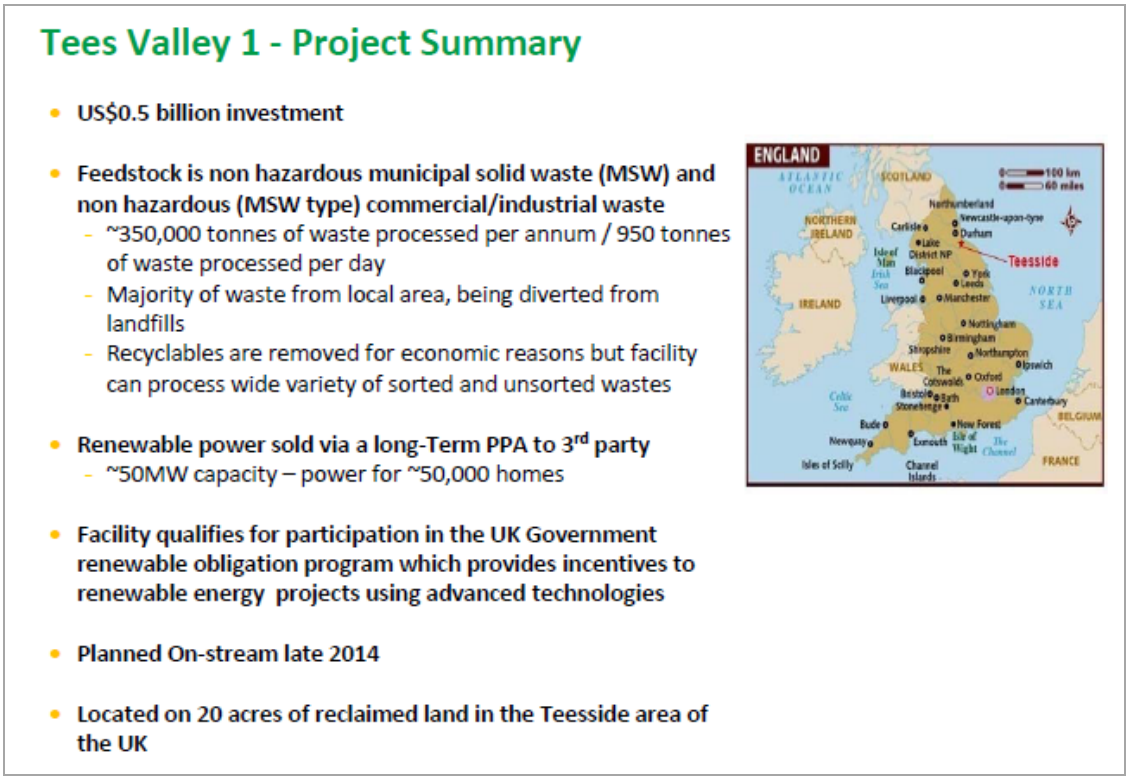
London's Office and the Department for Environment, Food and Rural Affairs, as well as representatives of the Institution of Mechanical Engineers ("IMechE") and the United Kingdom Without Incineration Network ("UKWIN") to learn more about the latest development of thermal waste treatment in the UK and the concerns of the local communities.

Air Products' waste-to-energy facilities in Teesside

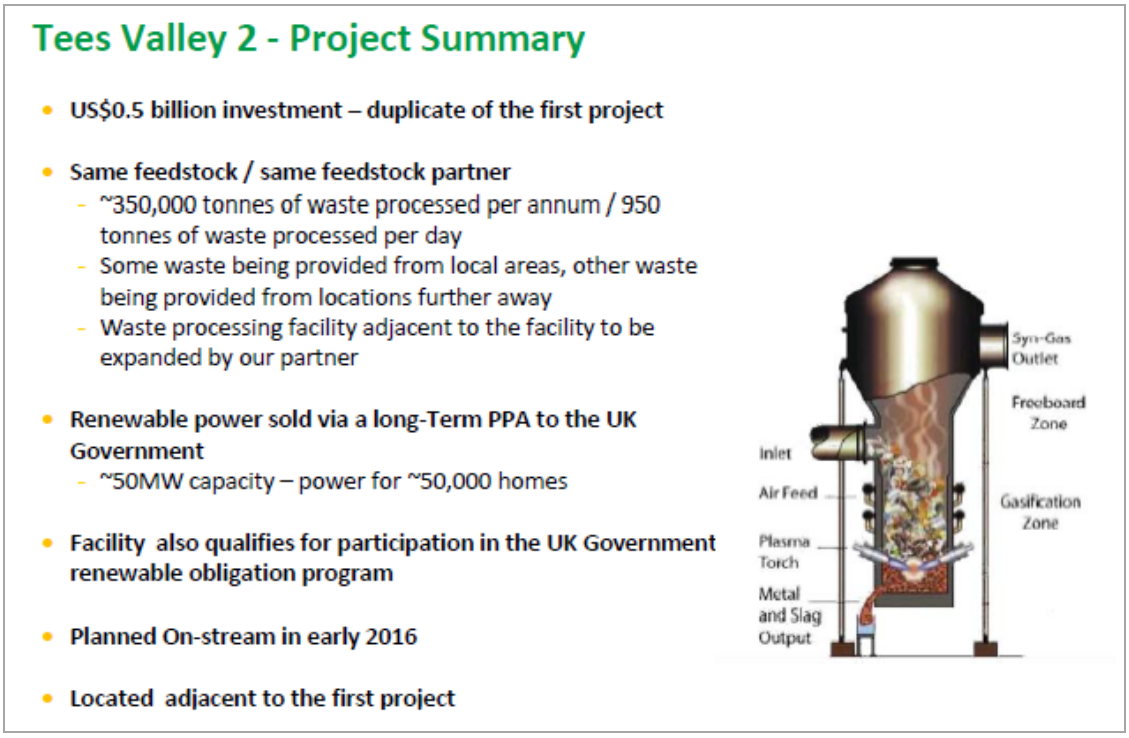
3.4.2 The delegation received an introduction by the representatives of Air Products on its waste-to-energy facilities in Teesside which is still under development. Members note that Air Products is an industrial gas and equipment supplier. It has been working on a waste-to-energy facility located on an industrial land, known as the Reclamation Pond site, adjacent to the North Tees Chemical Complex near Billingham (hereafter referred to as "Tees Valley 1"). Tees Valley 1 will use the plasma gasification technology to convert pre-processed waste into electricity for up to 100 000 households. The estimated energy output of Tees Valley 1 is around 50MW of electricity and the operating temperature of the plant will be over 1 200^{o}C. With the anticipated commissioning in March 2014, Tees Valley 1 is expected to be in full operation in late 2014. Once operational, Tees Valley 1 will be the first plasma gasification plant of its kind in the UK and the largest of its kind in the world to treat around 950 tonnes of pre-processed MSW and C&I waste per day.

3.4.3 Air Products is planning to build a second plant adjacent to Tees Valley 1 in the Reclamation Pond area (hereafter referred to as "Tees Valley 2"). Tees Valley 2, which will be of similar size to Tees Valley 1, is expected to be in operation in early 2016 with the same treatment capacity as Tees Valley 1. Both Tees Valley 1 and 2 will produce syngas for renewable electricity to power up homes. The by-product of the gasification process, an inert vitrified slag, will be recycled for use in road bedding and other construction-based applications.

Aerial view of Air Products' waste-to-energy facilities in Teesside

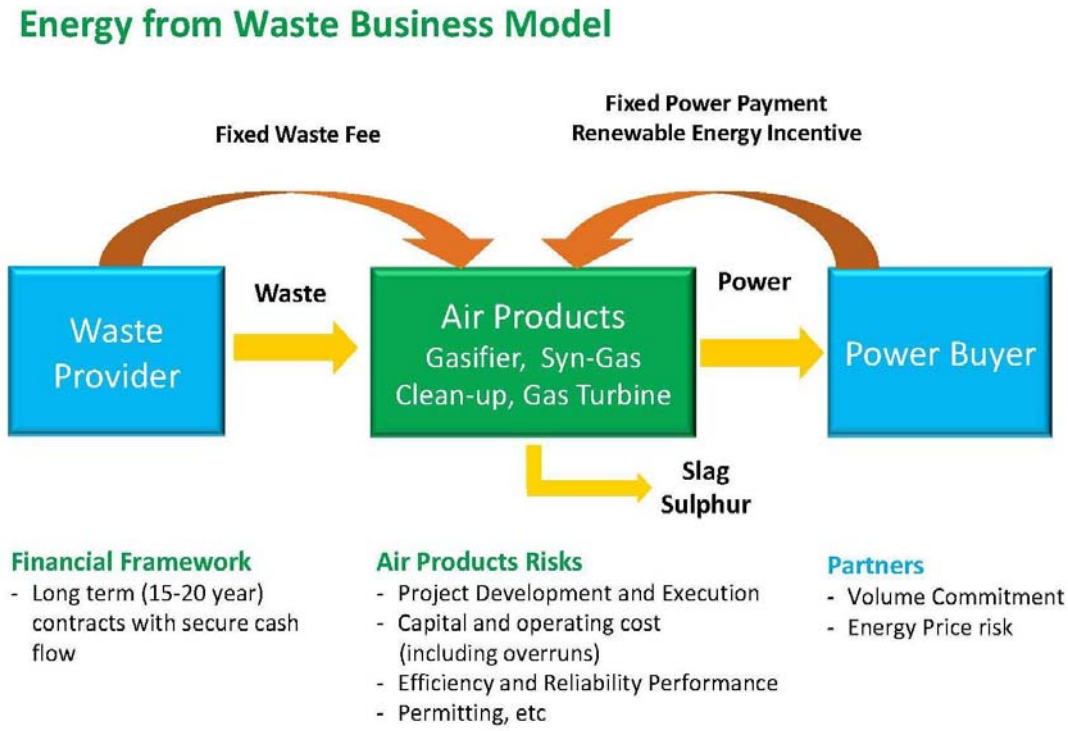


Project summary of Tees Valley 1



Project summary of Tees Valley 2

3.4.4 According to Air Products, Tees Valley 1 is set to cost around US$500 million and is financed almost entirely by Air Products with a £260,000 government grant awarded in 2010. As informed by the representatives of Air Products, while the company intends to build, own, operate and self-fund projects, it is open to partnerships and alternative financing arrangements. In reply to the delegation's enquiry about the business model of a typical plasma gasification plant, the representatives of Air Products have advised that the business models of plasma gasification plants may vary from countries to countries due to regional differences and local business opportunities and potentials. In general, the major revenues of a plasma gasification plant include the waste fees charged to waste generators, the wholesale of electricity to power buyer and the economic incentives for generating renewable energy.



The energy-from-waste business model of Air Products' waste-to-energy facilities

3.4.5 Air Products has further revealed that the feedstock for gasification is non-hazardous MSW and C&I waste and the majority of waste is from local area, being diverted from nearby landfills. A wide variety of sorted and unsorted waste will be processed in Tees Valley 1 where shredding machines will be installed. It is anticipated that Tees Valley 1 will provide 50 full time jobs including engineers and maintenance workers when it begins operation, as well as 700 jobs during the construction period. The plant will also provide an indirect boost to the local economy through the use of local service companies, hotels and other businesses.

3.4.6 Members also take the opportunity to understand more about the application of the plasma gasification technology in the world. They note that while the United States of America relies mainly on landfills for the disposal of MSW as it has adequate landfill space, other countries which have limited space for landfilling, such as the UK and Singapore, are proactively expediting the development of different thermal waste treatment technologies. Air Products' staff have advised that plasma gasification is deemed to be superior to traditional incineration

technology. Incineration stack emissions which contain tars, dioxins, and other hazardous chemicals must be treated with expensive and complex stack treatment technologies. Besides, incineration facilities produce a significant amount of hazardous bottom ash (about 30% of the waste feedstock) that must be landfilled or further treated. As such, incineration facilities have been shunned in some developed countries due to widespread opposition from the public and environmental groups. It is also difficult for the facilities to obtain environmental permits in some places.

3.4.7 Air Products has further told the delegation that as the UK Government is committed to diversifying its sources of energy, strengthening its energy and reducing carbon emissions, the plasma gasification technology provides an alternative to traditional incineration technologies and may offer a sustainable solution to the UK's waste management strategy. At present, there are 15 plasma gasification plants in the world and four of them are using the technology for MSW treatment. The four plants' capacity ranges from 15 to 220 tonnes a day. The largest of the four was in Japan but it was shut down in December 2012. On the reasons for the closure of the plant in Japan, Air Products' staff claimed that the closure was due to business reasons (i.e. it could not secure the supply of waste), rather than technical problems.

Group photo taken with the representatives of Air Products' waste-to-energy facilities

Lakeside Energy-from-Waste Plant

3.4.8 Following the briefing by Air Products, the delegation met with representatives of the Lakeside Energy-from-Waste Plant, which is a joint venture project between two recycling and waste management companies in the UK, i.e. Grundon Waste Management and Viridor. Members have learnt that the plant is located at Colnbrook near Slough and commenced operation in January 2010. Using the moving-grate incineration technology, the plant can process 410 000 tonnes of mixed and unsorted MSW from local authorities and businesses in southeast England per year, generating 37MW of electricity. A small amount of generated electricity is used to power the plant itself while the vast majority is exported to the national grid which is enough to meet the domestic needs of 50 000 homes, more than the population of Slough. The plant is designed with the potential to export surplus heat, thus making it a combined heat and power ("CHP") plant. It is operating under strict environmental controls as required by the Environment Agency.

Lakeside Energy-from-Waste Plant

3.4.9 Members have further been informed that the plant won the "Best Designed Renewable Energy Facility" and "Energy from Waste Facility of the Year" under the "Renewable Energy Infrastructure Award" in 2011. There is an education centre adjacent to the plant where schools and other groups can learn about sustainable waste management and energy from waste. The architectural design of the plant featuring a strongly curved roof profile is to avoid interference with the aircraft approach route to the Heathrow Airport.

Aerial view of Lakeside Energy-from-Waste Plant

3.4.10 According to the representative of the plant, the project cost of the plant was about £160 million which was entirely privately funded and did not cost taxpayers money. The design life of the plant is 25 years and some 50 direct new jobs are created. The plant recovers energy from non-hazardous residual waste diverted from landfills. After the installation of a world-class 250 kilowatt peak solar power system in November 2013, the plant has become more energy efficient. One-third of the south-facing curved roof at the back of the plant now accommodates 1 000 solar photovoltaic panels which generate 230 500 kWh of sustainable energy a year, delivering a total carbon saving of 137 000 tonnes a year.

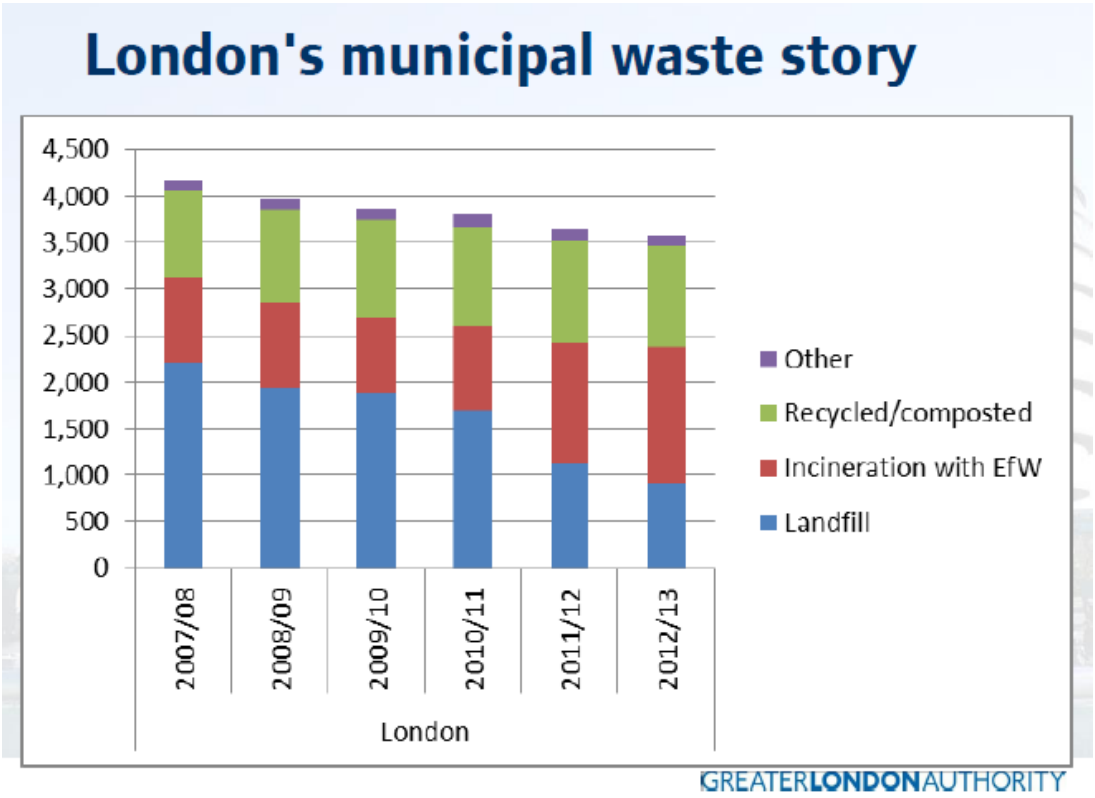
3.4.11 As informed by the representative of the plant, the moving-grate technology has been selected for MSW treatment because the technology is safe, robust and reliable with proven track records. The delegation has been told that although there was a report that the emission of respirable suspended particulates (i.e. PM10) and nitrogen dioxide from the plant in September 2013 had exceeded the statutory limits, emissions from the plant were controlled and monitored. The operation of the plant is also strictly regulated by the Environment Agency.

The delegation leader presented a souvenir to
the representative of Lakeside Energy-from-Waste Plant

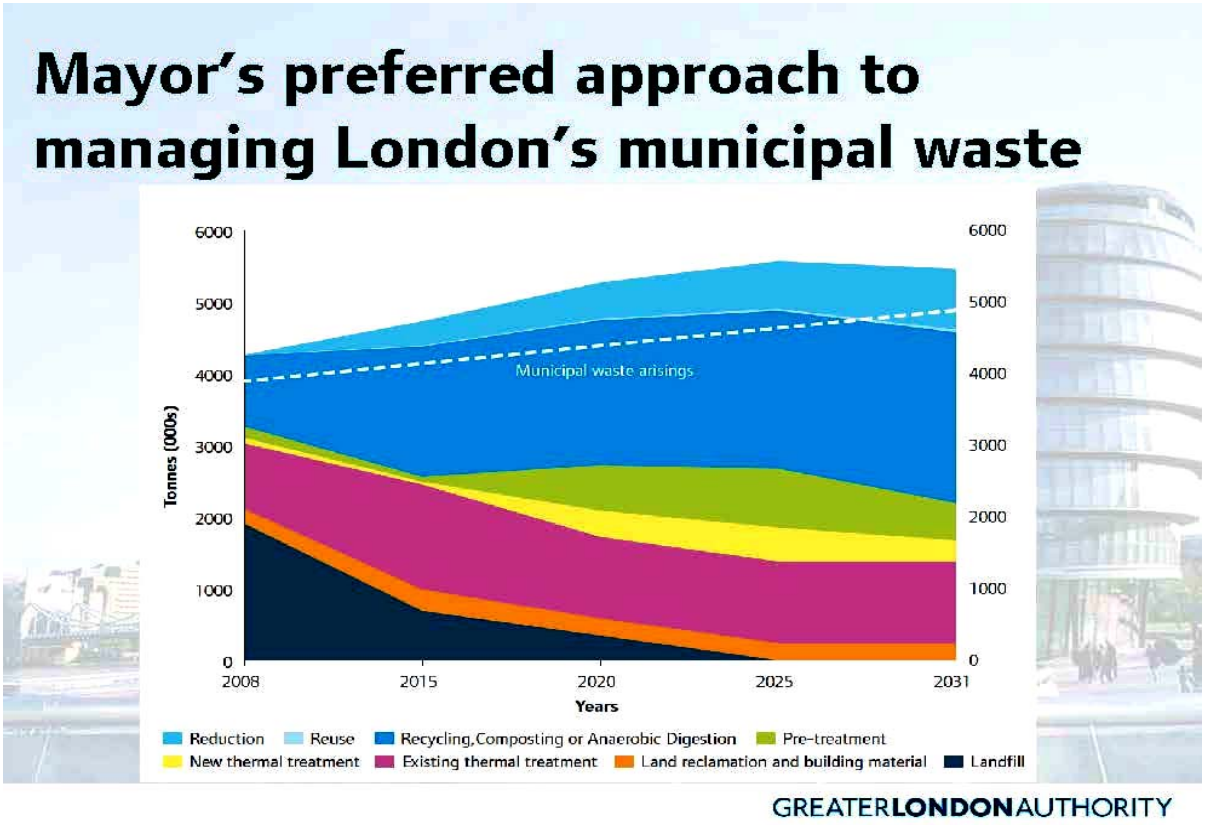
Mayor of London's Office

3.4.12 The delegation then met with the officials of the Mayor of London's Office to learn their experience in formulating and implementing waste management policies in London. Members note that the Mayor of London has a key role in running London and sets out plans and policies to improve the city. The current Mayor's vision is for London to become a world leader in waste management, making use of innovative techniques and technologies to minimize the impact of waste on the environment and fully exploit its economic value. He also wants London's waste to play a key role in achieving significant climate change mitigation and energy saving benefits.

3.4.13 The delegation also notes that London generated 15 million tonnes of waste in 2012 and the city expects to produce 16.5 million tonnes of waste in 2031, of which 80% will be recycled and the remaining 20% will be processed by thermal waste treatment. The bar chart below depicts the trend of waste treatment in London over the past 6 years from 2007/08 to 2012/13 –



3.4.14 According to the representative of the Mayor of London's Office, London aims to meet the targets of recycling 50% of MSW and 70% of C&I waste by 2020. Although there will be a small but steady increase in total MSW over time and landfill will continue to play an important role in the disposal of MSW in the near future, London is working towards zero biodegradable and recyclable waste to landfill by 2031. The Mayor's preferred approach to managing London's municipal waste is shown below –



3.4.15 The delegation has been advised that the Mayor aims to achieve significant carbon dioxide ("CO_2") equivalent emission savings from the management of all London's MSW, particularly from the waste being delivered to landfill or incineration. To this end, a greenhouse gas emissions performance standard ("EPS") has been developed for all municipal waste management activities in the city. EPS focuses on reusing and recycling high embodied carbon materials while generating energy from low-carbon waste remaining. The Mayor has also set a minimum CO_2 equivalent emissions performance for energy generated from waste such that energy is generated in a way that is no more polluting in carbon terms than the energy it replaces. It is expected that London will move towards cleaner, efficient energy generation from low-carbon waste material in the form of heat, power and transport fuel for local use, thus achieving the Mayor's target of a 60% reduction in London's CO_2 emissions (on 1990 levels) by 2025.

3.4.16 Members of the delegation have asked about the challenges of waste management in London. The representatives of the Mayor of London's Office have responded that while there are general statutory

recycling targets for local councils, there are no material specific targets. Local authorities' recycling targets are based on weight, and this gives them the incentive to pick up heavier materials and not things like plastic. Furthermore, there is an increasing proportion of high density housing in London, making it difficult for households to separate and recycle waste. On the other hand, the mixed building types and high building densities provide diverse energy demands that allow CHP systems to be run efficiently, as well as high heat demand densities that make heat network deployment more cost-effective.

Department for Environment, Food and Rural Affairs

3.4.17 The delegation then received a briefing by Defra on the environmental policy in England. As mentioned in paragraph 3.1.2, Defra is an UK Government department responsible for formulating policy and regulations on areas such as environmental, food and rural issues. It administers the environmental policy in England through the Environment Agency, which is a non-departmental public body tasked with (a) monitoring and enforcing legislation on the overall waste management in England, and (b) regulating waste management activities in England, including the transport, treatment and disposal of waste.

3.4.18 The delegation has been told that waste is a devolved matter in the UK. The devolved administrations of Scotland, Wales and Northern Ireland formulate strategies and policies relating to waste management in their regions. Local authorities have duties concerning the collection and disposal of household and C&I waste. Regarding the Central Government, it intervenes through the landfill tax, regulation to protect environment and health, and voluntary responsibility deals. In accordance with the waste hierarchy set out in EU's *Waste Framework Directive*, Defra has made waste prevention a priority while seeking to reuse and recycle unavoidable waste. Since most waste arises in the private sector (i.e. from the daily activities of businesses and individuals), Defra continues to increase the percentage of waste collected from both households and the business sector with an aim to recycle at least (a) 50% of waste from households by 2020 and (b) 70% of non-hazardous construction and demolition waste by 2020.

3.4.19 Members learned that after the UK Government has substantially raised the landfill tax, there was strong economic incentive for the growth of the recycling industry. The annual increase in landfill tax of £8 per tonne of waste from 2010 to at least 2014 (commonly known as "the landfill tax escalator") has further made recycling and incineration more commercially attractive than landfilling. The aim of this escalator is to give a strong economic incentive to diverting biodegradable waste from landfill as this type of waste has higher environmental impacts when sent to landfill. The targets for the UK are to reduce the biodegradable MSW going to landfill to 75% of the amount generated in 1995 by 2010, 50% by 2013 and 35% by 2020. The first two targets have been met accordingly.

3.4.20 According to Defra, the UK is moving towards perceiving waste as resources which can be reused, recycled and recovered. The growth in the UK waste industry is driven by recovering value from waste. The share of value added from material recovery has grown from 19% in 2003 to 33% in 2012. On the development of energy-from-waste infrastructure, the number of residual waste treatment facilities is projected to more than double from 43 at present to 88 by 2020. Of these facilities, about half are publicly funded and half are privately owned. The development of anaerobic digestion facilities is also growing very fast, over doubling since 2011. There are 125 operational plants in the UK processing 8.9 million tonnes of organic material and generating 110 MW of energy. A further 250 plants are expected to be commissioned to generate 145MW of energy over the next three to four years.

3.4.21 Noting that incineration is the most common thermal waste treatment adopted by waste-to-energy plants in the UK but there are also plants that adopt ATT such as pyrolysis and/or gasification, or plasma gasification, the delegation asked about the UK Government's considerations in the selection of technology for waste treatment plants. The officials of Defra have advised that the UK Government is technology neutral in the planning of waste treatment facilities and its main concern is the energy output and energy efficiency of a facility. While the UK Government does not have preferred technologies, it notes that new waste treatment technologies such as gasification are immature and lack proven track record. The Government thus provides more incentives to encourage the development of such technologies in order to drive growth in energy production from waste. In response to the

delegation's further enquiries, Defra officials have said that while incineration is regarded as the anchor technology, the UK Government incentivizes the newer technologies, accepting that they have certain risks and may fail. On the other hand, if they succeed, the country will have new technologies.

3.4.22 The delegation has also been informed that local authorities and the industry have the discretion to decide which thermal waste treatment technologies should be adopted. Relevant factors such as the volume of carbon emission, the type of energy produced (heat and/or power) and the overall generating efficiency of the technology would be taken into consideration. While the plasma gasification technology will generate less pollutant than other thermal waste treatment technologies as it operates at an oxygen-deficient condition, there is not much proven record of its reliability and efficiency in large-scale treatment plants. Defra officials have further advised that energy-from-waste plants are usually located in urban areas since they provide heat and electricity to meet domestic needs. The Environment Agency conducts regular inspection to ensure the proper operation of these plants. Irrespective of the technologies adopted by the plants, they are subject to the same emission standards.

3.4.23 The delegation further notes that Defra takes on board various instruments to stimulate waste prevention and recycling. It endeavours to encourage the business sector and individuals to contribute to a more sustainable economy by reducing waste as well as reusing and recycling products. To promote the quality of recyclables collected from households and businesses, Defra plans to mandate the separate collection of waste including waste paper, metal, plastic, and glass from 1 January 2015. Separate collection of biowaste is also encouraged.

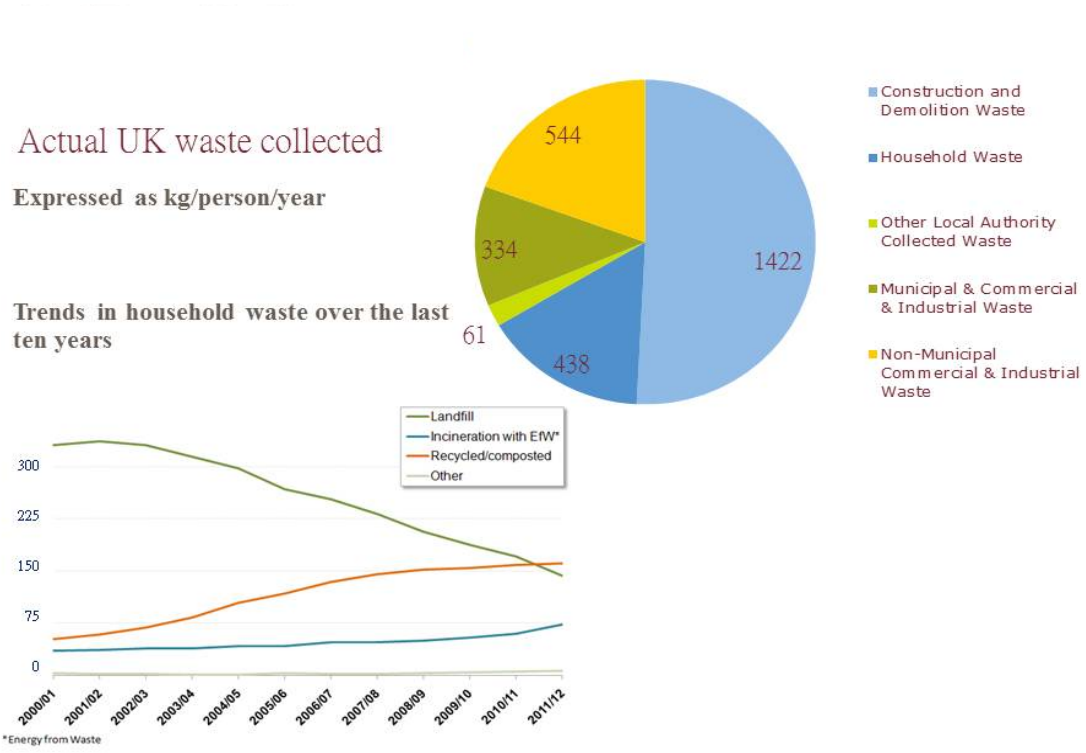
The delegation exchanged views with the officials of the Mayor of London's Office and Defra

The delegation leader presented a souvenir to the officials of the Mayor of London's Office

Institution of Mechanical Engineers

3.4.24 Established in 1847, IMechE is a professional society representing mechanical engineers in the UK. Based in London, IMechE is the largest network of mechanical engineering knowledge, skill and opportunity in the world.

3.4.25 The delegation exchanged views with representatives of IMechE on various environmental issues including waste management policies, waste treatment technologies and waste-to-energy facilities. Members note that the targets for the UK are to reduce the biodegradable MSW going to landfills to 75% of the amount generated in 1995 by 2010, 50% by 2013 and 35% by 2020. With the escalation of landfill tax in recent decades, there has been a substantial reduction of the use of landfilling for processing MSW in the UK and a greater drive for local authorities and communities to develop and adopt different thermal waste treatment technologies as part of their waste management strategies to reduce the volume of waste delivered to landfills and to recover energy from waste. The following diagrams illustrate the current situation of UK waste management –



3.4.26 According to the representatives of IMechE, the average capacity of energy-from-waste plants in the UK is increasing and most capacity is for treating residual MSW while only about 4% is for Refuse Derived Fuels from MSW or C&I waste. Incineration (i.e. combustion) remains the most common thermal waste treatment technology adopted by energy-from-waste plants in the country and all except one combustion plants work well. Apart from MSW combustion, gasification is a new thermal treatment option for MSW to recover energy from the organic portions of waste. Pre-treatment of MSW is required to ensure better performance of the gasification process. While gasification plants using a steam system generally work well in the UK, the only gasification/pyrolysis plant with a gas engine has failed to operate. The figures below show the updated thermal waste treatment development in the UK –

	No. of EfW Plants	Average Capacity (ktpa)	Total Capacity (ktpa)	Capacity (% of total)	Average Capacity (MWe)	Total Capacity (MWe)
Plants built (but 3 shut down due to technical problems)	35	194	6,797	52.9%	16.6	581
Plants under construction	21	288	6,042	47.1%	31.6	664
Total plants built or under construction	56	229	12,839	100.0%	22.2	1,245
Plants for residual MSW	47	256	12,023	93.6%	23.4	1,100
Plants for RDF from mixed MSW or C&IW	7	74	518	4.0%	9.2	65
Plants for ASR (both gasification; neither operational yet)	2	149	298	2.3%	40.0	80
Combustion plants (all except 1 successful)	48	247	11,843	92.2%	22.2	1,067
Fluidised bed combustion plants (both had severe problems)	2	310	620	4.8%	28.5	57
Gasification or pyrolysis plants (the 1 with gas engines failed to work)	8	94	656	5.1%	18.3	128
Plants shut down due to technical problems (2 being gasification)	3	46	138	1.1%	3.9	12

3.4.27 The representatives of IMechE have further advised that combustion is a well-proven and reliable technology for MSW treatment and it is a valuable energy source for electricity and heat. All combustion plants in the UK use the moving-grate technology. As regards gasification and pyrolysis, they are still developing technologies and are usually adopted by local treatment plants of smaller scale. Waste

treatment plant projects which adopt the gasification and pyrolysis technologies are almost unbankable in the UK due to a multitude of failures in the operation of such plants. In response to the delegation's enquiry about the "unbankability" of plasma gasification plants, the representatives of IMechE have said that such plants only have 2% chance of success, which is too risky. The UK Government is providing financial incentive to such plants through RO (as detailed in paragraph 3.1.17 above), otherwise no such plants would be built. As regards environmental performance, plants adopting combustion and gasifications/pyrolysis technologies are the same as they are subject to the same set of emissions standards and regulatory requirements.

Group photo taken with the representatives of IMechE

UK Without Incineration Network

3.4.28 The delegation then met with the Director of UKWIN. Founded in March 2007, UKWIN is an independent organization co-ordinating local community groups and individuals to campaign against waste incineration and promote sustainable waste management. The overall objectives of UKWIN are to –

(a) protect the environment by promoting sustainable waste management and influence public policy and practice; and

(b) educate the public on waste management options and promote the economic, social and environmental benefits arising from protecting the environment and reducing pollution.

3.4.29 UKWIN also facilitates the sharing of information on incineration amongst green groups and members of the public. In 2013, it participated in and organized a number of activities against the use of incineration and gasification for waste treatment.

3.4.30 The Director of UKWIN shared with the delegation his views on waste management. He has told members that incineration would release greenhouse gases and is an inefficient means of recovering energy from waste. Besides, it will pose significant health and environmental risks. As such, priority should be given to waste reduction and recycling without resorting to waste incineration. More efforts should be made to promote waste reduction, recycling and recovery on all fronts, thereby achieving a sustainable circular economy. On food waste management, the Director is of the view that food waste prevention and reduction should be high on the policy priorities of government authorities. Food waste should be recycled to useful resources as far as possible.

3.4.31 In response to the delegation's questions about his views on the way forward for waste management in Hong Kong, the Director has pointed out that he notes that Hong Kong is currently facing a very serious problem of waste. While the Action Blueprint issued by the Hong Kong Government has set out a series of waste management strategies for Hong Kong, it takes time to implement the measures therein and meet the target of reducing the MSW disposal rate by 40% on a per capita basis by 2022. Having regard that the three landfills in Hong Kong would be saturated in the near future, he opines that incineration could be the short-term solution to the problem of waste in Hong Kong. However, he has cautioned that any premature investment in energy recovery by incineration might result in building over-capacity waste management facilities in the medium term if Hong Kong is to move towards a green economy and sustainable development. He has also said that the potential of biological treatment of MSW should be further explored.

The delegation leader presented a souvenir to the Director of UKWIN

Chapter 4 — Waste management in the Netherlands

4.1 Overview of the waste management policies in the Netherlands

4.1.1 The Netherlands' waste management system is highly regarded around the world. In 2011, recycling and composting[5] of MSW together accounted for 61% of waste treated in the country, while incineration accounted for 38% of the remaining waste. Only 1% of MSW was deposited in landfill. The Netherlands is hailed as one of the front-runners in recycling and thermal waste treatment in Europe.

4.1.2 In the Netherlands, the Ministry of Infrastructure and the Environment is the government agency in charge of the overall environmental policies in the country. The Ministry develops national policy and strategies on the environment in a national context, as well as ensuring the implementation of EU legislation in national regulations. Rijkswaterstaat is an executive arm of the Ministry responsible for implementing national and EU waste policies and regulations. On the local level, the provincial governments are responsible for translating the national policy into the regional framework, granting environmental permits, inspecting waste treatment facilities (including incineration and landfilling) and stipulating limits for noise and emissions. Meanwhile, the municipal governments are in charge of implementing the national policy and strategy on environmental management, and enforcing environmental regulations such as separation, collection, treatment, recycling and disposal of waste from households, and commercial and industrial activities in their municipalities.

4.1.3 The waste management policy is primarily governed by the *Environment Management Act*, which stipulates an integrated approach to environmental management in the Netherlands and provides the legal framework by defining the roles of the national, provincial and municipal governments. The Netherlands is also governed by the *Industrial Emission Directive* issued by EU which commits its member states to control and reduce the impact of industrial emissions on the environment.

[5] Composting means the biological treatment of biodegradable matter resulting in a recoverable product.

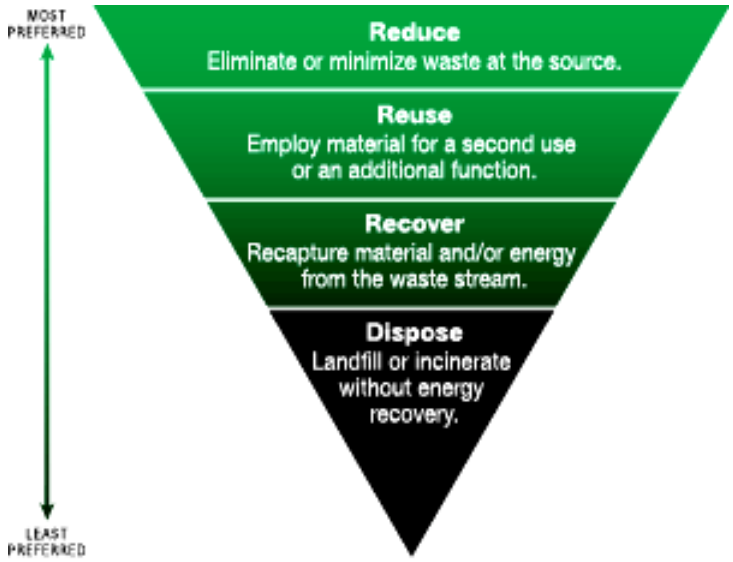
National Waste Management Plan

4.1.4 In 2002, the *Environmental Management Act* was amended to stipulate the Ministry of Infrastructure and the Environment to draw up a National Waste Management Plan ("NWMP") every six years, taking into account the waste hierarchy model introduced by EU and the national environmental policy plan. NWMP sets out the policy for waste management in the Netherlands. The Second Waste Management Plan covers the period from 2009 to 2015, looking ahead to the period up to 2021.

Elements of Dutch waste management

Waste hierarchy

4.1.5 The Dutch approach is to avoid creating waste as much as possible, recover the usable and valuable raw materials and generate energy by incinerating residual waste. The target is to increase recycling of household waste to 60% by 2015. Landfilling is only allowed for waste streams for which no recovery or incineration is possible.



The 4-tiered waste hierarchy of the Netherlands with waste reduction at source as the top priority

Stringent waste treatment standards

4.1.6 In order to reduce the environmental pressure arising from waste management, the following stringent standards are introduced –

(a) standards for soil protection from landfilling;

(b) standards for the quality of secondary materials derived from waste (building materials);

(c) air-quality standards for incineration;

(d) quality standards for organic fertilizers (from bio-waste); and

(e) a ban on landfill for 35 waste streams (basically all waste streams suitable for recovery or incineration are not allowed on landfills).

Extended producer responsibility

4.1.7 Extended producer responsibility means that producers or importers are responsible, or share responsibility, for the management of the products that they have or will put on the market when these products are discarded. This responsibility can be agreed upon voluntarily or through legislation. Instruments for promoting producer responsibility are generally used in combination with other instruments, e.g. the introduction of landfill bans and landfill tax levies.

Use of various instruments to stimulate prevention and recycling

4.1.8 The Dutch Government has been using the following instruments to stimulate prevention and recycling –

(a) Enforcement of legislation – An advanced waste tracking and monitoring system has been developed to support enforcement;

(b) Financial instruments – Instruments like landfill tax[6] and volume-based waste fee systems help achieve the shift towards less landfilling and more recovery and recycling of waste;

(c) Separate collection – There are systems for the separate collection of organic waste, paper and cardboard, plastics and glass. Every municipality also has a location where people can sort and dispose of their waste; and

(d) Effective communication – Communication and education are essential in raising public awareness. Engaging the public at large and providing the necessary information on different waste management programmes are instrumental.

Thermal waste treatment

4.1.9 Thermal waste incineration has a long tradition in the Netherlands and is widely accepted by the public as a better means to treat waste compared with landfill disposal. Waste incineration plants are equipped with waste–to-energy conversion and emission reduction capabilities. In the Netherlands, only those waste-to-energy facilities adopting the moving-grate incineration technology are in use for the treatment of mixed MSW due to the reliability and robustness of the technology in accommodating variations in composition and calorific value[7] of MSW. Other factors such as simplicity of operation, low personnel requirement and ease of training of personnel have also made the moving-grate incineration technology attractive to be adopted by new

[6] The Dutch Government introduced a landfill tax in 1995 in an effort to reduce waste generation by making landfill disposal more expensive while at the same time promoting recycling, composting and incineration as more attractive waste management options. When the landfill tax was first introduced, there was a single tax rate for all waste. In 2000, two different levels of taxes were introduced. Combustible MSW was charged with a high tax, while waste that was assumed to be non-combustible with no other favourable recovery was charged with a low tax. In 2002, there was a steep increase of the tax level which kept increasing marginally in the ensuing years. In 2010, the landfill tax surged from €65 (about HK$670) per tonne in the early 2000s to €107.5 (about HK$1,107) per tonne, the highest rate in Europe. Amid high landfill tax, more MSW has been diverted from landfilling to either recycling or incineration. However, the landfill tax was repealed in 2012 as the low level of landfilling had rendered its existence as an administrative burden without inducing further benefits.

[7] Calorific value is the amount of heat produced by the complete combustion of a fuel.

waste-to-energy plants. In contrast, pyrolysis and gasification have a very limited application in MSW management in the Netherlands as both technologies are applicable only to well-defined homogeneous waste streams and not suitable for mixed MSW.

4.1.10 Currently, there are 12 waste-to-energy facilities for mixed MSW in the Netherlands. The total amount of waste incinerated (both domestic and from abroad[8]) in 2012 was about 7.5 million tonnes. Among the capacity of 7.5 million tonnes per year, 31% of the capacity is private and all the others are publicly owned (municipalities and provinces own the shares).

Province	Facility	Amount incinerated (kton)				
		2008	2009	2010	2011	2012
Groningen	EEW Energy From Waste Delfzijl BV*	-	-	115	249	317
Friesland	REC Harlingen	-	-	-	154	228
Drenthe	Attero Noord BV GAVI Wijster	625	609	598	639	677
Overijssel	Twence Afval en energie	282	493	588	613	608
Gelderland	ARN B.V.	273	268	281	261	294
	AVR Afvalverwerking BV	354	361	365	397	383
Noord-Holland	HVC afvalcentrale locatie Alkmaar	662	682	664	608	640
	Afval Energie Bedrijf	1.309	1.284	1.401	1.473	1.473
Zuid-Holland	AVR Afvalverwerking Rijnmond	1.195	1.168	1.186	1.242	1.293
	AVR Afvalverwerking Rotterdam	384	355	-	-	-
	HVC afvalcentrale locatie Dordrecht	196	189	233	288	301
	ZAVIN CV*	7	8	9	9	9
Noord-Brabant	AEC Moerdijk	709	859	960	985	924
	SITA ReEnergy	57	57	59	288	334
Total		**6.053**	**6.333**	**6.459**	**7.207**	**7.480**

** Zavin is a dedicated facility for specific hospital waste and is privately owned.*

Energy recovery

4.1.11 Energy recovery is an important source of income for waste incineration plants in the Netherlands. Steam and electricity production of a modern waste-to-energy facility could cover up to about 50% of the total cost of operation, and by that allow for lower gate fees charged to waste generators. Of the electricity produced by waste incineration plants, 82% is exported offsite while the remaining 18% is used onsite. Meanwhile, the heat produced is used for industrial processing, district heating and greenhouse heating. In 2012, 4 014 GWh of electricity was produced and 14.1 PJ of heat was delivered by waste incineration plants.

[8] The amount of waste from abroad incinerated stood at 1.035 million tonnes, representing about 14% of the total amount of waste incinerated during 2012.

The following is the gross energy produced by the waste-to-energy facilities in the Netherlands yearly from 2008 to 2012 –

	2008	2009	2010	2011	2012
Produced electricity (GWh)	2.898	3.120	3.356	3.805	4.014
Produces warmth (PJ)	10.3	10.2	11.2	12.8	14.1
Total (PJ)	**20.7**	**21.4**	**23.3**	**26.5**	**28.5**

Source: Hernieuwbare energie in Nederland 2012 (CBS)

Environmental impact assessment and licensing

4.1.12 In the Netherlands, an environmental permit from the provincial government is required for the installation of waste incineration plants. Various stakeholders including green groups and local residents are invited to participate in the permit application process to provide their views. The provincial government is also responsible for the Environmental Impact Assessment ("EIA") procedure. The independent Commission on EIA will evaluate the adequacy of the EIA reports of waste incineration plants.

Self-monitoring system

4.1.13 The Dutch environmental legislation prescribes self-monitoring measures on the emission of pollutants from waste incineration plants. A waste incineration plant is required to install an automatic system to prevent waste feeding into the plant when its emissions exceed the statutory limits. Plant operators are also required to calibrate and perform periodic and annual checks on the proper function of the measurement system of their plants with the assistance of accredited professionals.

Environmental inspection and reporting

4.1.14 The provincial government is in charge of conducting environmental inspection of waste incineration plants. Plant operators are required to submit an environmental report to the provincial government on an annual basis describing the impact of their activities on the environment.

4.2 Visit to Afval Energie Bedrijf's Waste Fired Power Plant in Amsterdam

4.2.1 During its stay in the Netherlands, the delegation visited Afval Energie Bedrijf ("AEB")'s Waste Fired Power Plant ("WFPP") in Amsterdam to observe the application of the moving-grate incineration technology to treat a large amount of mixed MSW. Members note that AEB, a waste-to-energy company owned by the City of Amsterdam, is committed to expediting a sustainable conversion of waste into energy and valuable, reusable raw materials. Being a municipal organization, AEB has as its primary catchment area the City of Amsterdam itself and 19 affiliated municipalities in the region. Since 1993, AEB has run a waste-to-energy plant which has a processing capacity of 850 000 tonnes per year (i.e. 2 800 tonnes a day). In 1998, AEB planned to develop another waste treatment plant which was WFPP. With an investment of about €420 million, WFPP commenced operation in the end of 2006. The expected technical life span of WFPP is around 25 years.

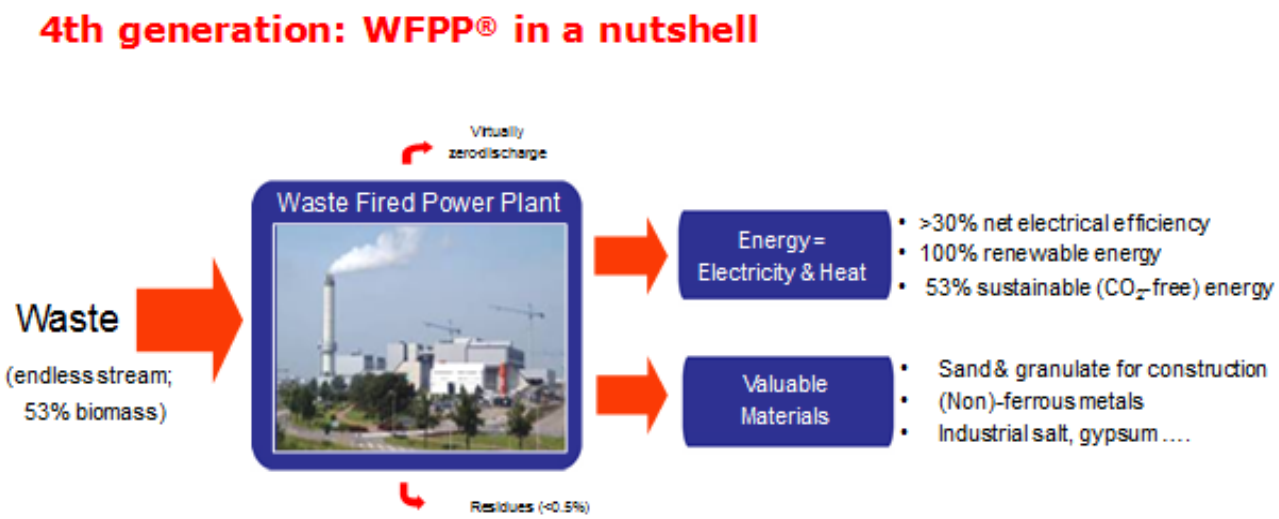
A major concern about combustion incineration is emission. According to AEB staff, the AEB emission is 20% lower than the EU standard. The smoke from the chimney is mostly water vapour and very clean

4.2.2 The delegation received a briefing on the operation of WFPP and then toured around the plant. According to AEB staff, WFPP adopts the moving-grate incineration technology and can process 530 000 tonnes of MSW per year with an availability of 90% of the time (i.e. 1 600 tonnes a day) and achieves a net energy efficiency of 30%, which is very high as an energy efficiency ratio at 20% is internationally considered to be acceptable. With both the original waste-to-energy plant and WFPP, the total processing capacity of AEB is 1.5 million tonnes of waste (including sludge) per year (i.e. 4 400 tonnes a day), making it the largest renewable energy plant in Amsterdam and the world's largest waste-to-energy plant. The plant now comprises six incineration lines.

Mr Erik KOLDENHOF (left), Director for International Advisory of AEB's WFPP, briefed the delegation on the operation of the plant

Members of the delegation visited the Control Room of AEB's WFPP

4.2.3 The delegation notes that WFPP, instead of being just a waste disposal plant, has been developed in the direction of complete reuse of energy and materials. Nearly 99% of the waste treated by WFPP is reused. After the waste treatment process, metals (Ferro and non-Ferro) are extracted and recycled. Bottom ash is washed to supply clean sand and grit for construction purposes. WFPP is also supplying heat to companies and households in Amsterdam. There are about 18 000 households connected to the district heating system. For air pollution control, WFPP uses selective non-catalytic reduction for nitrogen oxide reduction. An electrostatic precipitator has also been adopted for the pre-separation of fly-ash. A fabric filter has been fitted to remove fine particles. Scrubbers are used to clean acid components and ammonia from the flue gas.

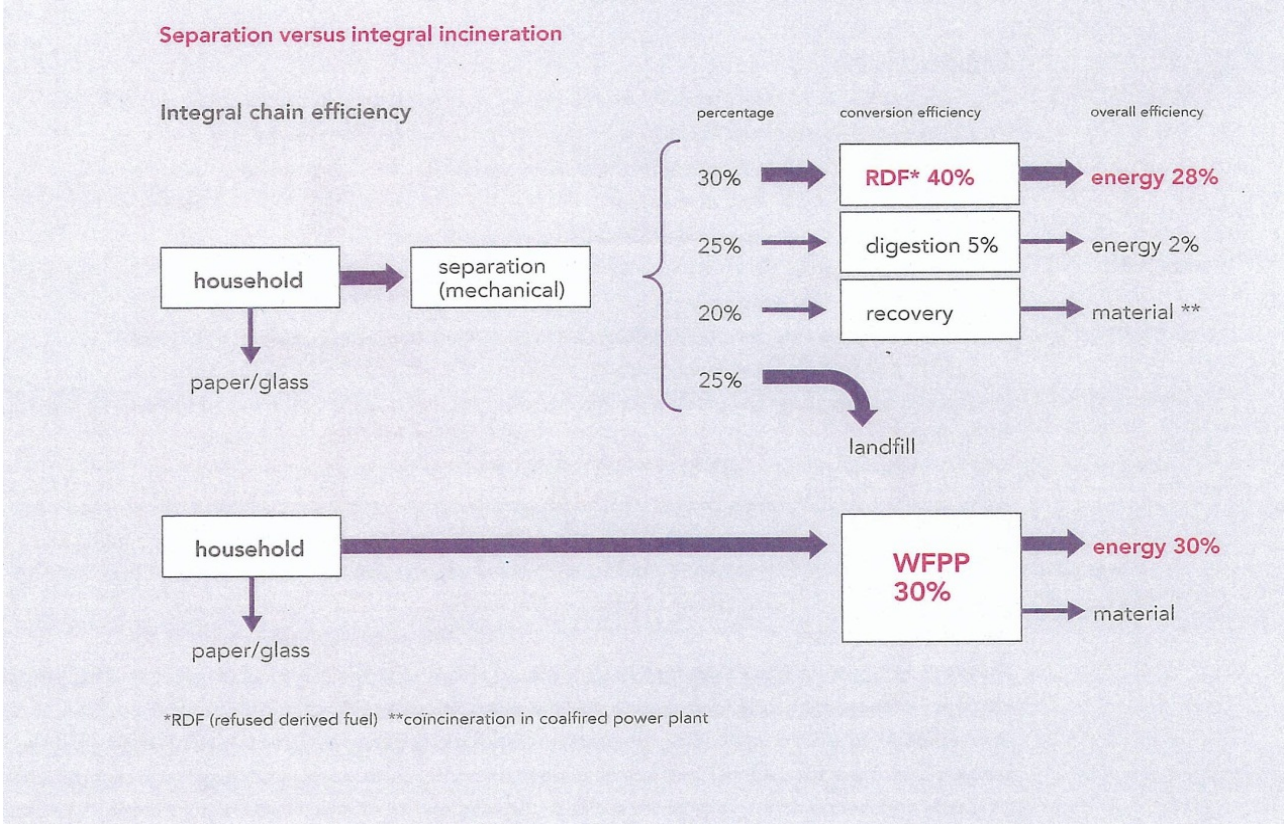


The waste-to-energy process in AEB's WFPP

4.2.4 As advised by AEB staff, the waste for WFPP does not come from Amsterdam alone but is supplied from the whole of the Netherlands. Before the construction of WFPP commenced, AEB had concluded contracts with three national waste collectors/transporters, representing an annual quantity of waste of 495 000 tonnes over 15 years to ensure the supply of waste. This means that 95% of the capacity of WFPP has been contracted for the entire write-off period of the plant. Agreements have also been made with waste suppliers to keep transport of waste by road to the present level in spite of the expansion of the plant by using transport by barge, train and/or waste-presses. AEB staff have further told the delegation that waste has become an international commodity in Europe, which are traded in global markets instead of being landfilled. Countries which are short of enough feedstock to fuel their waste-to-energy plants will import waste from neighbouring countries. For example, the Netherlands is importing waste from the UK and nearly 20% of the waste being treated in the Netherlands is imported waste.

4.2.5 In response to members' question about the reason for the high energy efficiency of WFPP, AEB staff have advised that compared with other thermal waste technologies, the moving-grate incineration technology adopted by WFPP has achieved "optimal recycling". As moving-grate incineration accepts feeding of mixed MSW in a furnace without pre-processing, the integral incineration of waste leaves no

residue for low-yield reprocessing or dumping. According to AEB staff, gasification is usually adopted by smaller-scale treatment plants and it does not work for waste-to-energy plants handling large amounts of mixed MSW. The big advantage of WFPP lies in its robustness and its low costs. The following diagram shows a comparison of the efficiencies of separation incineration and integral incineration –



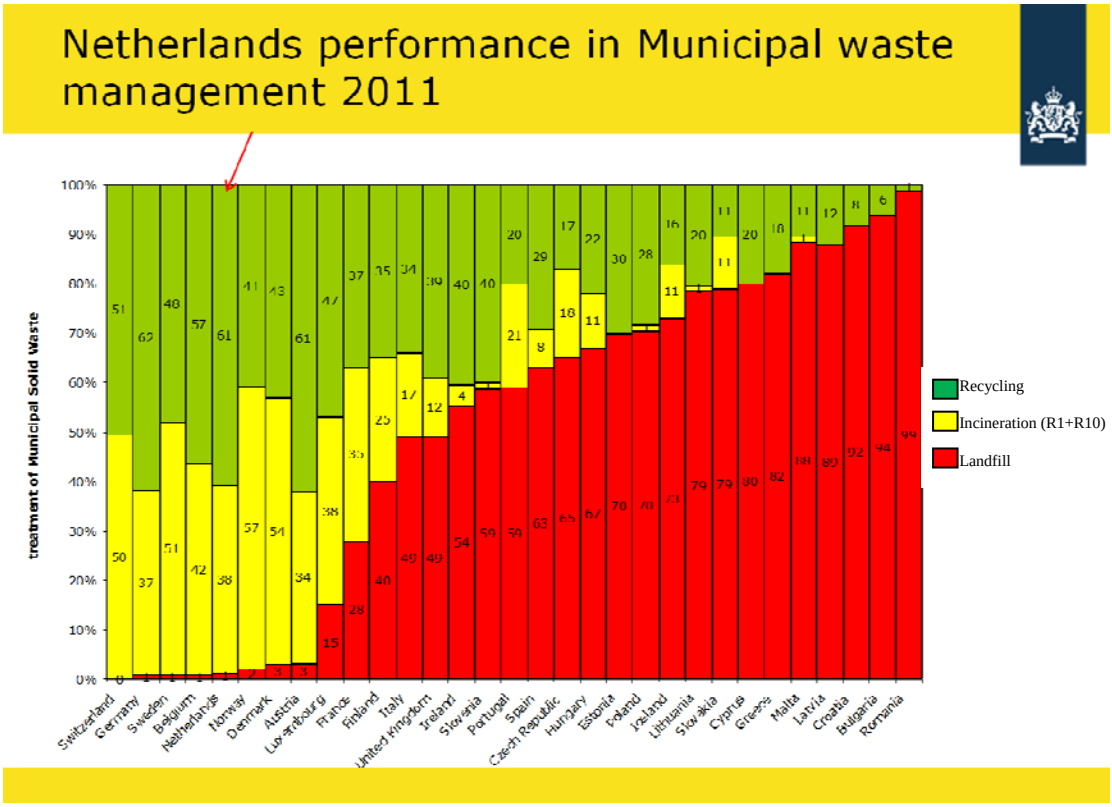
4.2.6 Regarding the distance between the nearest resident and WFPP, the delegation has been advised that WFPP is located approximately four kilometers away from an urban area with a population of about 130 000 and no betterment measure or compensation has been given to the residents. To enlist support from the local community, AEB has launched a communication programme six years before the completion of WFPP to enhance residents' understanding of its operation and facilitate exchange of views amongst relevant stakeholders. AEB also makes WFPP-related information transparent in an understandable language to the public, thereby building trust and credibility. Site visits have been arranged for non-governmental organizations and the public.

4.3 Meeting with government officials and waste management experts

4.3.1 After the visit to AEB's WFPP, the delegation had a meeting with Mr Siebe RIEDSTRA, Secretary General of the Ministry of Infrastructure and the Environment of the Netherlands, and waste management experts in The Hague to learn about the waste management policy of the Netherlands and exchange views on various environmental issues. As mentioned in paragraph 4.1.2, the Ministry of Infrastructure and the Environment is in charge of the overall environmental policies in the Netherlands and responsible for the implementation of EU legislation in national regulations. Rijkswaterstaat is the executive body of the Ministry.

Members of the delegation received a briefing on the Netherlands' policy on circular economy

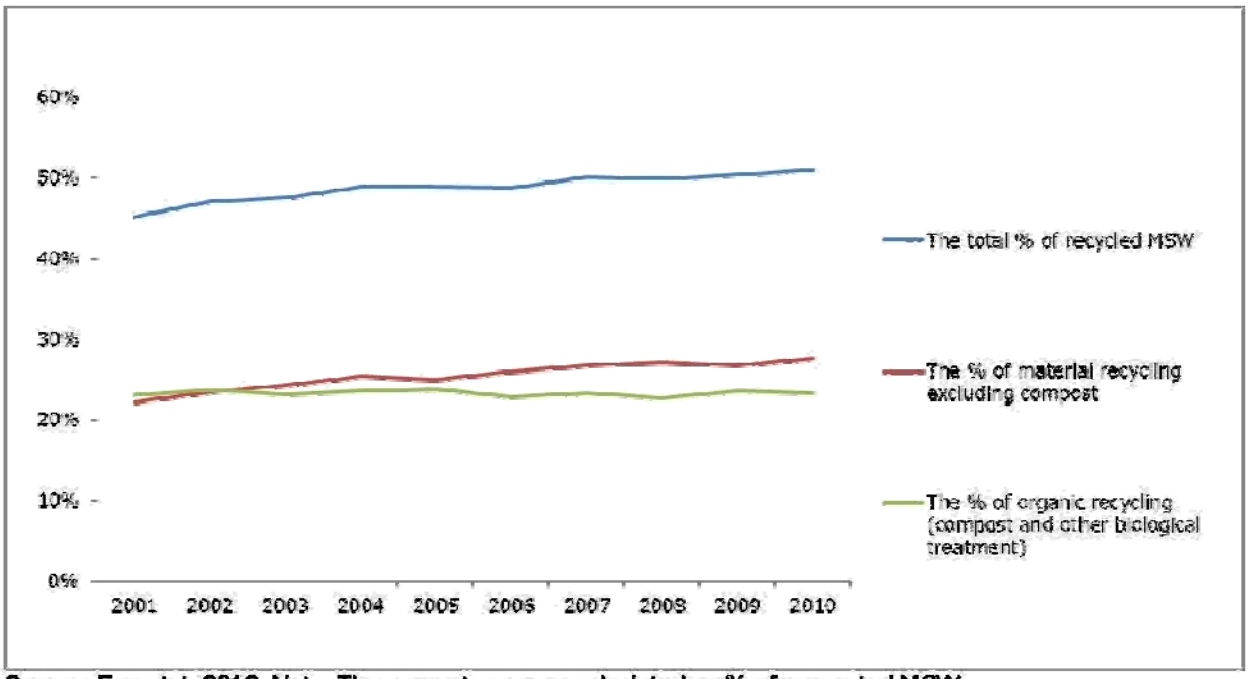
4.3.2 The delegation has been told that the Netherlands has a population of about 17 million, generating 60 million tonnes of waste a year (of which 9.2 million tonnes are household waste). In Europe, the Netherlands has established a leading position in waste management. In 2011, recycling accounted for 61% of waste treated in the Netherlands, while incineration accounted for 38% of the remaining waste. Only 1% of waste was deposited in landfill. Currently, there are 12 waste-to-energy facilities in the Netherlands. The total amount of waste incinerated in 2012 was about 7.5 million tonnes.



In 2011, the Netherlands achieved high recycling and incineration rates while minimizing the amount of landfilled waste to only 1% of MSW

4.3.3 Members also note that recycling has been evolving positively throughout the years in the Netherlands. At present, the total recycling rate of the Netherlands is 80% and MSW recycling rate has reached 52%, meaning that the country has already fulfilled the target of 50% by 2020. As the recycling levels in the Netherlands have been consistently high, it is expected that MSW recycling can reach 55% to 60% by 2020 if the increase rates of the recent years maintain. The following diagram shows

the development of MSW recycling in the Netherlands from 2001 to 2010 –

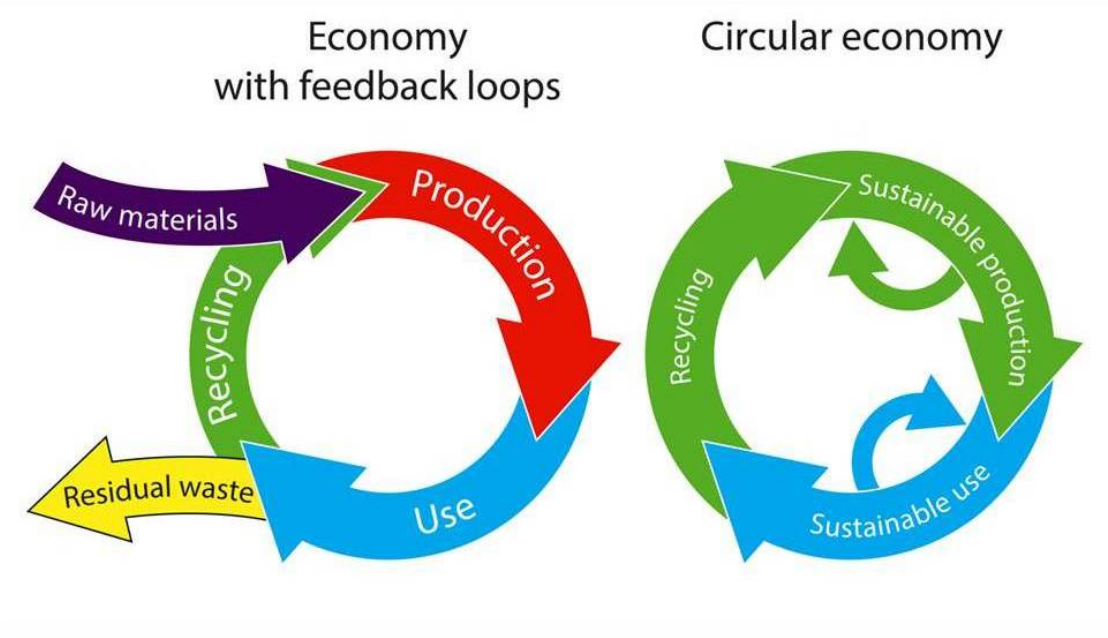


Source: Eurostat, 2012. Note: The percentages are calculated as % of generated MSW

4.3.4 The officials of the Ministry of Infrastructure and the Environment further shared with the delegation the major elements of the waste management policy of the Netherlands (which are set out in detail in paragraphs 4.1.5 to 4.1.8 above). Members learned that the Netherlands had introduced a landfill tax in 1995 in an effort to reduce waste generation by making waste disposal more expensive and at the same time promoting recycling and incineration as more attractive waste management options. In 2000, two different levels of landfill taxes were introduced. Combustible MSW was charged with a high tax, while non-combustible waste with no other favourable recovery alternative was charged with a lower tax. This has resulted in a significant decrease in the percentage of MSW landfilled. The landfill tax together with additional measures, such as the waste charging scheme whereby households pay in proportion to the quantity of waste generated, have acted as strong drivers to divert MSW from landfills and maximize recycling.

4.3.5 The elements of the waste policy of the Netherlands are shown below –

4.3.6 The officials of the Ministry of Infrastructure and the Environment have further told the delegation that the future challenge of waste management is to achieve a circular economy in the Netherlands. To meet this challenge, a "Waste to Resource" programme has been developed which aims at stimulating the transition to a circular economy. The transition requires a broad, integral and Cabinet-wide approach. Therefore, the Ministry of Infrastructure and the Environment works intensively with other ministries. Details of the "Waste to Resource" programme are set out in the fact sheet in **Appendix IV**. Rijkswaterstaat will stimulate integrated waste prevention throughout product chains. It will also promote sustainable consumption and production inside and outside the Netherlands.



The "Waste to Resource" programme proposes a transition to a circular economy in the Netherlands to encourage repeated uses of resources and materials

4.3.7 On the considerations about different thermal waste treatment technologies, the Dutch waste management experts have advised the delegation that ATT includes gasification, plasma gasification and pyrolysis. The number of plants in commercial operation using ATT is unclear but such plants generally have low annual treatment capacity and require a homogeneous waste input. ATT also has few proven record of reliability and efficiency in large-scale treatment plants. While ATT plants in Japan are operating on a high gate fee, those in Europe have largely failed.

4.3.8 In reply to members' enquiry, the experts have stressed that when making the decision to adopt incineration for waste recovery, it will be of paramount importance to have open and sincere communication with the local communities and non-governmental organizations. Information related to the incineration proposal should be made readily available at all times for public inspection. When the proposed waste-to-energy plant comes to operation, real-time publication of the monitoring results should also be made on the internet. On the emissions level, compared to modern energy-from-waste facilities, with flue gas cleaning, emissions of ATT are not lower. However, lower flue gas quantities are to be expected.

4.3.9 While in the Netherlands, the delegation also attended a lunch hosted by Ms Carolien GEHRELS, Vice Mayor of Amsterdam, with various government officials to learn more about the waste management strategy of the city and shared views on environmental issues of mutual concern.

Chapter 5 — Waste management in Denmark

5.1 Overview of the waste management policies in Denmark

5.1.1 The Danish waste management has progressed markedly over the years. A clear division of roles, responsibilities and competence between the individual actors of the waste system (such as state and local authorities, waste management companies and waste generators) has facilitated the progress. Denmark has now become one of the countries in the world achieving high incineration rates and minimized amount of landfilled waste. However, Denmark is also one of the European countries producing the most waste per inhabitant. In 2011, Danish households produced 447 kg of waste per person.

5.1.2 Waste management in Demark is primarily governed by the *Environmental Protection Act.* There are also specific waste management laws governing different waste-related matters. The Ministry of the Environment is the government agency in charge of the overall environmental policies. Under the Ministry, the Environmental Protection Agency is responsible for setting out the overall framework for waste management.

Landfilling, incineration and recycling

5.1.3 Landfilling was the primary means of disposing waste in Denmark in the 1970s. In 1982, the Danish Government revised the environmental protection law requiring counties and municipalities to devise waste disposal strategies. To improve municipal waste management, Denmark introduced landfill and incineration taxes in 1987 and became the first country to completely ban landfilling of combustible waste in 1997.

5.1.4 The enactment of EU's *Landfill Directive* in 1999 further shifted the Danish waste treatment paradigm from landfilling to recycling. The amount of waste going to landfill decreased notably along with the separation of combustible and non-combustible waste. Moreover, the establishment of separate collection schemes for paper, glass packaging, and garden waste has contributed significantly to the increased level of recycling within the country. As a result, the recycling rate of municipal waste went up from 14% in 1995 to 31% in 2011. The incineration rate

remained at around 55% whereas the percentage of municipal waste landfilled dropped considerably from 18% to 3% over the same period.

Thermal waste treatment

5.1.5 Thermal waste treatment was introduced in Denmark in 1903 with the establishment of the first waste incineration plant in Copenhagen. After more than a century of development, the technology has been integrated into the Danish waste management system with a high level of public acceptance. MSW management in Denmark is now characterized by a high degree of incineration. Around one-quarter of all Danish waste ends at waste incineration plants. The waste incineration plants supply about 20% of district heating and 5% electricity. Since incineration plants typically provide heat in addition to electricity to district heating systems, they are usually located in dense urban areas. Danes rarely have objections to the localization of an incineration plant in their municipality or neighbourhood.

5.1.6 At present, Denmark has 25 waste incineration plants that process waste from household and business sectors, with a total incineration capacity of around 4 million tonnes per year. Most Danish incineration plants are owned by municipalities or inter-municipal companies. Although some of the plants were commissioned in the 1980's, they have either been upgraded or with new lines installed to meet the emission standards.

Incineration tax

5.1.7 Tax on incineration was introduced on 1 January 1987 along with the introduction of landfill tax. Since 2010, the incineration tax has been related to the amount of energy produced as well as the amount of CO_2 emissions produced from the incinerated waste. At present, the tax for incineration is €44 (about HK$466) per tonne of waste.

Environmental permit

5.1.8 In Denmark, an environmental permit from the Environmental Protection Agency is required for the installation of waste incineration plant, or when the operation of the plant is subject to significant changes or expansion.

Environmental inspection and reporting

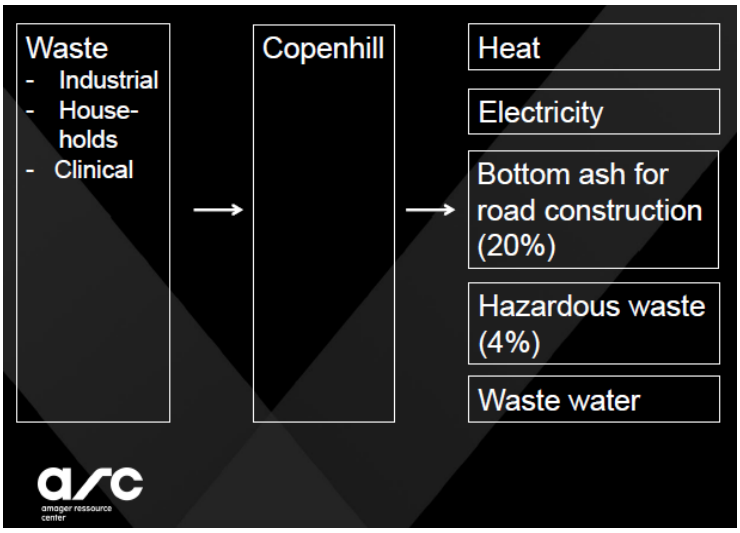
5.1.9 Environmental inspections of waste incineration plants are conducted by municipalities which are obliged to submit a report on their inspections and approvals to the Environmental Protection Agency. Penalties will be imposed on operators who fail to comply with the provisions on operating their incineration plants.

5.2 Briefing on the Amager Bakke Waste-to-Energy Plant project

5.2.1 The delegation visited the House of Green[9] and received a briefing on the Amager Bakke Waste-to-Energy Plant project ("Amager Bakke"). Members note that Amager Bakke, also known as "Copenhill", is a waste-to-energy plant under construction by the Amager Resource Center ("ARC") in Copenhagen. ARC is a waste and energy company owned by the City of Copenhagen and four nearby municipalities. Its core businesses are waste-to-energy incineration and recycling. ARC currently operates a waste-to-energy plant in Copenhagen and supplies around 150 000 households with district heating and electricity every year. It also operates 13 recycling stations and a large controlled landfill.

The delegation received a briefing on Amager Bakke

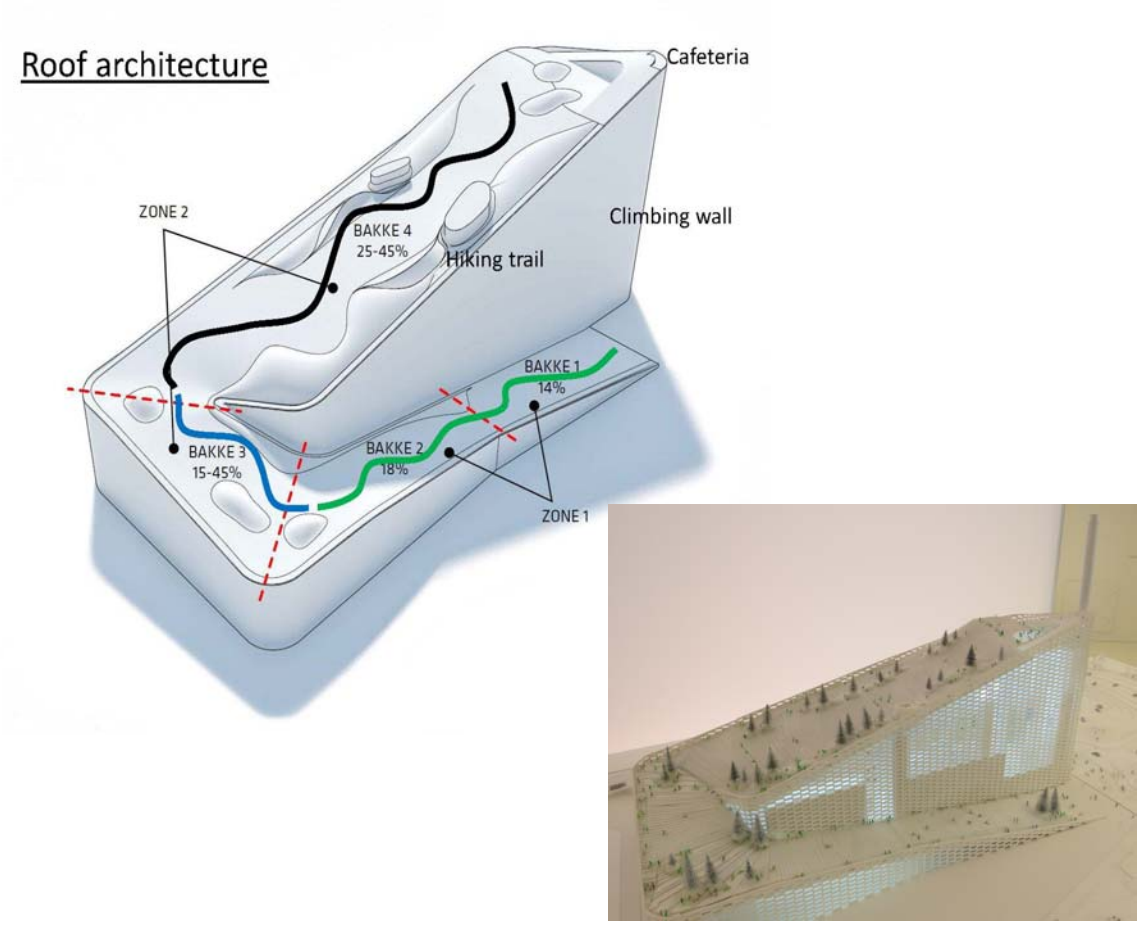
[9] The House of Green is an interactive showroom and visitor centre located in Copenhagen to showcase Denmark's green technology in the fields of energy, water, climate, resources and the environment.



The waste-to-energy process in Amager Bakke

5.2.2 Members have also been advised that Amager Bakke is estimated to cost €470 million (about HK$5,007.8 million). It will employ the moving-grate incineration technology to treat about 400 000 tonnes of waste annually (i.e. around 1 500 tonnes of waste per day). Amager Bakke has an innovative architectural design, with its rooftop to be integrated with a ski slope, a walking trail, a climbing wall and a cafe, to serve as a recreational area for the public, paired with high environmental performance and energy efficiency. New apartments will also be built next to the facility, forming an integrated part of the urban setting. The construction of Amager Bakke began in March 2013 and it is scheduled for commission in 2017.

The delegation observed the model of Amager Bakke



The novel architectural design of Amager Bakke makes the facility a landmark in Copenhagen

5.2.3 According to Mrs Ulla Röttger, Managing Director of ARC, new engineering and architectural approaches to integrate or interact with the surrounding environment are leading to a new generation of waste-to-energy facilities. Modern waste-to-energy facilities will break with all known standards of functionality and design, adding a new dimension to the urban landscape. Apart from creative designs, these facilities will have multi-functional purposes. Amager Bakke is an example of innovative architectural design paired with sustainability and energy efficiency. The facility has a dual purpose of CHP production and recreational area for Copenhageners. It will supply low-carbon electricity to 550 000 citizens and heat to 140 000 households in Copenhagen. Meanwhile, the rooftop of Amager Bakke will be open to the general public to offer a new way of interaction amongst Copenhageners, visitors and the city, making the top of "Copenhill" the highest vantage points in Denmark.

5.2.4 In short, the delegation has been told that the integration of communal recreational activities, aesthetically appealing design and a highly efficient power recovery plant makes Amager Bakke a highly successful and innovative environmental project in Europe.

5.2.5 Members also learned that in January 2011, there were concerns about the sustainability and environmental impacts of Amager Bakke. Some city planners proposed to reduce the treatment capacity of the facility to half and export waste to adjacent municipalities. In October 2012, the City Council of Copenhagen gave their formal approval of the establishment of Amager Bakke. It was because the facility would be 25% more efficient than old waste-to-energy plants. Moreover, if the waste that Amager Bakke would handle was to be buried in landfills, the decomposition would have led to greater atmospheric harm through release of methane, greenhouse gas which would be 25 times more potent than CO_2 as a heat-trapping gas.

Group photo taken at the House of Green

5.3 Visit to KARA/NOVEREN's Waste-to-Energy Facility in Roskilde

5.3.1 The delegation notes that Denmark's existing waste-to-energy facilities have been optimized and existing capacity replaced, but no new thermal treatment capacity has been established since 2002. KARA/NOVEREN, a non-profit company owned by nine municipalities and situated in the west and south of Copenhagen, is the first waste management company to receive the authorities' approval since 2002 to develop a new waste-to-energy facility. The delegation visited KARA/NOVEREN's new waste-to-energy facility in Roskilde.

The exterior design of KARA/NOVEREN's Waste-to-Energy Facility in Roskilde

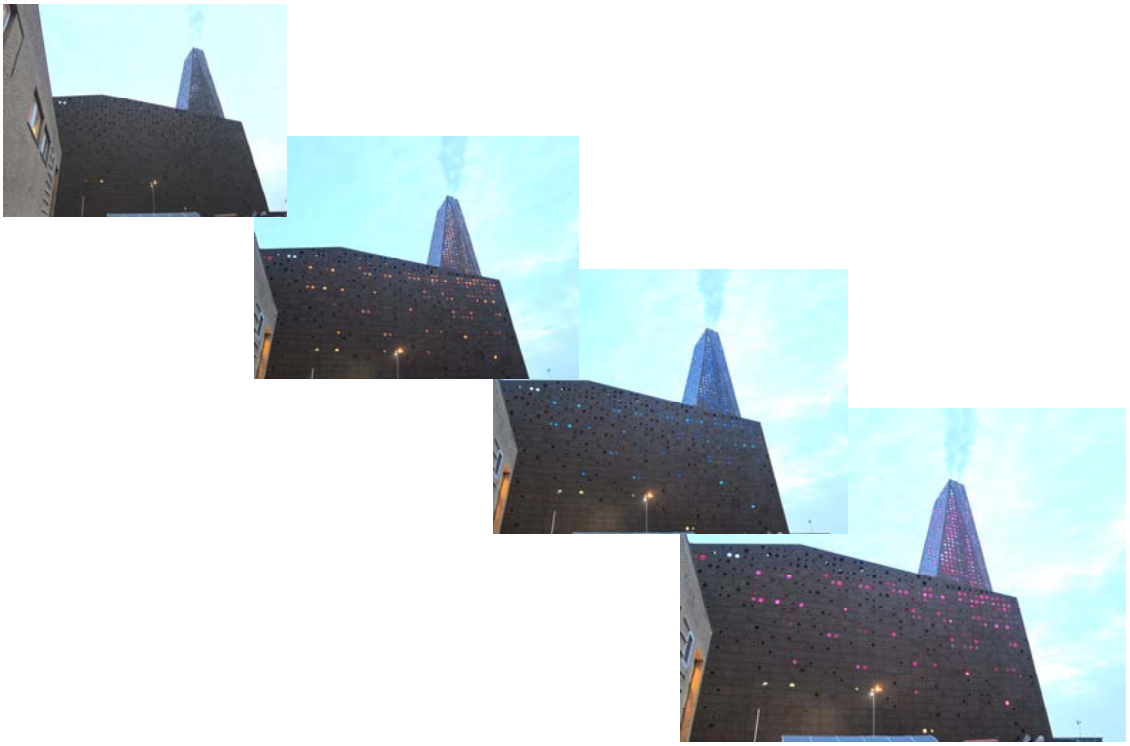
5.3.2 The delegation received a briefing on the design and operation of the facility and toured the Energy Tower. According to the representatives of KARA/NOVEREN, the project cost of the facility is about €175 million (about HK$1,864.6 million), of which €9 million is the design fee. Scheduled for commercial operation in 2013, the facility adopts the moving-grate incineration technology and is capable of meeting the capacity demands for thermal treatment of waste generated in its nine owner municipalities (i.e. about 2 500 tonnes of waste per day). The energy output of the facility is around 19MW of electricity and 52MW of heat. The facility has four main parts, i.e. an incineration chamber, a boiler where the heat of combustion is converted to steam, a

flue gas treatment unit, and a turbine to produce electricity and district heating.

The delegation received a briefing on the operation of KARA/NOVEREN's Waste-to-Energy Facility

The control room of KARA/NOVEREN's Waste-to-Energy Facility where staff will monitor the waste-to-energy process 24 hours a day

5.3.3 On the design of the facility, members learned that KARA/NOVEREN had held a design competition for the facility in order that it would become an architectural landmark, and the design by the world famous Dutch architect, Erick van Egeraart, was selected as it could embrace the historic and industrial heritage of the surrounding area. The large, outspoken, amber-coloured design gives an insight into the hidden processes of transforming waste into energy. At night, the backlighting of the perforated façade will transform the spire to an illusion of a glowing beacon, symbolizing the energy production inside the facility. On special occasions, the building will be illuminated, and for a few minutes every hour a spark will gradually grow into a blazing flame eating up the entire building. The facility also forms an axis with the Cathedral of Roskilde.

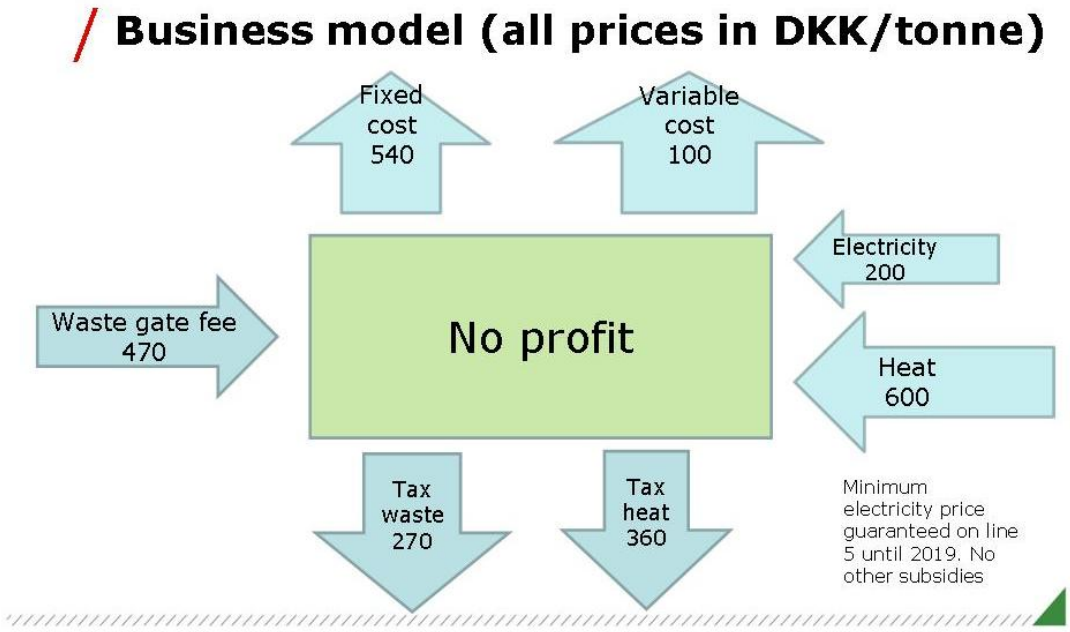


Circular openings in the building's aluminium facade serve to transform the station into a beacon at night, when light from the facility shines through the exterior

5.3.4 The representatives of KARA/NOVEREN further told the delegation that the local community was engaged in the planning process and there had been protests against the height of the stack and the main building of the facility. After half-a-year's negotiation, the height of the

stack was reduced from 115 meters to 98 meters and the building was reduced by 8 meters.

5.3.5 In response to members' question about the business model of the facility, the representatives of KARA/NOVEREN have advised that the facility does not receive any government subsidy. The major revenues of the facility comes from the waste gate fee and the wholesale of electricity and heat, while the expenditure includes the fixed and variable costs for operating the facility, the waste tax and the heat tax. There is no profit or loss in the business. If the operating costs go up, the waste gate fee will be adjusted to a higher level in order to ensure the efficient running and financial balance of the facility. The design life of the facility is 25 years. The following is the business model of the facility –



5.3.6 Members have also been informed that the facility adopts the moving-grate technology because it allows mixed MSW to be fed into a furnace without pre-processing. Other waste treatment technologies such as gasification or plasma gasification require pre-processing of waste, leading to higher operating and capital costs in comparison with the moving-grate incineration technology. The major part of the waste treated by the facility is household and C&I waste.

The delegation took a group photo outside KARA/NOVEREN's Waste-to-Energy Facility

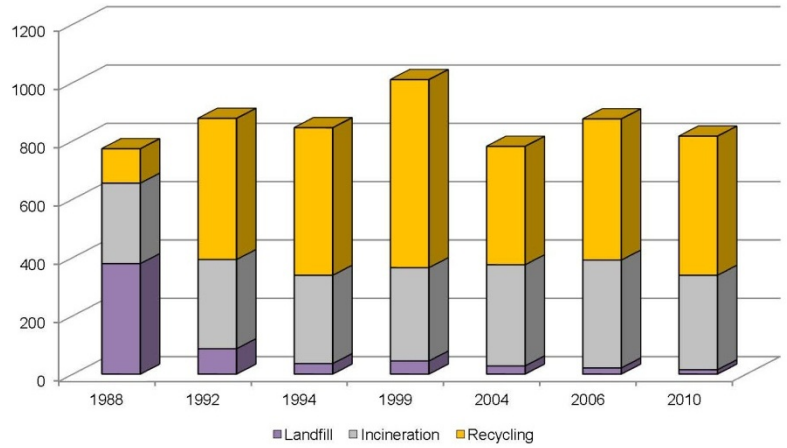
5.4 Meetings with government officials

5.4.1 During its stay in Denmark, the delegation met with officials of the Technical and Environmental Administration of Copenhagen, the Ministry of the Environment of Denmark and the Danish Environmental Protection Agency to study the country's experience in waste management policies and infrastructure.

Meeting with the Technical and Environmental Administration of Copenhagen

5.4.2 At the meeting with Mr Morten KABELL, Technical and Environmental Mayor of Copenhagen, and other officials of the Technical and Environmental Administration, the delegation has been advised that as set out in the Resource and Waste Management Plan 2018, the City of Copenhagen targets to reduce the quantities of waste for incineration by 20% and to have at least 45% of household waste recycled by 2018. Over the past 20 years, more and more MSW has been diverted from landfilling to recycling or incineration. As the amount of waste going to landfill has been decreasing significantly, the recycling rate has been going up and the incineration rate has remained steady. The

bar chart below shows the shift in the waste treatment methods in the City of Copenhagen from landfilling to incineration and recycling in the past 20 years –



5.4.3 Furthermore, the delegation has been told that public acceptance of waste incineration is generally high in Denmark. Since incineration plants provide heat in addition to electricity for district heating systems, they are usually located in urban areas. To make incineration plants more attractive to local residents, new plants in Denmark are built based on creative designs and multi-functional purposes. The Amager Bakke Waste-to-Energy Plant project currently under construction is a good example.

5.4.4 In reply to members' enquiry about the recycling of waste plastics in Denmark, the officials of the Technical and Environmental Administration have advised that Copenhagen plans to divert plastic waste away from incineration to separate collection and reprocessing into a quality allowing for the manufacture of new plastics. The target is to separate around 35% of the plastics contained in waste suitable for incineration by 2018. As the technologies for sorting and treatment of plastics have been developing and improving continuously, the share of plastics that can be recycled will increase. Besides, since waste has become an international commodity in Europe, Copenhagen will export waste plastics to neighbouring countries such as Germany for sorting and recycling. On education front, members note that a wide array of educational programmes and campaigns are being rolled out in the local

communities to promote waste reduction and recycling, thereby facilitating the public to understand more about proper waste management.

Members of the delegation exchanged views with
the Technical and Environmental Mayor of Copenhagen on waste management policies

Meeting with the Ministry of the Environment of Denmark and the Danish Environmental Protection Agency

5.4.5 The delegation also had a meeting with Mrs Kirsten BROSBØL, Minister of the Environment, and other officials of the Ministry of the Environment and the Danish Environmental Protection Agency to learn about Denmark's waste management policies. Members note that the Ministry of the Environment is the government agency in charge of the overall environmental policies and state-level administrative matters relating to the environment in Denmark. The Danish Environmental Protection Agency is part of the Ministry of the Environment and tasked with a wide range of environment-related issues, ranging from waste management, sustainable development, tackling air and noise pollution, use of chemicals and pesticides, to agriculture etc.

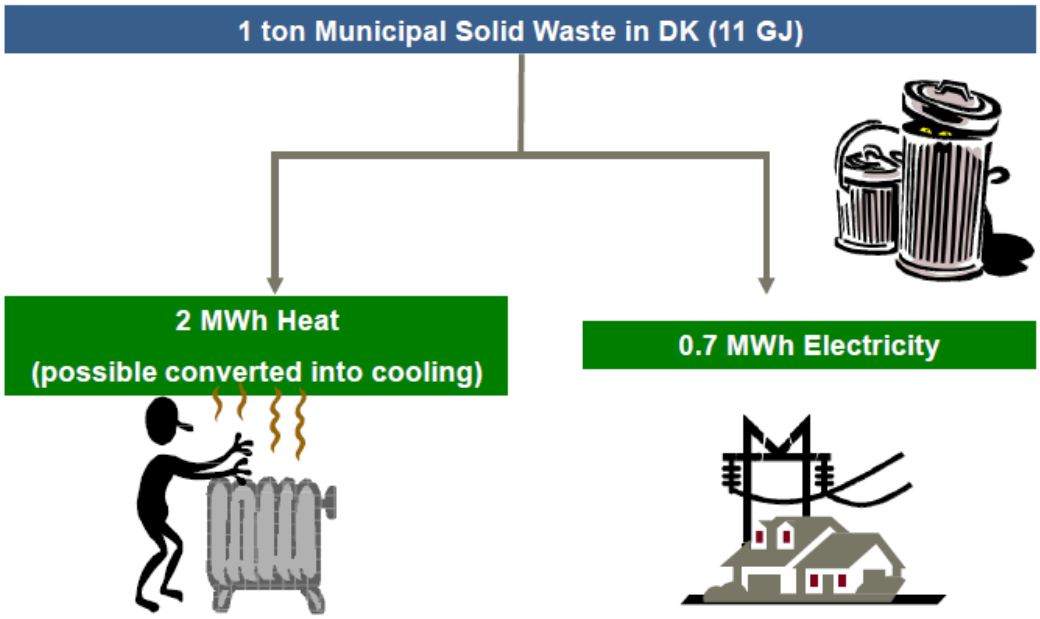
The delegation received a briefing by the Minister of the Environment of Denmark on the waste management policy of Denmark

5.4.6 The delegation has been told that Denmark introduced landfill and incineration taxes in 1987 and became the first country to completely ban landfilling of combustible waste in 1997. At present, the tax for incineration is €44 (about HK$466) per tonne of waste while that for landfill is €64 (about HK$678) per tonne of waste. The introduction of landfill tax and incineration tax has not only resulted in waste reduction in Denmark, but has also provided strong economic incentive for recycling. The figures below illustrate that in 2011, about 9 million tonnes of material ended up as waste in Denmark, of which 61% was recycled, 29% was incinerated and 6% was landfilled –

	1985	2011
Total waste generation (mill tonnes)	9	9
Treatment and disposal of waste (%)		
Recycling	35	61
Incineration with energy recovery	26	29
Landfilling	39	6

5.4.7 According to the officials of the Ministry of the Environment, Denmark has been incinerating almost 80% of household waste in the recent decades. Even though incineration has made an important contribution to green energy production, materials and resources have been lost. To move towards perceiving waste as resources which can be reused and recycled, the Danish Government issued a document entitled "Denmark without Waste: Recycle more-incinerate less" in November 2013 to present its new approach in waste management as well as to set out its goal of recycling 50% of household waste (including food waste) by 2022. In the long run, Denmark will recycle more and incinerate less waste. Recycling of waste will become an economically attractive option for the public and private sector. Widespread source separation and collection of waste will also facilitate the development of functional markets for secondary raw materials.

5.4.8 The delegation has further been informed that as compared with many other countries, there is no public opposition to waste incineration in Denmark. There are around 500 000 Danes living within five kilometers from incineration plants, but the community has no objection against waste incineration and no betterment measures or compensation is given to residents. Public acceptance of waste incineration is generally high in Denmark as incineration plants are the mainstay of garbage disposal and crucial fuel sources. They provide cheap and clean energy. Currently, waste incineration plants provide about 20% of heating and 5% of electricity used in Denmark. In Denmark, incineration facilities are regarded as infrastructure that can integrate with the surrounding environment for the public to enjoy.



About 2 MWh of heat and 0.7 MWh of electricity will be recovered from every tonne of MSW in Denmark

5.4.9 In reply to members' enquiries about the key to achieve high public acceptance for waste infrastructure, the officials have emphasized the importance of democratic process and public engagement throughout the planning and development stages. They have further advised that in Denmark, there is a high degree of transparency in the decision-making process that informs members of the public of the project details and they can participate in the process. People can voice their concerns and opposition and their views will be taken into account. Besides, the authorities pay close attention to the emissions of the plants to ensure that the plants are safe. People are aware that EU and the Danish Government have placed strict regulations on emissions from waste incineration and are confident that such regulations will be enforced.

5.4.10 Members have also learned that most waste incinerators are publicly owned and engaged in many waste management activities other than incineration. For example, plant operators will undertake public engagement for the community to understand the operation of their incineration plants and express views on the planning and design of the plants. In future, to make incineration plants more attractive to local residents, new plants in Denmark will be built based on creative designs and multi-functional purposes. Waste facilities will also be equipped

with new technologies for separation and recycling such that recyclable waste will not be incinerated. The officials have stressed that as the Danish people have strong sense of environmental protection, there have been public calls for the Danish Government to continuously improve its waste management system and introduce new legislation on waste management.

5.4.11 On the selection of waste treatment technologies, the delegation has been advised that the development of gasification technology is in its infancy and not widely adopted in Denmark. Neither is the plasma gasification technology a common technology selected for waste treatment and energy recovery in Denmark. To develop a circular economy and minimize the potential loss of resources in waste materials, local waste management companies and waste incinerators are committed to the development of more sustainable waste management solutions.

Chapter 6 — Waste management in Sweden

6.1 Overview of the waste management policies in Sweden

6.1.1 Sweden has established an effective waste management system with only 1% of MSW ended at landfills in 2011. The treatment of the remaining MSW was characterized by an almost equal share of recycling/composting (48%) and incineration (51%).

6.1.2 The Ministry of the Environment is responsible for formulating national policies on environmental issues and co-ordinating the Government's work on sustainable development. It has established the Swedish Environmental Protection Agency to co-ordinate and promote environmental policies and protection, as well as to implement environmental regulations and issue guidelines for regulation compliance. Local municipalities are responsible for collecting and treating household waste, and working out their own sanitation plan and regulations for local waste management.

Important initiatives taken to improve MSW management

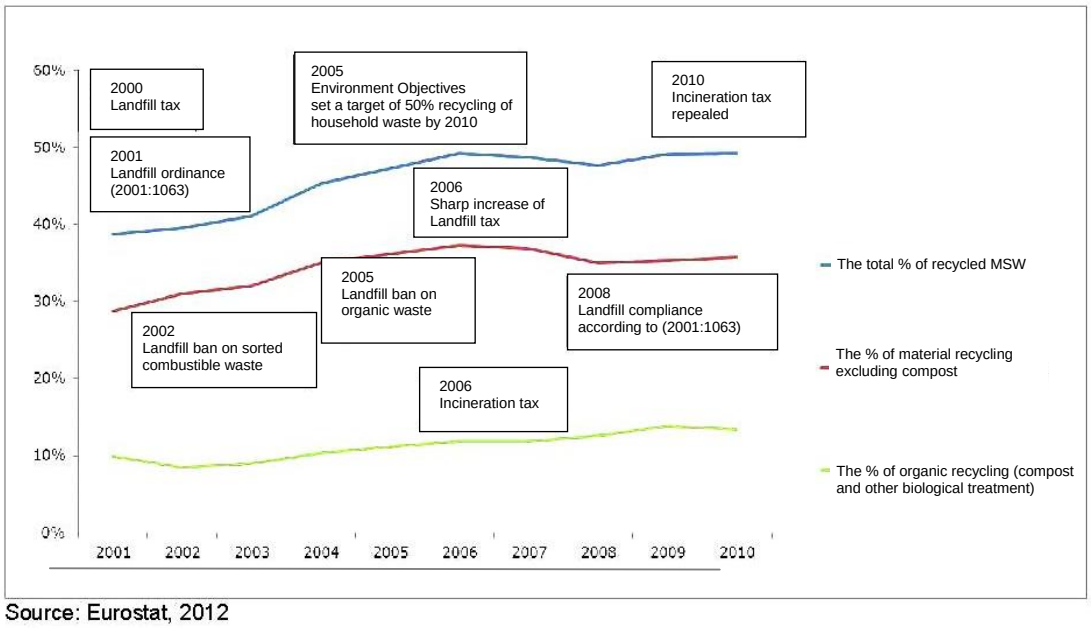
6.1.3 The waste management policy in Sweden is primarily governed by the *Environmental Code* and the *Waste Ordinance* – the former sets out the framework for promoting sustainable development while the latter contains general provisions for the regulation of waste management. Sweden is also governed by the *Industrial Emission Directive* issued by EU which commits its member states to controlling and reducing the impact of industrial emissions on the environment.

6.1.4 Currently, Swedish waste management system is enshrined by the waste hierarchy under EU's *Waste Framework Directive*, which places waste prevention as the priority, followed by reuse, recycling and other recovery (such as waste incineration with energy recovery). The last option for treating waste is disposal without energy recovery, like landfilling. Swedish waste management is also characterized by a clear division of responsibilities for all involved stakeholders, including municipalities, individual households and producers.

6.1.5 Municipalities have traditionally undertaken the management of waste in Sweden. Since 1991, Swedish municipalities have come under the obligation of laying down a detailed waste management plan to set out their measures to reduce the quantity and hazardousness of waste. The plan shall also contain targets based on national environmental objectives.

6.1.6 Throughout the years from 1994 to 1998, several ordinances on producer responsibility for a range of materials (e.g. packaging waste, paper, oil, etc.) came into force, imposing upon producers the physical and economic responsibility for collecting and disposing of certain end-of-life products. These measures improved the management of waste and paved the way to a sustainable reuse, recycling or safe disposal of materials.

6.1.7 In 2005, the Swedish Environmental Protection Agency issued "A Strategy for Sustainable Waste Management – Sweden's Waste Plan" to lay down the direction of waste management in the next five years and set distinctive targets to be met by 2010, based on the Swedish Environmental Objectives enacted by the Swedish Government in the same year. A challenging target was the 50% recycling of household waste by 2010, which was nearly attained.



Source: Eurostat, 2012

Recycling of MSW and other important waste management policies in Sweden

6.1.8 The Swedish Government has issued a new waste management plan to set out measures for promoting further material recycling. To increase MSW recycling, the recycling of household waste shall increase by making it easier to sort out and submit materials for recycling or reuse. The plan also sets specific goals for food waste, promoting food waste management into a priority area to be considered in future.

Landfilling

6.1.9 The landfill tax which came into force on 1 January 2000 played a vital role in the diversion of MSW from landfill in favour of recycling and incineration. Consecutive increases in taxation level in 2002, 2003 and finally in 2006 instigated a continuous increase in material recycling of MSW. The landfill ban on sorted combustible waste in 2002 and the landfill ban on organic waste in 2005 were catalysts for the diversion of MSW from landfills.

Thermal waste treatment

6.1.10 Incineration is currently the major thermal waste treatment technology adopted in Sweden while other thermal waste treatment technologies, such as pyrolysis and gasification, are rarely used due to the concerns over the limited track record on treating MSW and the energy efficiency of the process. A tax on incineration was introduced in 2006 to boost material and organic recycling but was repealed in 2010. Since then, incineration has gradually picked up its share of waste handled and accounted for 2.2 million tonnes or 51% of MSW treated in 2011.

6.1.11 In recent years, Sweden saw an increase in incineration capacity with the start-up of new plants and capacity expansion at existing plants. At present, Sweden has an incineration capacity of about 6 million tonnes of MSW per year. However, it is producing less burnable waste than it needs for fuelling its incineration plants as Swedes have been recycling efficiently. To meet the feedstock requirements for its incineration plants, Sweden starts importing about 800 000 tonnes of waste from other European countries annually. Imported waste has become an increasingly important source of Swedish district energy system. Waste incineration is widely accepted in Sweden. Some incineration plants are located close to the residential area or city centre.

6.1.12 Sweden has the highest rate of energy recovery from waste incineration. A number of incineration plants in Sweden adopt CHP applications to produce both heat and electricity simultaneously. The generated heat is distributed through district heating grids and the electricity generated is sold in the power market. The sale of heat is the largest and most dependable revenue stream for Swedish CHP plants. Every year, waste incineration produces heating which corresponds to the need of 810 000 households, approximately 20% of all the district heating produced. It also produces electricity which corresponds to the need of more than 250 000 houses. Apart from the 31 plants for incineration of household waste, there are other waste-to-energy facilities including over 30 composting plants and 18 anaerobic digestion plants.

Environmental permit

6.1.13 Waste incineration plants are statutorily required to have environmental permits for operation. The permit sets out the terms regulating the environmental impact of a permitted facility such as the permissible amount of pollutants that can be emitted. Application for an environmental permit must be accompanied by an environmental impact report for the proposed waste incineration plant.

Self-monitoring and reporting

6.1.14 To enforce the compliance with the statutory requirements for waste incineration plants, it is mandatory for plant operators to establish a self-monitoring system.

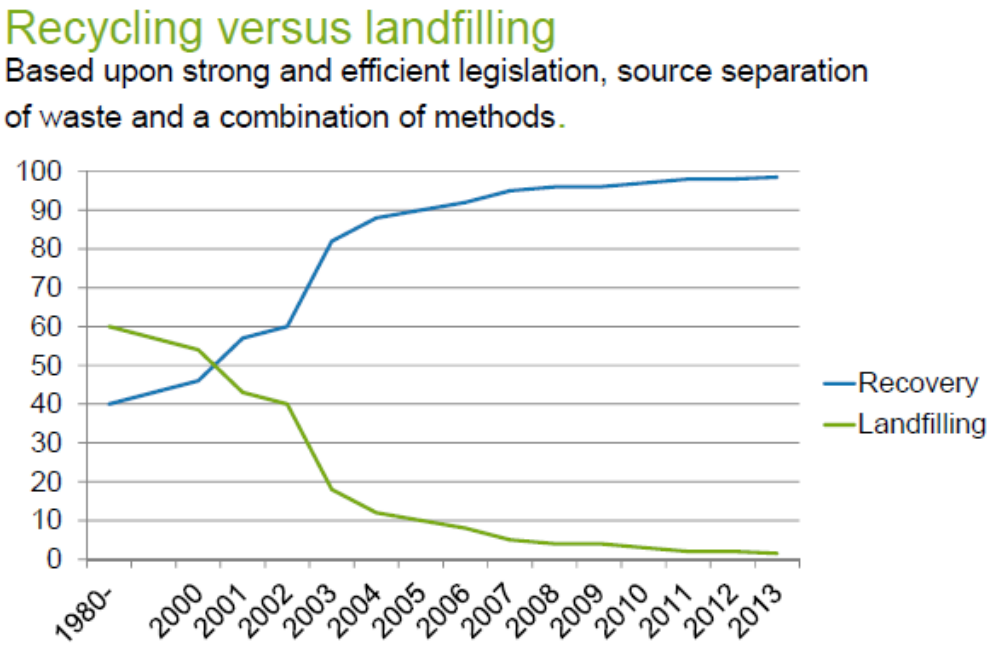
Penalty

6.1.15 According to the *Environmental Code*, any operators of waste incineration plants creating pollution that is significantly harmful to human health, animal or plant, or cause serious harm to the environment, may be convicted for environmental crime and liable to a fine and/or imprisonment.

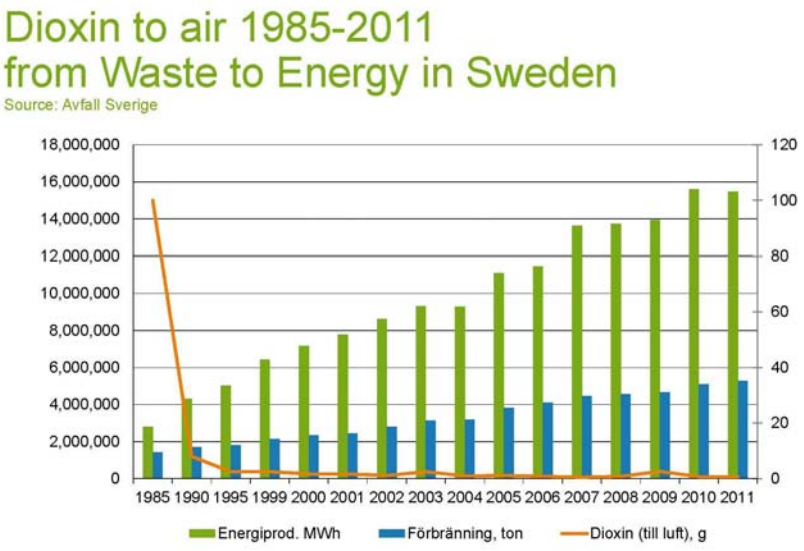
6.2 Visit to Sysav's Waste-to-Energy Plant and meeting with representatives of relevant organizations and government departments

Sysav's Waste-to-Energy Plant

6.2.1 During its stay in Sweden, the delegation visited Sysav's Waste-to-Energy Plant in Malmö and had a meeting with representatives of relevant organizations and government departments to learn about Swedish waste management experience. Sysav is a waste management company owned by 14 municipalities with a joint population of about 706 000 in the south of Skåne, the most southern region of Sweden. Sysav receives, recycles and treats waste from households and industries in southern Scania. Using waste as a fuel, and thereby recovering energy in the form of district heating and electricity is one of Sysav's waste treatment methods. Other treatment methods include reuse, recycling, biological treatment and management of hazardous waste, as well as landfill. Out of the 984 000 tonnes of waste handled by the Sysav Group in 2013, 98.5% was recycled as material or energy and only 1.5% was landfilled.



Sweden sees a diversion of MSW from landfilling (annotated by the green line) to recycling (annotated by the blue line) through effective legislation, source separation of waste and a wide array of waste management initiatives



In Sweden, the level of dioxin emitted from the waste-to-energy process (annotated by the orange line) has been decreasing in the recent 20 years

6.2.2 The delegation first received a briefing on the operation of Sysav's waste-to-energy plant and then toured the plant. According to Sysav staff, the waste-to-energy plant uses the moving-grate technology and it has four boilers. The two oldest came into operation in 1973 and they are hot-water boilers for producing district heating. The two newest boilers are steam boilers and generate both electricity and district heating. They came online in 2003 and 2008 respectively. In total, the plant is permitted to process 580 000 tonnes of waste a year and produce 1 400 000 MWh of district heating which roughly equals to the heating of 70 000 small houses and 250 000 MWh of electricity a year. The waste combusted in the plant is made up of domestic waste and combustible waste from C&I establishments and recycling centres. Sysav also operates 16 recycling centres to collect recyclables and bulky waste from households as well as household hazardous waste. These recycling centres handled 155 600 tonnes of waste in 2013.

The delegation received a briefing on the operation of Sysav's waste-to-energy plant

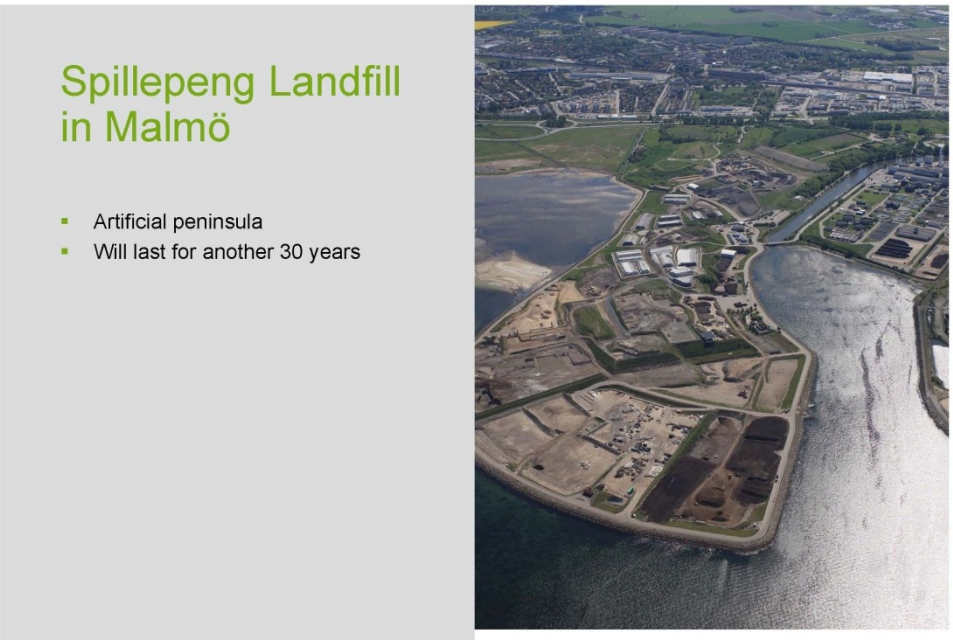
Members of the delegation studied the use of the recycle bag which was designed for households in Malmö of Sweden to separate waste

The delegation observed the operation of the furnace to understand the combustion process of Sysav's waste-to-energy plant

The temperature in the furnace is over 1 000°C

6.2.3 Members have been informed that apart from the waste-to-energy plant, Sysav has four waste sites and one waste station, distributed throughout Skåne. Located in the north of Malmö, Spillepeng waste site is an artificial peninsula that extends into the Oresund. It is the only waste site in Sweden constructed through reclaiming land from the sea.

The site has facilities for fuel preparation and sorting of slag as well as storage for combustible waste. It also contains landfill sites for hazardous waste and ordinary waste. In reply to members' questions about the leachate management of the landfill sites, Sysav staff have advised that as the bottom of Spillepeng waste site lies two to three metres below sea level, the water pressure against the outside of the earthwork is higher than the pressure from within. As such, leachate from the landfill sites will not get into the sea.



Spillepeng waste site

6.2.4 The delegation has also learned that under the *Environmental Code*, human health and the environment are protected against damage and detriment, whether caused by pollutants or other impacts. Waste incineration plants are statutorily required to have environmental permits issued by the County Administrative Boards or the Land and Environmental Court for operation. Application for an environmental permit must be accompanied by an environmental impact statement with details of the consultations that have been held for the proposed waste incineration plants and proposals for protective/precautionary measures. According to the representative of a local law firm, there have been complaints from local residents against the noise level of a waste-to-energy plant in the vicinity. If the complaints are substantiated after investigation, corresponding measures will be taken to rectify the

situation. Although sometimes financial compensation is involved, it is not the common practice to provide financial compensation to affected residents.

6.2.5 With respect to food waste management in Sweden, Sysav staff have advised that as set out in its new waste management plan, the Swedish Government sought to achieve the national goal of having 50% of household food waste collected separately and treated in a biological way in 2018 the latest. Through biological treatment, food waste will be recycled into biogas or biofertilizer for local use. To boost the recycling of food waste, the recycling network should be enhanced to make it easier and convenient for Swedish households to dispose and separate food waste from the waste stream.

6.2.6 Sysav staff further shared with the delegation their views on the ways to cultivate environmental awareness in the people and win public acceptance to the construction of waste infrastructure in the vicinity of their home. They have advised that communication is the key to let the public understand waste management and enhance their environmental awareness. While legislation and regulations are the strongest and most efficient way to make people change their behaviours in a short period of time, communication is vital in fostering the sense of environmental responsibility and motivating attitude and behavioural change towards environmental protection in the long run. Taking the waste-to-energy plant in Malmö as an example, Sysav established effective communication channels with the media and the public during the construction of the plant. Sysav disseminated information on the plant to the press regularly and held press conferences. It also organized study visits to the plant. Sysav staff have stressed that openness and transparency are the essential elements of effective communication. By combining laws and technology advancement with communication, public confidence will be developed and better environment will be achieved.

6.2.7 The delegation also attended a lunch hosted by Ms Katrin Stjernfeldt JAMMEH, Mayor of Malmö, with representatives of the City Government to learn about the waste management policies of Malmö and shared views on environmental issues of mutual concern.

The delegation leader presented a souvenir to Ms Katrin Stjernfeldt JAMMEH, Mayor of Malmö of Sweden

Chapter 7 — Follow-up event in Hong Kong

7.1 Exhibition

7.1.1 Shortly after the visit to the UK, the Netherlands, Denmark and Sweden, the delegation held an exhibition of the photographs taken and the souvenirs and publications received in the Dining Hall of the Legislative Council Complex on 26 March 2014. Members of the delegation briefed the media and other Legislative Council Members on their experience gained from the visit. The Secretary for the Environment also joined to share his views on the visit.

The photographs, souvenirs and publications displayed

Chapter 7 — Follow-up event in Hong Kong

Media briefing by the delegation

Group photo taken after the media briefing

7.1.2 To share with members of the public the information collected during the duty visit, the exhibition was moved to the Exhibition Area and the Legislative Council Library of the Legislative Council Complex and opened to the public from 28 March to 30 April 2014.

Exhibition held in the Exhibition Area of the Legislative Council Complex

Chapter 8 — Observations and conclusions

Having received briefings and exchanged views with different government officials and representatives of relevant organizations, and visited a number of waste-to-energy plants, the delegation has the following observations.

8.1 Observations

Development of thermal waste treatment

8.1.1 The delegation is highly impressed by the rapid development of different thermal waste treatment technologies which can generate energy in the form of electricity and/or heat from waste for local use and help reduce reliance on landfilling as a means for waste disposal. In the four countries visited, the percentage of wastes disposed of in landfills has been reduced to a very low level after the introduction of thermal waste treatment technologies. In the UK, the share of MSW landfilled reduced significantly during the 2010s, falling from 80% in 2001 to 34% in 2012. The Netherlands, Denmark and Sweden saw an even greater reduction in the proportion of MSW sent to landfills. Only 1.5%, 6%, and 1% of MSW in the Netherlands, Denmark and Sweden was landfilled respectively in 2012.

8.1.2 The delegation notes that while the moving-grate incineration technology is widely adopted for thermal waste treatment, there are a number of other new and emerging technologies (i.e. ATT) producing energy from waste and other fuels without direct combustion. In the UK, various financial incentive schemes have been provided to waste treatment operators, particularly those adopting ATT. While most ATT facilities in the UK are under planning or construction (e.g. Air Products' waste-to-energy facilities in Teesside), there are a few operating as technology demonstration sites (e.g. APP's pilot plasma gasification plant in Swindon). ATT facilities tend to use either pyrolysis and/or gasification while some adopt plasma gasification. The delegation understands that at the present stage of development, ATT facilities are of small scale and their treatment capacities are generally smaller than those adopting the moving-grate technology. In addition, ATT are applicable only to well-defined homogeneous waste streams and not suitable for

treating mixed MSW. As such, most ATT facilities can only treat pre-processed residual MSW, such as Refuse Derived Fuels.

8.1.3 The delegation observes that unlike the UK, ATT is rarely adopted in the Netherlands, Denmark and Sweden due to the concerns about the limited track record of such emerging technologies on treating MSW and about their energy efficiency. While some operators have advised the delegation that the plasma gasification technology would generate less pollutant and is cleaner, other operators consider that its reliability, safety and cost-effectiveness in treating a huge amount of MSW are still unproven. The plasma gasification technology is mainly used for treating industrial or special wastes and its commercial application for large scale treatment of mixed MSW is uncommon. Members note that the moving-grate incineration technology with its substantial proven track record and environmental performance still remains the mainstream technology adopted by most waste-to-energy facilities in European countries for large-scale MSW treatment. The delegation is of the view that the Hong Kong Government, in planning and developing future thermal waste treatment facilities in Hong Kong, should carefully examine the merits and demerits of various thermal waste treatment technologies and adopt an open attitude in the choice of technology.

8.1.4 The delegation also notes that in the past decades, there were concerns that incineration would adversely affect air quality, produce dioxins and damage public health. However, as technology advances, there have been significant improvements in different types of thermal waste treatment technologies. The delegation finds that modern incinerators adopt advanced technologies to mix waste thoroughly to ensure complete combustion. They have air pollution-control devices to remove pollutants, such as particulates, dioxins, heavy metals, nitrogen oxides and acidic gases, to ensure that the flue gas meets EU standard. Waste and flue gases are also superheated to reduce air pollutants.

8.1.5 The delegation considers that modern waste treatment facilities are much more than a place merely for waste disposal. Innovative and creative designs in the aesthetic appearance of these facilities will add a new dimension to the urban landscape. For example, the aluminum façade with circular openings where light from within will shine through the exterior of the waste-to-energy facility operated by

KARA/NOVEREN in Roskilde, Denmark makes it not just a power station, but also an iconic building on the horizon. Members are particularly impressed by the multi-functional purposes served by some waste-to-energy facilities. The Amager Bakke Waste-to-Energy Plant with its rooftop to be integrated with a ski slope, a walking trail, a climbing wall and a café is an example of innovative architectural design paired with sustainability and energy efficiency.

8.1.6 The delegation notes that while it is not the common practice of overseas countries to provide betterment measures to residents living in the vicinity of waste treatment facilities, the Governments of European countries often gain the support of the local communities for the localization of waste management facilities in their vicinity by integrating communal recreational facilities, aesthetically appealing design and high energy performance in the waste-to-energy plants. The delegation therefore urges the Hong Kong Government to follow the European experience and build multi-functional waste-related infrastructures that integrate social, recreational and educational facilities for public enjoyment. Members also recommend that the design of IWMF Phase 1 should match in harmony with the surrounding environment and blend with other local community amenities.

Public education and community engagement

8.1.7 The delegation observes that thermal waste treatment is widely accepted by the people of the four countries visited. The recovery of energy from waste through thermal processes has become a steady source of energy. Since waste treatment plants provide heat and electricity to the local communities, they are regarded as a part of the whole range of basic community facilities and are usually located close to residential areas. Local residents rarely have objections to the localization of these plants. In contrast, the general public in Hong Kong is deeply concerned about the environmental impacts of waste-to-energy plants. To overcome opposition from the public, the delegation urges the Hong Kong Government to step up public education and articulate relevant information in easily understandable language, so as to raise public awareness about thermal waste treatment and clarify people's doubts. To enhance public understanding about waste treatment facilities, the Hong Kong Government should also organize seminars, workshops and site visits to share with the public the feasibility, effectiveness and

implications of different thermal waste treatment technologies. Consideration could also be given to inviting overseas experts, such as those whom the delegation has met during this visit, to directly share their experience with the parties concerned in Hong Kong.

8.1.8 The delegation finds that overseas waste treatment plant operators have close communication with local residents during the planning and construction of their plants. For example, AEB launched a communication programme six years before the completion of WFPP to enhance residents' understanding of the operation of the plant and facilitate exchange of views amongst relevant stakeholders. To enlist support from the local community, Sysav also established effective communication channels with the media and the public and regularly disseminated information on its waste-to-energy plant in Malmö. Since community engagement is of paramount importance to the smooth implementation of waste treatment infrastructure, the delegation urges the Hong Kong Government to proactively engage the public, local residents and other stakeholders and thoroughly consult and communicate with them in the planning and construction of thermal waste treatment facilities in Hong Kong.

8.1.9 Overseas experience has also highlighted that communication is the key to let the public understand waste management and enhance their environmental awareness. Communication is also vital for fostering the sense of environmental responsibility and motivating attitude and behavioural change towards environmental protection in the long run. As such, the delegation sees the need for the Hong Kong Government to communicate closely and work together with the public at large to tackle the waste challenge. The Hong Kong Government should put substantial effort in organizing educational campaigns at the community level to increase public awareness of waste recycling and instill an environmentally-sustainable culture into Hong Kong people's daily life. It should step up its efforts to collaborate with the business sector and non-governmental organizations to launch public and community actions. The application of green technology in waste management is also worthy of exploration by the Hong Kong Government.

Comprehensive waste management strategy

8.1.10 The delegation believes that advanced waste treatment technology alone is not enough to tackle the problem of waste. In the four countries visited, a comprehensive waste management strategy with targets, policies and action plans is in place to reduce waste and maximize waste recycling. In the delegation's view, while expediting the development of waste-related infrastructures, the Hong Kong Government should in parallel put in place a comprehensive and holistic waste management plan setting out the whole spectrum of waste issues ranging from waste reduction, recycling, and recovery to disposal. Otherwise, any landfill extension or development of waste-to-energy facilities will not serve any useful purpose in the long run if the public continue to generate a large amount of waste.

8.1.11 The delegation also observes that the four countries visited are moving towards perceiving waste as resources and waste recovery has been included as part of their waste management strategies. To promote waste recovery in Hong Kong, the delegation calls on the Hong Kong Government to highlight in its waste management plan the value of resources that can be recovered from waste to encourage recycling and promote the recycling industry. The Hong Kong Government should also engage relevant stakeholders and the District Councils to provide convenient channels for the collection of recyclables to further enhance waste recycling, thereby ensuring the recovery of materials with economic value and achieving a sustainable circular economy.

8.2 Conclusions

8.2.1 The delegation considers the visit very fruitful and enlightening. It has deepened members' understanding of the development of different thermal waste treatment technologies and the various policies and initiatives adopted by the governments of the countries visited. The briefings by and exchanges of views with government officials and representatives of relevant organizations and waste-to-energy plants have also provided the delegation with first-hand information on the planning and operation of thermal waste treatment facilities and the potential

application of different ATT technologies in Hong Kong. The experience of the European countries is valuable.

8.2.2 The delegation appreciates that rapid development in environmental technology has made waste management more effective and efficient. Thermal waste treatment has become an indispensable part of the waste management strategies of many European countries. Notwithstanding this, overseas experience has revealed that technologies alone will not solve the problem of waste. To tackle the imminent waste challenge that Hong Kong is facing, apart from expeditiously taking forward the development of waste-to-energy facilities, a comprehensive waste management strategy should be put in place to set out effective measures to reduce waste and maximize recycling.

Acknowledgements

The delegation wishes to thank all the distinguished individuals, government officials as well as representatives of relevant organizations and plants with whom we met during the visit. The delegation is most grateful to them for their detailed briefings and the useful exchanges of views and information with us.

The delegation would also like to thank the Secretary for the Environment and other members of the delegation of the Hong Kong Government for sharing with us information on waste management in the UK, the Netherlands, Denmark and Sweden to facilitate our study of various issues during the visit. In the course of the visit, members of the delegation and public officers had the opportunity to exchange views on different waste management issues and the common experience acquired by both parties has facilitated our follow-up discussions in Hong Kong.

The delegation is grateful to the Hong Kong Economic and Trade Offices in London and Brussels for their assistance in putting together the visit programme and making the logistical arrangements. Last but not least, the delegation expresses sincere gratitude to staff of the Legislative Council Secretariat for their unfailing support and hard work.

Acronyms and abbreviations

AEB	Afval Energie Bedrijf
Amager Bakke	Amager Bakke Waste-to-Energy Plant project
APP	Advanced Plasma Power
ARC	Amager Resource Center
ATT	Advanced Thermal Treatments
C&I	Commercial and industrial
CHP	Combined heat and power
CO	Carbon monoxide
CO_2	Carbon dioxide
Defra	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
EPS	Emissions performance standard
EU	European Union
IMechE	Institution of Mechanical Engineers
IWMF	Integrated waste management facilities
MSW	Municipal solid waste
NWMP	National Waste Management Plan
Ofgem	Office of the Gas and Electricity Markets

Acronyms and abbreviations

RO	Renewables Obligation
ROCs	Renewables Obligation Certificates
the Action Blueprint	Hong Kong Blueprint for Sustainable Use of Resources 2013-2022
the Panel	Panel on Environmental Affairs
the UK	The United Kingdom
UKWIN	UK Without Incineraton Network
WFPP	Waste Fired Power Plant

Appendix I

Visit Programme

2 March 2014 (Sunday)	Arrive at London, the United Kingdom
3 March 2014 (Monday)	Visit to Advanced Plasma Power's pilot plasma gasification plant in Swindon
	Visit to New Earth Solutions' pyrolysis and gasification plant in Avonmouth, Bristol
4 March 2014 (Tuesday)	Meeting with the Institution of Mechanical Engineers
	Meeting with UK Without Incineration Network
	Meeting with representatives of Air Products' waste-to-energy facilities in Teesside
	Meeting with the Mayor of London's Office and Department for Environment, Food and Rural Affairs
	Meeting with representatives of Lakeside Energy-from-Waste Plant
	Depart for the Netherlands
5 March 2014 (Wednesday)	Visit to Afval Energie Bedrijf's Waste Fired Power Plant in Amsterdam
	Luncheon hosted by the Deputy Mayor of Amsterdam
	Meeting with the Ministry of Infrastructure and the Environment and waste management experts
	Depart for Denmark

6 March 2014 (Thursday)	Meeting with the Technical and Environmental Administration of Copenhagen
	Meeting with the Ministry of the Environment of Denmark and the Danish Environmental Protection Agency
	Briefing on the Amager Bakke Waste-to-Energy Plant project
	Luncheon hosted by the Denmark – Hong Kong Trade Association
	Visit to KARA/NOVEREN's Waste-to-Energy Facility in Roskilde
7 March 2014 (Friday)	Visit to Sysav's Waste-to-Energy Plant and meeting with representatives of relevant organizations and government departments
	Luncheon hosted by the Mayor of Malmö
8 March 2014 (Saturday)	Arrive at Hong Kong

Appendix II

List of organizations and persons met by the delegation

3 March 2014 (Monday) **The United Kingdom**
Advanced Plasma Power ("APP")'s pilot plasma gasification plant in Swindon Mr Rolf STEIN, Chief Executive Officer, APP Mr Richard TAYLOR, Technical Director, APP Mr Graeme RUMBOL, Chief Executive Officer, Tetronics International Dr Tim JOHNSON, Technical Director, Tetronics International Mr Stephen GILL, Group Sales Director, APP and Tetronics International Ms Kate COLCLOUGH, Group Marketing Manager, APP and Tetronics International
New Earth Solutions' pyrolysis and gasification plant in Avonmouth, Bristol Mr Mark SCOBIE, Chief Executive Officer Mr Adam SHORE, Commercial Director Mr Robert ASQUITH, Communications Director
4 March 2014 (Tuesday) **The United Kingdom**
Institution of Mechanical Engineers ("iMechE") Mr Paul DARLEY, Head, Waste Infrastructure Team, Department for Environment, Food and Rural Affairs Dr Tim FOX, Head of Energy and Environment, iMechE Dr Colin BROWN, Engineering Director, iMechE Mr Richard CAMPBELL, Senior Communications Manager, iMechE
UK Without Incineration Network Mr Tim HILL, Director
Air Products' waste-to-energy facilities in Teesside Mr Jeffrey LOCKETT, Global Asset Manager, Energy and Equipment Division Mr Jamshid SALIMOV, Business Development Support – Energy from Waste, Europe

Mayor of London's Office and Department for Environment, Food and Rural Affairs ("Defra") Mayor of London's office Mr Matthew PENCHARZ, Senior Advisor - Environment and Energy, Greater London Authority Mr Andrew RICHMOND, Policy and Strategy Manager – Energy and Waste, Greater London Authority Mr Wayne HUBBARD, Chief Operating Officer, London Waste and Recycling Board Defra Dr Jane STRATFORD, Head, EU and International Waste Team Dr James COOPER, Head, Energy from Waste Policy Mr Paul BRADLEY, Head, Waste Infrastructure Team
Lakeside Energy-from-Waste Plant Mr Danny COULSTON, Director of Operations
5 March 2014 (Wednesday) **The Netherlands**
Afval Energie Bedrijf ("AEB")'s Waste Fired Power Plant in Amsterdam Mr Erik KOLDENHOF, Director for International Advisory Mr Peter SIMOES, Strategic Advisor Ms Susanna VAN DER HEIDE, Secretary
Luncheon with the Deputy Mayor of Amsterdam Ms Carolien GEHRELS, Deputy Mayor, City of Amsterdam Mr Paul OOSTELBOS, Director International Business Development, Orgaworld Mr Andre STRUKER, Strategic Advisor, Waternet Mr Erik KOLDENHOF, Director for International Advisory, AEB Mr Jos DE BRUIJN, Department of Urban Planning, Amsterdam Mr Erik VAN DER KOOIJ, Team Leader, Team Metropolitan Area Amsterdam Mr Victor PALLEMANS, Senior Manager China, Amsterdam in Business Ms WENG Shen-cheung, Project Manager China, Amsterdam in Business

Ministry of Infrastructure and the Environment and waste management experts

Ministry of Infrastructure and the Environment
Mr Siebe RIESTRA, Secretary General
Mr Reggie HERNAUS, International Department
Mr Herman HUISMAN, Senior Advisor, RWS Environment

Waste management experts
Mr Bernard SHEFFENS, Chief Executive Officer, WSS Asia
Mr Paul OOSTELBOS, Director International Business Development, Orgaworld
Mr Ewald KOREVAAR, Independent Environmental Consultant
Mr Frans J M LAMERS, Senior Consultant, DNV KEMA

6 March 2014 (Thursday)
Denmark

Technical and Environmental Administration of Copenhagen
Mr Morten KABELL, Technical and Environmental Mayor of Copenhagen

Ministry of the Environment of Denmark
Mrs Kirsten BROSBØL, Minister of the Environment
Mr Mikkel AARØ-HANSEN, Deputy Permanent Secretary
Mr Mikkel DAM SCHWARTZ, Senior Advisor
Mr Jesper STUBKJÆR, Head of Section, International Environmental Co-operation

Danish Environmental Protection Agency
Mr Klaus TORP, Deputy Director
Ms Elisabeth WOLSTRUP, Head of Department
Mr Søren BUKH SVENNINGSEN, Head of Department
Mr Niels BUKHOLT, Deputy Head of Department
Mr Søren FREIL, Head of Section

Amager Bakke Waste-to-Energy Plant project
Mrs Ulla RÖTTGER, Chief Executive Officer, Amager Resource Center
Mr Rasmus MEYER, Communications Manager, Amager Resource Center
Mrs Hanne ROULUND, Business Development Manager, State of Green
Ms Tanya JACOBSEN, Project Manager, State of Green

Luncheon hosted by the Denmark – Hong Kong Trade Association

Mr Claus V HEMMINGSEN, President, Denmark – Hong Kong Trade Association
Mr LIU Biwei, Ambassador of China to Denmark
Mr Stephen WONG, Regional Director, Europe, Hong Kong Trade Development Council

KARA/NOVEREN's Waste-to-Energy Facility in Roskilde

Mr Thorkil JØRGENSEN, Director
Mr Klaus W HANSEN, Deputy Director

7 March 2014 (Friday)
Denmark/Sweden

Sysav's Waste-to-Energy Plant and the relevant organizations and government departments

Mr Milan OBRADOVIC, Deputy Mayor, Malmö
Mr Stefan LINDHE, Deputy Mayor, Malmö
Mr Håkan RYLANDER, CEO, Sysav
Mr Jörgen HALLDIN, Consul General of Sweden in Hong Kong
Mr Allen MA, CEO, Hong Kong Science & Technology Parks Corporation
Mr Björn SEGERBLOM, Overseas Representative, Hong Kong Science & Technology Parks Corporation
Mr Jonas TÖRNBLOM, Chairman, Sweden China Greentech Alliance
Mr Ebbe NORDELL, CEO, IE Solutions
Mr Jonas KAMLEH, Deputy Head of Unit, Environment Department, City of Malmö
Ms Monika MÅNSSON, Project Manager, Environment Department, City of Malmö
Ms Jenny ÅSTRÖM, Project Manager, Export of Swedish Waste Management
Mr Dave BORG, Head of Unit, Environment Department, City of Malmö
Ms Elin ANDERSEN, MAQS Law Firm (Environmental Legislation)
Ms Savita UPADHYAYA, Project Manager, VA Syd
Ms Susanna JOHNMARK, Environment Inspector, Environment Department, City of Malmö

Luncheon at City Hall hosted by the Mayor of Malmö

Ms Katrin Stjernfeldt JAMMEH, Mayor of Malmö
Mr Björn SEGERBLOM, Chairman, Royal Sweden – Hong Kong Business Council
Mr Jörgen HALLDIN, Consul General of Sweden in Hong Kong

Appendix III

List of the Hong Kong Government delegation

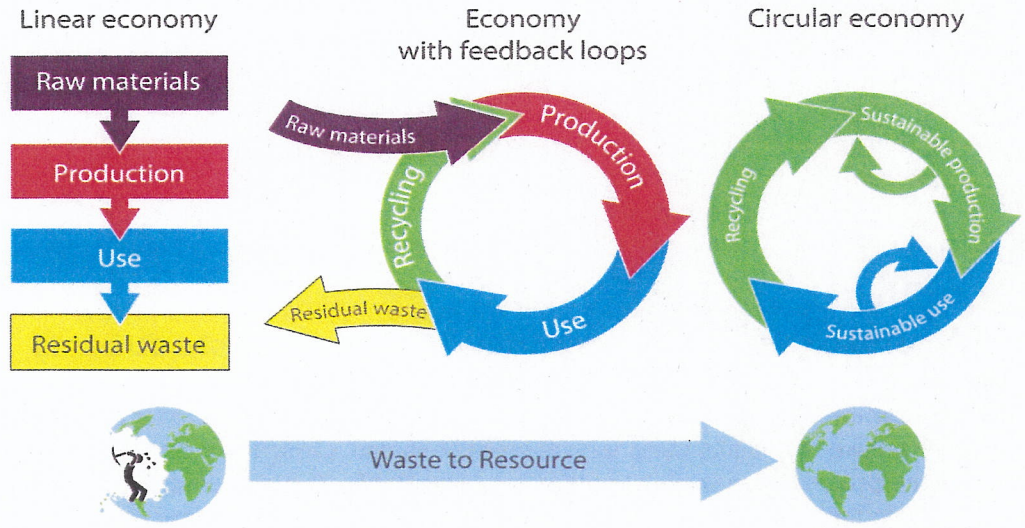
1. Mr WONG Kam-sing	Secretary for the Environment (Head of the Hong Kong Government Delegation)
2. Mr Howard CHAN	Deputy Director of Environmental Protection (2)
3. Mr Elvis AU	Assistant Director (Nature Conservation and Infrastructure Planning), Environmental Protection Department
4. Ms Katharine CHOI	Administrative Assistant to Secretary for the Environment
5. Ms Connie WONG	Press Secretary to Secretary for the Environment
6. Ms Michelle AU	Political Assistant to Secretary for the Environment
7. Mr CHENG Tak-kuen	Senior Environmental Protection Officer (Infrastructure Planning)1, Environmental Protection Department
Hong Kong Economic and Trade Office ("HKETO"), London	
1. Ms Erica NG	Director-General, HKETO, London
2. Mr Dennis CHING	Deputy Director-General, HKETO, London
3. Miss Noel PUN	Deputy Director-General, HKETO, London
4. Mr LAU Chung-sing	Assistant Director-General, HKETO, London

Appendix III (Con't)

Hong Kong Economic and Trade Office, Brussels	
1. Ms Linda LAI	Special Representative for Hong Kong Economic and Trade Affairs to the European Union
2. Miss Alice CHOI	Deputy Representative, HKETO, Brussels
3. Miss Lily LEE	Assistant Representative, HKETO, Brussels
4. Mr Mark NEIRYNCK	Public Relations Officer, HKETO, Brussels

Appendix IV

Fact sheet waste to resource programme



The Netherlands *Waste to Resource* programme aims at stimulating the transition to a circular economy, which requires a broad, integral and Cabinet-wide approach. Therefore the Ministry of Infrastructure and the Environment works intensively with other ministries.

The Netherlands is also pursuing a more circular economy outside the EU. The Netherlands exports a lot of knowledge and environmental technology that can help establish a circular economy in other countries.

The programme elaborates eight operational objectives in the sequence of the value chain.

1. Promoting sustainability at the front of the chain

A circular economy reuses products and raw materials and conserves natural resources. Products are made and marketed in a way that makes them fit perfectly into a circular economy. The creation of closed natural cycles is also promoted. Therefore, the government is pursuing to:

- Stimulate circular design
- Close local cycles
- Stimulate preservation and finance of Natural Capital
- Make packaging more sustainable

2. Making consumption patterns more sustainable

To accelerate the transition to a circular economy, it is important for members of the public to start consuming sustainably. As a major purchaser, the national government also has a possibility to use its purchasing power to speed up the transition. With this in mind the Cabinet wants to:

- develop an approach to sustainable consumption patterns based on behavioural knowledge;
- strengthen the role of the retail sector, thrift stores and repair companies;
- enhance sustainable procurement by public bodies
- use the retail sector to make consumption more sustainable

3. Improving waste separation and collection

In a circular economy there is no waste. The government's ambition is to minimise the volume of recyclable materials ending up in incineration plants. The separation of waste – particularly at the source – is a precondition. The programme seeks to:

- minimise the quantity of residual Dutch waste in incineration plants;
- facilitate municipalities in improving the separation and collection of waste;
- inspire households to improve their separation of waste;

- separate waste from offices, shops and public spaces.

4. Focusing existing waste policy on a circular economy

The goal of waste policy must be to reuse materials. At present, legislation is often seen as obstructing this goal. The following needs to be done:

- identification and elimination of unnecessary obstacles in legislation;
- stimulate the application of end-of-waste status;
- promotion of recycling by means of a level European playing field for waste;
- creation of scope for innovation in legislation and in standards

5. Adopting an approach to specific material chains and waste streams

An advantage of focusing on specific material chains is that all parties in the value chain are stimulated to establish a common approach for the entire chain. A specific approach to a material chain is geared more to the use of specific material and product chains. Central government can stimulate and facilitate the process of making a value chain sustainable. It can facilitate consultations between chain parties, enabling them to formulate joint goals and define what they need from each other in order to achieve those goals. This focus on specific material chains is being expanded and institutionalised by the *Waste to Resource* programme. This entails:

- setting up a support desk for a material chain approach;
- accelerating specific material chains such as the one for plastics;
- stimulating high-quality recycling in each chain;
- high-quality use of biotic residual materials.

6. Developing financial and other market incentives

To close material chains and reduce the burden on the environment, it is important for financial incentives to stimulate circularity. Unless there are good business cases, the opportunities for a circular economy will not be seized by the market. For that reason, the government will:

- stimulate the use of new business models;
- drive the dissemination of knowledge and the widespread application of innovative solutions;
- adapt landfill tax rules to ensure they tie in with promoting the circular economy.

7. Connecting knowledge and education to the circular economy

The transition to a circular economy requires system innovation, including technical innovation as well as institutional and cultural changes. This programme seeks to promote the development and sharing of knowledge in the field of the circular economy. For that reason the Cabinet will:

- set up knowledge and education programmes for *Waste to Resource*;
- focus European research programmes on the circular economy;
- make the Netherlands a circular hotspot.

8. Simplifying measurement methods, indicators and certification labels

Criteria, assessment methods, indicators and quality labels provide transparency. They help consumers, companies and policymakers to make informed choices. The Cabinet wants to promote the use of reliable and unambiguous methods and also innovative measurement methods. Therefore, the programme will:

- harmonise and standardise methods and indicators;
- improve information about waste streams.