SMART WASTE MANAGEMENT FOR LOW-CARBON SOCIETY IN MULTIMEDIA SUPER CORRIDOR CITY – CYBERJAYA, MALAYSIA

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Compares to other middle income developing countries, Malaysia is emitting a significant amount of greenhouse gases (GHG) that causes global warming. Feasibility study on building a low-carbon society in its Multimedia Super Corridor city, Cyberjaya Digital Green City 2025 (DGC2025) was launched following the study of Putrajaya Green City 2025. The main objective of these studies is to build the cities to become a pioneer township in Green Technology. Smart 3R Cyberjaya is one of DGC2025 four themes and focuses on planning alternative solid waste management that fulfil the challenge of building both low-carbon and sound material society. Smart 3R Cyberjaya set the target of building a zero emission society that depend less on landfill and actively practicing waste reduction at source. This is quantitatively represent as 75% reduction of waste sent to landfill site and 50% reduction of total greenhouse gases emission, compare to 2025 business as usual scenario. Three counter measure scenarios were evaluated from combination of waste reduction at source; 2R actions and waste treatment selection; food disposer, recycling and thermal treatment. Solid wastes modelled in our scenarios are household solid waste, business solid waste, sludge, green waste and electrical and electronic waste (e-waste). In 2025, total waste generation is 207 ton/day and 1041 ton/year of e-waste. Both waste and GHG reduction target is achievable at 2025CM3 scenarios, 78% (172 t/day) and 84% (1459 t-CO₂/day), respectively. Results of other scenarios could also give us a new image of alternative future society.

Key Words: 3R, solid waste management, sound-material cycle society, low-carbon society, Malaysia

1. INTRODUCTION

“Think globally, act locally” phrase was first applied in town planning field to represent the needs to be aware of not only global but also urban and rural differences in every planning¹⁾. Since then the phrase has been widely implemented in various field including environmental. It is best defined as urging people to consider the health of the entire planet and to take action on their own communities and cities¹⁾.

This concept is also represented in the report of Malaysia Economic Monitor – Smart Cities that give a strong consideration of Malaysia’s own need and ability to keep taking part in global market. The report portrays Malaysia’s Smart Cities as Innovative, Green and Resilient, and uses greenhouse gases (GHG) and solid waste management as benchmark for Smart Green Cities.

The World Bank also stated that “it involves taking stock of the existing urban environmental problems, their comparative analysis and prioritization, setting out objectives and targets, and identification of various measures to meet the objectives of addressing the complex urban environmental problems”²⁾.

In this study of building a Smart 3R city that practices a sound-material cycle within low-carbon prospect, we are also presenting our model using the two indicators; GHG and solid waste amount.

2. BACKGROUND

(1) Overview of Cyberjaya Malaysia

Cyberjaya is a town with a science park as the core that forms a key part of the Multimedia Super

Corridor (MSC) in Malaysia. The city aspires to be known as the Silicon Valley of Malaysia. The establishment of the MSC program was crucial to accelerate the objectives of Vision 2020 and to transform Malaysia into a modern state by the year 2020, with the adoption of a knowledge-based society framework. MSC Malaysia covers an area of approximately 750 km² stretching from the Petronas Twin Towers to the Kuala Lumpur International Airport, and including the towns of Putrajaya and Cyberjaya.

Cyberjaya the core of Malaysia MSC covers an area of 29 km² freehold land that consist four main zones known as enterprise, commercial, institutional and residential. It is now the home for over 500 MSC Status companies, several tertiary education institutes, and residential for both living in and commuting people of the city. By 2025, the city is also expected to see a large boom in population growth with residential developments to cater up to a target population of 210,000, business developments providing for up to 120,000 employees and institutional establishments for 30,000 students³⁾.

(2) Feasibility study of Cyberjaya Digital Green City 2025

During 15th Conference of Parties, Copenhagen, held in December 2009, Malaysia Prime Minister (PM) announced that Malaysia is adopting an indicator of a voluntary reduction 40% in terms of GHG emission intensity of gross domestic products by 2020 compared to 2005 level. The PM also said that Malaysia is committed to ensure at least half of its land area remained as forest as pledged at the Rio Summit⁴⁾. These two announcements then bring to another announcement in 2010 budget speech by The PM and Minister of Finance of Developing Green Technology. In item 54 of the speech, stated “develop Putrajaya and Cyberjaya as pioneer townships in Green Technology, as a showcase for the development of other townships”⁵⁾.

Ministry of Energy, Green Technology and Water, Malaysia as the key stakeholder of promoting the importance of green technology in sustainable development has been promoting measures such as “National Green technology Policy” and Feed-in Tariff”. Besides that, in September 2011, “Low Carbon City Framework” was launched by The PM. This is a green rating system based on the carbon footprint baseline, and a 10% saving in energy and water in all government buildings⁶⁾.

In October 2010 Putrajaya Corporation, local authority of Putrajaya proposed a preliminary study of ‘Putrajaya Green City 2025’ (PGC2025) which

was carried out under three elements of environment: ‘Low-Carbon Putrajaya’ ‘Cooler Putrajaya’ and ‘3R Putrajaya’. Each element presents its own target with the study target to achieve a low-carbon society by the target year of 2025⁷⁾. Following the completion of PGC2025, Cyberjaya developer, Cyberview also proposed the interest in carrying out a preliminary study in Cyberjaya. For ‘Cyberjaya Digital Green City 2025’ (DGC2025), four themes were introduced: ‘Low-carbon Cyberjaya’, ‘Smart 3R Cyberjaya’, ‘Liveable & Vibrant City’ and ‘Smart Digital Network City’. Towards realizing DGC2025 through the four themes, a ‘Dozen Actions’ table was formulated as a concrete vision for such society. Two out of the four actions are represented quantitatively; ‘Low-carbon Cyberjaya’ and ‘Smart 3R Cyberjaya’ with reduction of 50% CO₂ emission and 75% solid waste sent to landfill by the year of 2025 compared to Business as Usual (BaU), respectively.

3. METHOD

(1) Scenario building

This paper focuses on ‘Smart 3R Cyberjaya’ with the targets to reduce 75% of solid waste amount sent to landfill by the year of 2025 compared to 2025BaU where in 2010CM (counter measure) scenario, only 5% of generated waste is being recycled and the rest are directly sent to landfill site for final disposal. ‘Smart 3R Cyberjaya’ covers the entire scope of waste management from waste generation to waste final disposal (**Fig.1**). On top of that, we did not only considered municipal solid waste (MSW) (household solid waste (HSW) and business solid waste (BSW)) but also green waste from park and garden, sewage sludge, and electrical and electronic equipment waste (e-waste). In order to evaluate our target of 75% waste reduction, we proposed three alternatives solid waste management (SWM) scenarios for MSW. The scenarios are as follows:

(i) Business as usual (BaU)

All waste generated is sent directly to final landfill site without any pre-treatment process. This is the current scenario for waste handling in the study area.

(ii) Low level of enforcement (2025CM1)

Waste management with 3R actions are introduced and carried out. Both public participation and efficiency of carrying out actions are set at low level. In this scenario for MSW, except for thermal treatment, participation and efficiency are set at 50% level. In the thermal treatment action

Fig.1 Study flow.

participation and efficiency are set at 90% and 50% respectively. At low level waste management scenario only Reduce and Reuse actions (2R) rated 3 will be calculated.

(iii) Moderate level of enforcement (2025CM2)

Waste management with 3R actions are introduced and carried out. Both public participation and efficiency of carrying out actions are set at moderate level. In this scenario for MSW, except for thermal treatment, participation and efficiency are set at 75%. In the thermal treatment action participation and efficiency are set at 90% and 75% respectively. At moderate level waste management scenario only 2R actions rated 3 and 1 will be calculated.

(iv) High level of enforcement (2025CM3)

Waste management with 3R actions are introduced and carried out. Both public participation and efficiency of carrying out actions are set at high level. In this scenario for MSW, for all actions, participation and efficiency are set at 100% and 90%, respectively. At high level waste management scenario all 2R actions will be calculated.

(2) Modelling

a) Waste generation

(i) Household solid waste (HSW)

Using socio-economic indicators provided by Cyberview (land owner of Cyberjaya) through their Cyberjaya City Survey 2010 “Outcome of Report” and The Study on National Waste Minimisation in Malaysia (TNS), we projected HSW generation for base year 2010. HSW generation for target year 2025 are projected using socio-economic indicators from Setia Haruman (master developer of Cyberjaya)⁹ and TNS. Combination of night time and student population for base and target year is 33,574 and 240,000, respectively. Total waste generation for Cyberjaya is calculated using urban per capita generation rate of 0.71 kg/day and the composition of 40% food, 31% paper, 8% plastic, 4% glass, 2% metal and 15% other¹⁰. Product and packaging waste classification are projected using the Report on Household Expenditure Survey^{11,12}, National Input-Output Table^{13,14} and Annual Survey of Manufacturing Industries¹⁵. The generation coefficients are paper (0.02, 0.98), plastic (0.26, 0.74), glass (0.14, 0.86), and metal (0.43, 0.57), with the former is product and the latter is packaging waste generation coefficient.

(ii) Business solid Waste (BSW)

Employment number for 2010 and 2025 is 12,838 and 120,000, respectively, and from the same source as HSW. TNS stated that urban per capita generation of BSW is 0.30 kg/day with 18% food, 32% paper, 9% plastic, 8% glass, 4% metal and 29% other. In order to calculate waste reduction via 2R actions, we have to project product and packaging waste classification. Product and packaging waste classification for business sector are projected using National Input Table 2010¹⁶ and Report on the Annual Survey of Manufacturing Industries. Business expenditures are categorized into seven groups based on information from few office item suppliers. The seven groups are personal computer (PC) related goods, office device, file and cases, clerical device, writing material, packaging and operational goods, and living ware¹⁷. After the categorization, we classify the expenditure type into its related manufacturing industries. **Table 1** summarized the manufacturing group and its contribution in each division (manufacturing activity) based on the annual survey of manufacturing industries. Which were then used to project generation coefficient of product and packaging waste (**Table 2**). The generation coefficients are paper (0.45, 0.55), plastic (0.41, 0.59), glass (0.38, 0.62), and metal (0.87, 0.13), with

Table 1 Share composition of various industries in Malaysia manufacturing

Description	Industry Code	Composition (%)
Manufacture of paper and paper products	170	
Manufacture of pulp, paper and paperboard	17010	0.24
Manufacture of corrugated paper and paperboard and of containers of paper and paperboard	17020	0.43
Manufacture of envelopes and letter-card	17091	0.03
Manufacture of household and personal hygiene paper	17092	0.17
Manufacture of gummed or adhesive paper in strips or rolls and labels and wallpaper	17093	0.09
Manufacture of effigies, funeral paper goods, joss papers	17094	0.02
Manufacture of other chemical products	202	
Manufacture of soap and detergents, cleaning and polishing preparations	20231	0.13
Manufacture of perfumes and toilets preparations	20232	0.09
Manufacture of plastic products	222	
Manufacture of plastic articles for the packaging of goods	22203	0.29
Manufacture of other fabricated metal products; metal working service activities	259	
Manufacture of tins and cans for food products, collapsible tubes and boxes	25991	0.15
Manufacture of general-purpose machinery	281	
Manufacture of office machinery and equipment (excepts computers and peripheral equipment)	28170	0.02
Other manufacturing	329	
Manufacture of stationery	32901	0.66

the former is product and the latter is packaging waste generation coefficient.

(iii) Sewage sludge

Data from sewage treatment plants in Cyberjaya was not accessible during the modelling proposed. As an alternative, the generation rate of sludge was calculated based on data provided by local authority of Putrajaya during PGC 2025 study. We make an assumption that sewage sludge per capita generation of Malaysian is fix. Sewage generation rate of Putrajaya is $0.22 \text{ m}^3/\text{capita}/\text{day}$ with sludge ratio of $0.0002 \text{ ton}/\text{m}^3$ ¹⁸⁾.

(iv) Green waste from park and garden

Using land use data provided by Setia Haruman – the master developer of Cyberjaya, we learnt that Cyberjaya is composed of 282.79 hectare of green area in 2025. We calculated green waste generation using two generation factors: grass cutting and branch tipping, with the former producing $4.6 \text{ kg}/\text{ha}/\text{day}$ and the latter are $11 \text{ kg}/\text{ha}/\text{day}$ ¹⁸⁾.

(v) Electrical and electronic equipment waste

In 2007, Department of Environment, Malaysia carried a study on The E-waste Inventory Project in Malaysia (e-waste study)¹⁹⁾. In Malaysia, under Environmental Quality (Scheduled Waste) Regulation 2005 waste from the assembly of

electrical or electronic appliances that consist of components such as accumulators, mercury-switches, glass from cathode-ray tubes and other activated glass or polychlorinated biphenyl-capacitors, or contaminated with cadmium, mercury, lead, nickel, chromium, copper, lithium, silver, manganese or polychlorinated biphenyl are listed as e-waste²⁰⁾. The e-waste study focused on seven selected types of e-waste that is television sets (TV), personal computers (PC), mobile phones, refrigerators, air conditioners (AC), washing machines and rechargeable batteries. Since this study is the only e-waste related data that we can get, e-waste generation in Cyberjaya is calculated using result of this study. According to Cyberjaya planning by 2025, 500 MSC status companies and several tertiary education institutes will be base in Cyberjaya. Using these information we projected 2025 e-waste amount generated in Cyberjaya with the 9 education institute counted as large scale institution and the rest of companies are 50% small and 50% small scale. According to the e-waste study small, medium and large business are represented by 5 to 50, 51 to 150, and more than 150 employers, respectively. E-waste generation rate by business activity scale are as **Table 3**.

(b) Waste reduction at source

Table 2 Product and packaging waste classification based on expenditure type and manufacturing activity

Expenditure type	Manufacture	Description	Waste Classification
Personal computer related goods	Manufacture of radio, television and communication equipment and apparatus	Manufacture of recording and reproducing apparatus	Product
	Manufacture of electrical machinery and apparatus	Manufacture of insulated wire and cable	Product
Office device	Manufacture of general-purpose machinery	Manufacture of office machinery and equipment (excepts computers and peripherals equipment)	Product
		Manufacture of stationer	Product
File and cases	Other manufacturing	Manufacture of pulp, paper and paperboard	Product
		Manufacture of envelopes and letter-card	
Clerical device	Manufacture of paper and paper products	Manufacture of gummed or adhesive paper in strips or rolls and labels wallpaper	Product
		Manufacture of stationery	
Writing material	Other manufacturing	Manufacture of corrugated paper and paperboard, and of containers of paper and paperboard	Packaging
		Manufacture of plastic articles for packaging of goods	
Packaging and operational goods	Manufacture of paper and paper products	Manufacture of tins and cans for food products, collapsible tubes and boxes	Packaging
		Manufacture of soap and detergents, cleaning and polishing preparations, manufacture of perfumes and toilet preparations	
Living ware	Manufacture of other chemical products	Manufacture of household and personal hygiene paper	Product
		Manufacture of paper and paper products	

For projection of waste reduction at source, we asked various stake holders of Cyberjaya to rate two sets of waste 2R actions each prepared for household and business sector. In the household sector, 11 sub-actions are group under three actions namely smart purchase, waste refuse and smart planning. Respondents were asked to rate these actions with regard to reduction of household consumption from 0 for actions that had no effect, 1 for little effect, 2 for moderate effect, and 3 for the most important actions. From 12 expenditure groups, six were picked out as major waste-generating

factors. The six expenditure groups are ‘food’, ‘beverages’, ‘clothing and footwear’, ‘furnishing, household equipment and routine household maintenance’, ‘recreation, services and culture’, and ‘miscellaneous goods and services’.

The same rating method is applied for business sector. However, in the business sector, 25 sub-actions are group under 5 categories namely general, paper, break room, building maintenance, and shipping, receiving and distribution. **Table 4** and **Table 5** summarized both sectors action and sub-actions. Calculation of waste reduction from 2R

Table 3 E-waste generation rate by business activity scale

	Use pattern (Unit)			Average weight (kg)
	Small	Medium	Large	
TV	1.1	2	5.3	35
Mobile phone	3.3	10.7	77.8	0.1
PC	9.6	68.1	220.4	30
Refrigerator	1.6	2	0.1	70
AC	3.9	13.8	14.5	60
Washing Machine	2.9	1	1.5	50

Table 4 2R actions for household sector

Action	Sub-action
Smart purchase	Buy according to need
	Buy in bulk
	Buy refill and concentrates
	Buy local products
Waste refuse	Not to buy over packaged products
	Do not take plastic bag
	Use my shopping bag
Smart planning	Rent or borrow instead of buying
	Sharing
	Choose for durable items
	Choose for reusable items

Table 5 2R actions for business sector

Group	Sub-action	Group	Sub-action
General	Plan purchase to avoid leftover	Break room	Use reusable utensil
	Choose refillable items		Bring lunches in reusable container
	Choose multi-purpose items		Set-up a food waste composting program
	Use rechargeable battery	Building maintenance	Use a multipurpose product
	Use rewritable computer media		Use metered dispenser
	Buy recycled products		Use concentrate and refillable applicator
	Use rental and lease service		Use cloth roll towel / air dryer in the restrooms instead of paper product
Paper	Priority to digital documentation	Shipping, receiving and distribution	Buy supplies in bulk or economy size packaging
	Limit printout number per employee		Ask for minimal packaging option
	Set printer to double-sided printing mode		Ship product in returnable, reusable container
	Set a one-sided paper corner		Reuse incoming packaging material
	Use central filing system		Use shredded office paper or discarded material for packaging
	Refuse junk mail		

actions for both household and business sector is represented in the following equation:

$$W_{2R} = (\alpha \times P_i \times E_i) \times W_{BaU} \quad (1)$$

α indicates the effect of actions rating on waste generation; P_i indicates participation level; E_i indicates efficiency level in response with counter measure scenarios ($i = 1, 2, 3$). All waste types except food are calculated.

(c) Self-treatment

Cyberjaya with its role as the core of Malaysia MSC is moving towards building a high-technology community. In line with this, we projected scenario of self-treatment using food disposer in each household compared to a more nature basis selection of composting that introduced in PGC2025. Under this action, disposer instalment is introduced to household depending on the enforcement level. However, for business sector, food waste generated will be sent directly to treatment facility. Amount of waste reduced from self-treatment action (W_{Sf}) is calculated as in Eq. (2), where En_i indicates enforcement level in response with counter measure scenario.

$$W_{Sf} = (En_i \times E_i) \times W_{BaU} \quad (2)$$

(d) Separate collection

In Malaysia generally waste collection and transportation is contracted to be handle by private concessionaire. However, this is not true for Cyberjaya that is under jurisdiction of Sepang Local Authority (LA). Waste collection is carried out by

contractor appointed by Sepang LA. In term of waste separation, we proposed separate collection that meets the requirement of thermal treatment that is also modelled for DGC2025. This action includes both household and business waste. Waste types estimated under this action are paper and plastic product waste, and paper, plastic, glass and metal packaging waste, with calculation equation as follows:

$$W_{Sc} = (P_i \times E_i) \times (W_{2R_{Prod}} + W_{2R_{Pack}}) \quad (3)$$

Where;

W_{Sc} : Amount of waste reduced from separate collection action

$W_{2R_{Prod}}$: Amount of product waste generated after waste reduction at source; paper and plastic

$W_{2R_{Pack}}$: Amount of packaging waste generated after waste reduction at source; paper, plastic, glass and metal

(e) Thermal treatment

On top of separate collection of recyclable materials, combustible waste is considered to be treated using thermal treatment such as incineration. Product and packaging waste of paper, plastic, and glass from household and business sector are considered for this action. On top of that, food waste from business sector is also treated using thermal treatment. Calculation of waste reduction using thermal treatment (W_{Tt}) is:

$$W_{Tt} = (P_i \times E_i) \times (W_{ScProd} + W_{ScPack}) \quad (4)$$

Where;

W_{2RProd} : Amount of product waste generated after separate collection action; food from business waste, paper, plastic and glass

W_{2RPack} : Amount of packaging waste generated after separate collection action; paper, plastic and glass

(f) Final landfill

After all waste reduction and treatment consideration remaining waste is sent to currently available landfill site. Besides the remaining waste, residual from waste treatment facility such as thermal treatment and construction waste are also sent to landfill site.

$$W_{Ld} = W_{BaU} - (W_{2R} + W_{Sf} + W_{Sc} + W_{Tt}) + W_R \quad (5)$$

where, W_{Ld} is amount of waste sent to landfill site and W_R is residual from waste treatment facility.

(3) Greenhouse Gases Calculation

Greenhouse gases are one of the major indicators of environmental quality. According to the report of Malaysia Economic Monitor – Smart Cities stated that Malaysia's GHG emissions are relatively high for a country at its level of income and development.

Not only that its per capita GHG emissions were significantly higher than other middle income countries, but also Malaysia is now a net emitter not a net emission.

In this study we calculated GHG emitted from waste treatment facility and compare it with GHG emitted from landfill; the only waste treatment selection at BaU scenario. Our calculation considers not only CO₂ but also CH₄, N₂O, NO_x, SO_x and smoke dust^(21, 22).

4. RESULT AND DISCUSSION

Household population in Cyberjaya were calculated from two types of population; night time population and student population. In base year of 2010, the former is 13, 353 and the former is 20, 221 people. In 2025, major increase of 16 times night time population and 1.5 times student population will caused HSW generation to hike from 22.7 t/day to 170.4 t/day. In term of business sector increase of 9.3 times employment number caused BSW increase from 3.7 t/day to 36.5 t/day. Waste generation of sewage sludge, green waste and e-waste is 8.9 t/day, 4.5 t/day and 1041 t/year, respectively. **Table 6** shows detail composition on MSW in BaU2010 and BaU2025 based from our product and packaging waste classification using household/business expenditure and manufacturing demand. Our calculation results show that for both MSW generation of packaging waste is bigger than product waste except for metal in BSW.

Fig.2 shows the comparison of our alternative

Table 6 Result of municipal solid waste generation (ton/day) for business as usual case

	2010			2025		
	BaU		Total	BaU		Total
	HSW	BSW		HSW	BSW	
Food	8.99	0.67	9.66	67.65	6.60	74.25
Paper	7.07	1.20	8.27	53.16	11.82	64.98
Product	0.12	0.54	0.66	0.92	5.29	6.20
Packaging	6.94	0.66	7.61	52.25	6.53	58.78
Plastic	1.83	0.33	2.16	13.80	3.21	17.01
Product	0.47	0.13	0.60	3.55	1.31	4.86
Packaging	1.36	0.19	1.56	10.25	1.90	12.15
Glass	0.79	0.29	1.08	5.96	2.81	8.77
Product	0.11	0.11	0.22	0.81	1.06	1.88
Packaging	0.68	0.18	0.86	5.15	1.75	6.90
Metal	0.50	0.14	0.64	3.75	1.39	5.14
Product	0.21	0.12	0.34	1.60	1.21	2.81
Packaging	0.29	0.02	0.30	2.15	0.18	2.33
Other	3.46	1.08	4.55	26.07	10.65	36.72
Total	22.65	3.71	26.35	170.40	36.48	206.88

Fig.2 Waste amount by reduction action

Fig.3 GHG emission by sector

SWM scenarios. The study target of reducing 75% solid waste amount sent to landfill by the year of 2025 compared to BaU is achievable under scenario CM3 at 78% (172 t/day). Even though CM1 and CM2 waste reduction are below the target, reduction amount from both actions are significant compare to base year, 2010. In 2010 3R rate in Malaysia is as small as 5% but CM1 and CM2 reduction is 46% (102 t/day) and 65% (144 t/day), respectively. The most GHG reduction from alternatives scenario is also under CM3 at 84% (1459 t-CO₂/day) follows by CM2 at 64% (1119 t-CO₂/day), and CM1 at 43% (749 t-CO₂/day) (**Fig.3**). The results also show that as the participation and efficiency level increase the need to rely on waste treatment decreases. This directly influences generation of GHG in a positive way.

In 2025, at least 500 MSC base companies will be allocated in Cyberjaya with employer number of 120, 000. On top of that, nine tertiary educations that specialize in ICT with 30, 000 students are already operating in the area. The sectors are projected to generate 1041t/year of e-waste. Waste manager should take this into serious consideration not that only e-waste is part of hazardous waste but the generation rate cover at least 0.1% of national e-waste generation. This is based from e-waste generation forecast by Department of Environment Malaysia that stated by 2020 generation of e-waste to be 1.1 million tonnes. One of measure that could be consider is adopting reduction at source method

such as utilization of rental and lease service, and sharing or circulating electrical and electronic equipment between offices.

The proposed scenarios provide us image of future society achievable through changes of waste treatment priority under combination of waste handling method. At high level of public participation in waste reduction at source and high accuracy of waste segregation, the needs of high-technology treatment such as waste disposer and thermal treatment decreases. In contrast dependency on high-technology waste treatment will become crucial without support from public in waste reduction at source and segregation.

Our study is conducted based on local authority targets and plans for their future SWM therefore we regard our result as an easily adopted proposal into future Cyberjaya SWM implementation. Besides, during the study process, not only SWM authority but also all stakeholders – Cyberview and Setia Haruman, are closely involve through few series of focal group discussion to ensure the sustainability of Smart 3R Cyberjaya and its continuity with three other themes in this study of DGC2025. Additionally our three alternative counter measures (2025CM1, 2025CM2, 2025CM3) range widely between low, moderate and high law enforcement level, public participation and technology application to give the local authority wider scope and freedom of shaping their jurisdiction area. However cost factor was not considered in this

study. It is because this study is a preliminary and baseline towards the feasibility study. Based on this snapshot of future achievable society, further study using backcasting method where pathway that linking the target year to the base year that consider all – technical, economic, legal, operational and scheduling factors will be carried out.

As a follow up of this preliminary study and to implement specific efforts towards the Low Carbon City, “Basic Research for Low Carbon City development in Putrajaya and Cyberjaya” was launched. This is a project by the Malaysian Government and supported by the Japanese governmental agency New Energy and Industrial Technology Development Organization (NEDO)⁸⁾.

5. CONCLUSION

Smart 3R Cyberjaya study is carried out in conjunction with the feasibility study of Cyberjaya Digital Green City 2025. Our study objective is to come out with alternative SWM that fulfil the challenge of building both low-carbon and sound material cycle society. We set the target of building a zero emission society that depend less on landfill and actively practicing waste reduction at source. In term of quantitative we set the target of reducing 75% of waste sent to landfill site compare to 2025BaU. Smart 3R Cyberjaya includes all aspect of SWM management –generation, reduction, treatment and final landfill, from all waste source – household, business, sewage sludge green area and e-waste.

Impact of combination of waste reduction at source actions and waste treatment facility on waste amount sent to landfill and GHG emission were evaluated. From three counter measures, the most waste to landfill and GHG emission reduction achievable in 2025CM3, 78% (172 t/day) and 84% (1459 t-CO₂/day).

Even though our target of 75% reduction waste amount sent to final landfill compare to 2025BaU is only achievable at 2025CM3, waste reduction from other scenarios are also significant. Target of 50% GHG reduction is achievable at all counter measure selection.

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