LC Paper No. AS 56/16-17

The Legislative Council Complex
Greenhouse Gas Accounting Report
For the Period 1 April 2015 - 31 March 2016

Prepared by

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1. Executive Summary

1.1 Key findings from the GHG accounting project

i. The reported greenhouse gases (GHG) emissions of the Legislative Council Complex (the Complex) during the period from 1 April 2015 to 31 March 2016 are 8,127.84 tonnes CO_2 equivalent (CO_2-e), with Scope 2 emissions contributing to 97.37% through purchased energy. Scope 1 direct GHG emissions which include fuel combustions by vehicles, generators, Towngas equipment and fugitive emissions from refrigerant and fire suppression system take 1.76% while Scope 3 other indirect emissions, including fresh water processing, sewage processing, paper waste and general waste sent to landfill, account for 0.87% of reported emissions.

ii. The GHG emission intensity of the Complex is calculated at 154.14 kg CO_2-e/m^2, based on the included construction floor area at 52,731 m^2.

iii. Absolute GHG emissions show a 1.40 % reduction compared to the base year (1 April 2013 - 31 March 2014), though a 0.94% increase compared to the previous year (1 April 2014 - 31 March 2015). The GHG performance in terms of construction floor area presents a 2.20% reduction compared to the base year, but an increase at 0.12% compared to the previous year.

1.2 Recommendations on carbon reduction and information management

i. Carbon Road Map: It is recommended that the Commission may engage different stakeholders to develop its reduction targets.

ii. GHG information management system: It is recommended to establish an internal instruction for data collection procedure which will be helpful and make the team well-prepared. A ratio indicator relevant to the nature of the Complex, which can reflect the actual GHG performance is suggested to be identified.

iii. Fresh water reduction - grey water usage can be considered and rainwater harvesting can also be explored.

iv. Waste Management: Since the paper waste sent to landfill has been significantly decreased and the general waste increased by 59.12% compared to the base year, the general waste becomes the main contributor of the Scope 3 GHG emissions. It is recommended to review the waste composition and recycling rate of the total recyclables. Source reduction is also important, thus to engage suppliers to reduce packaging materials could be considered.

v. Communication and engagement: The Complex is the centre of public attention. It can play a leadership role in championing the cause of combating climate change in carbon management.
   - Setting up and announcing a long term carbon reduction target;

- Sharing best practices to the stakeholders for both GHG information management and GHG reduction measures;
- Engaging suppliers: The Commission may also lead and influence its service providers to take actions for the environment, which could provide strong support to the Commission for introducing more innovative and efficient carbon reduction measures;
- Engaging the Complex users: More interactive engagement programme can be explored, for instance, gamification is an emerging approach to encourage involvement. It is recommended to launch the engagement programme to demonstrate a few more innovative and interactive elements in carbon management; and
- Engaging the employees: Internal communication platform could be established to engage staff with environmental information by the environmental team, and this can encourage the sharing of innovative initiatives among the staff on sustainability and carbon reduction.

2. BACKGROUND

2.1 Name of the reporting entity

The Legislative Council Commission (the Commission)

2.2 Description of the reporting entity

The Commission is a statutory body established under The Legislative Council Commission Ordinance (Cap. 443).

2.3 Reporting period

1 April 2015 - 31 March 2016[1], and this is the third consecutive GHG reporting period for the Legislative Council Complex (the Complex).

2.4 Scope of physical boundary

(a) Location of the building

1 Legislative Council Road, Central, Hong Kong

(b) Description of the purpose of the building

The Complex is the first purpose-built building to house the Legislature of Hong Kong.

(c) Description of physical boundary with detailed information

The GHG accounting is compiled from an assessment of facilities under operational control as qualified by the Commission. Due to the 427 m^2 additional area of footbridge entrance at 1/F of the Complex, the construction floor area of the Complex has been updated to 52,955 m^2 (from 52,528 m^2) in the reporting period, comprising the Council Block, the Office Block, and the adjacent open space area namely the Legislative Council Square and the Legislative Council Garden. The Cafeteria with area of 224 m^2 is operated by outsourced contractor.

(d) Description of areas excluded from the GHG accounting

Since the operation of the contractor is not under control of the Commission, the area of Cafeteria, namely 224 m^2, is excluded in this GHG accounting project. The included construction floor area is 52,731 m^2.

[1] 1 April 2013 – 31 March 2014 has been set as the base year for the Legislative Council Complex's GHG accounting in order to compare the GHG emissions over time.

2.5 Scope of operational boundary

(a) Scope 1 Direct GHG emissions from:

- Combustion of fuels in stationary sources – diesel used in electricity generators
- Combustion of fuels in stationary sources – Towngas used in boilers and room kit
- Combustion of fuels in mobile sources – petrol used in owned vehicles
- Unintentional GHG release from equipment and system (fugitive emissions from fire suppression system and refrigeration/air-conditioning equipment)

(b) Scope 2 Energy indirect GHG emissions from:

- Electricity purchased from The Hongkong Electric Company
- Towngas purchased from The Hong Kong and China Gas Company

(c) Scope 3 Other indirect GHG emissions from:

- Methane gas generation at landfill in Hong Kong due to disposal of paper waste
- GHG emissions due to electricity for fresh water processing by Water Supplies Department (WSD)
- GHG emission due to electricity used for sewage processing by Drainage Services Department (DSD)
- Methane gas generation at landfill in Hong Kong due to general waste disposal

2.6 Methodologies for quantifying GHG emissions

The accounting process follows the Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong (2010) (EPD-EMSD Guidelines) in data collection, classification of emission source, quantification methods and the reporting format. The GHG emissions are quantified in terms of CO_2-e, and the types of GHG covered in this report are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluoro-carbons (HFCs), perfluoro-carbons (PFCs) and sulphur hexafluoride (SF_6).

(a) List of activities for which simplified methodologies and conversion factors in the Guidelines are used for quantification:

- Direct emissions from stationary combustion (Scope 1)
  Emission (CO_2) = Σ Amount of fuel consumed × Emission factor of CO_2
  Emission (CH_4 / N_2O) =Σ Amount of fuel consumed × Emission factor of (CH_4 / N_2O) × Relative Global Warming Potential (GWP)
  where

Emission is summed over all types of fuel used by all generators and Towngas consuming devices; and
Amount of diesel consumed is in terms of litre and amount of Towngas consumed is in terms of unit.

- Direct emissions from mobile combustion (Scope 1)
  Emission (CO_2) = Σ Amount of fuel consumed × Emission factor of CO_2
  Emission (CH_4 / N_2O) =Σ Amount of fuel consumed × Emission factor of (CH_4 / N_2O) × GWP
  where
  Emission is summed over petrol used by all vehicles owned by the Commission; and
  Amount of fuel consumed is in terms of litre.

- Indirect emissions from electricity / Towngas purchased (Scope 2)
  Emission (CO_2-e) = Quantity of purchased electricity / Towngas × Emission factor
  where
  Purchased electricity is measured in kilowatt-hours (kWh); and
  Purchased Towngas is measured in unit.

- Other indirect emissions due to electricity used for processing fresh water by WSD (Scope 3)
  Emission (CO_2-e) = Quantity of fresh water consumed × Emission factor
  where
  Water consumed is measured in cubic metre (m^3).

- Other indirect emissions due to electricity used for processing sewage water by DSD (Scope 3)
  Emission (CO_2-e) = Quantity of sewage discharged × Emission factor
  where
  Sewage discharged is measured in cubic metre (m^3).

- Other indirect emissions from paper disposed at landfills (Scope 3)
  In order to simplify the calculations, the default emission factor assumes that the total raw amount of CH_4 emitted throughout the entire decomposition process of the paper waste disposed at landfills will be emitted into the atmosphere within the same reporting period as paper waste collected.

  Emission (CO_2-e) = (P_s + P_i – P_r – P_e) × Emission factor (estimated at 4.8 kg CO_2-e/kg)
  where
  P_s = Paper inventory at the beginning of the reporting period (in storage) (kg)
  P_i = Paper added to the inventory during the reporting period (kg)
  P_r = Paper collected for recycling purpose (kg)
  P_e = Paper inventory at the end of the reporting period (in storage) (kg)

(b) Details (including necessary reference) of other methodologies and conversion factors used for quantification:

- Fugitive emissions from fire suppression system – portable extinguishers (Scope 1)
  2006 IPCC Guidelines for National Greenhouse Gas Inventories[2] is referred, as below:
  Emissions (CO_2-e) = Σ Amount of extinguishing agent leakage × GWP of extinguishing agent
  where
  Amount of extinguishing agent leakage = Amount of extinguishing agent × leakage rate
  The IPCC default leakage rate is 4% ± 2% and midpoint of the interval, 4%, is adopted.

- Fugitive emissions from fire suppression system – FM 200 system (Scope 1)
  2006 IPCC Guidelines for National Greenhouse Gas Inventories is referred, as below:
  Emissions (CO_2-e) = Σ Amount of HFC-227ea[3] leakage × $GWP_{HFC-227ea}$
  where
  Amount of extinguishing agent leakage = Amount of HFC-227ea × leakage rate

  The IPCC default leakage rate is 2% ± 1%. In consideration of the periodical pressure tests have been conducted during the reporting period, the lower value 1% is selected.

- Fugitive emissions from refrigeration / air-conditioning systems – refrigerators / air conditioning equipment (Scope 1)
  2006 IPCC Guidelines for National Greenhouse Gas Inventories is referred, as below:
  Emissions (CO_2-e) = Σ Amount of refrigerant leakage × GWP of refrigerant
  where
  Amount of refrigerant leakage = Amount of refrigerant charge × operation emission factor

  The IPCC default operation emission factor for domestic refrigeration is 0.1% - 0.5% of initial charge per year and for chiller is 2% - 15% of initial charge per year. The lower end of the emission factors are intended to specify the status in developed region, thus, 0.1% and 2% are selected accordingly.

- Other indirect GHG emissions from general waste disposal (Scope 3)
  The Guidelines of Carbon Audit Toolkit for Small and Medium Enterprises in Hong Kong is referred, as below:

[2] Source: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_7_Ch7_ODS_Substitutes.pdf
[3] HFC-227ea is the fire suppression agent used in FM 200 system.

The general waste sent to landfill will be decomposed through anaerobic digestion and CH_4 will be emitted. It is estimated that anaerobic digestion of one kg of the general waste is equivalent to 1.5 kg CO_2-e, then
Emission (CO_2-e) =Amount of general waste disposal × Emission factor (estimated at 1.5 kg CO_2-e/kg).

(c) Details of any changes in methodologies and conversion factors since the last GHG report by the Entity:

- The GHG Emission Factor for purchased electricity within Scope 2 has been updated from 0.79 kg CO_2-e/kWh (2014) to 0.78 kg CO_2-e/kWh (2015) according to the HK Electric Investments Sustainability Report 2015.

- The GHG Emission Factor of Towngas purchased within Scope 2 has been updated from 0.60 kg CO_2-e/unit (2014) to 0.605 kg CO_2-e/unit (2015) according to the Towngas Sustainability Report 2015.

- The GHG Emission Factor for fresh water processing by WSD within Scope 3 has been updated from 0.398 kg CO_2-e/m^3 (2014) to 0.407 kg CO_2-e/m^3 (2015) according to the recent WSD Annual Report 2014-2015.

- The GHG Emission Factor for Sewage Processing by DSD within Scope 3 has been updated from 0.169 kg CO_2-e/m^3 (2014) to 0.181 kg CO_2-e/m^3 (2015) according to the recent DSD Sustainability Report 2014-2015.

(d) Details on any re-calculation of previously reported emissions and removals because of changes in methodologies and conversion factors
Not applicable.

2.7 Contact person of the reporting entity

The Administration Division, Legislative Council Secretariat (the Secretariat)

2.8 References

The following guidelines are taken as references in this *Report*:

- *Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong (2010)*. Environmental Protection Department and Electrical and Mechanical Services Department of the Government of the Hong Kong Special Administrative Region

- *ISO14064-1 (2006): International Standard on Greenhouse Gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*. ISO

- *2006 IPCC Guidelines for National Greenhouse Gas Inventories - Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances.* IPCC

- *Carbon Audit Toolkit for Small and Medium Enterprises in Hong Kong (2010).* Published in February 2010 by The University of Hong Kong

- Other references, where appropriate (e.g. emission factors), have also been taken into consideration and are quoted under corresponding sessions in this report.

3. GHG EMISSIONS DATA

3.1 Information on GHG emissions and removals

Summary of Results

Scope 1 Emissions:	143.27	tonnes of CO_2-e
Scope 1 Removals:	Nil	tonnes of CO_2-e
Scope 2 Emissions:	7,914.32	tonnes of CO_2-e
Scope 3 Emissions:	70.25	tonnes of CO_2-e
Other GHG Offsets / Removals:	Nil	tonnes of CO_2-e
Accounted GHG Emissions in total:	8,127.84	**tonnes of CO_2-e**

In terms of absolute GHG emission, the reported emissions of the Complex in the current reporting period increases 0.94% compared to 8,052.44 tonnes CO_2-e in 2014-2015 (the previous year), by 75.40 tonnes CO_2-e; while this corresponds to a 1.40% reduction versus 8,243.16[4] tonnes CO_2-e in 2013-2014 (the base year), by 115.32 tonnes CO_2-e.

GHG Performance in Ratio Indicator: Based on the included construction floor area of 52,731 m^2, the GHG emission intensity of the Complex in terms of construction floor area is 154.14 kg CO_2-e/m^2, also indicating a 0.12% increase compared to previous year and a 2.20% reduction compared to the base year's 157.60 kg CO_2-e/m^2.

3.2 Total and breakdown of the GHG emissions

The GHG emissions of the Complex accounted for reporting period: 1 April 2015 to 31 March 2016, are 8,127.84 tonnes CO_2-e. Table 1 summarizes the GHG emissions of the Complex from different emission sources. The summary of activity data and calculation details are shown in APPENDIX 1 and APPENDIX 3 respectively. The GHG emissions summary for the base year is attached in APPENDIX 4.

[4] This figure in *The Legislative Council Complex Greenhouse Gas Accounting Report For the Period 1 April 2013 - 31 March 2014* was 8,243.17 and updated to 8,243.16 due to the rules for rounding off in the current reporting period.

Table 1: Summary of GHG emissions accounted for the Complex during the reporting period

Emission source	in tonnes of CO_2-e						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Sub-total
Scope 1 Direct Emissions							
Combustion of fuels in stationary sources – diesel used in generators	0.54	0.0001	0.0005	N/A	N/A	N/A	0.54
Combustion of fuels in stationary sources – Towngas consumption	11.76	0.004	0.014	N/A	N/A	N/A	11.78
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	11.91	0.03	1.73	N/A	N/A	N/A	13.67
Unintentional GHG release from equipment and system	0.05	N/A	N/A	117.23	N/A	N/A	117.28
Scope 2 Energy Indirect Emissions (To be reported in general without being classified into specific gas type)							
Electricity purchased from The Hongkong Electric Company							7,911.53
Towngas purchased from The Hong Kong and China Gas Company							2.79
Scope 3 Other Indirect Emissions (GHG emission from fresh water processing and sewage discharge disposal to be reported in general without being classified into specific gas type)							
Methane gas generation at landfill in Hong Kong due to disposal of paper waste	N/A	0.00[5]	N/A	N/A	N/A	N/A	0.00[5]
GHG emissions due to electricity for fresh water processing by WSD							4.28
GHG emissions due to electricity used for sewage processing by DSD							1.85
Methane gas generation at landfill in Hong Kong due to general waste disposal	N/A	64.12	N/A	N/A	N/A	N/A	64.12

[5] Since the recorded amount of paper recycling is more than the paper used during the reporting period, the impact of paper waste disposal within the boundary is calculated at zero.

3.3 Data collection

i. Scope 1 - Stationary fuel combustion

The data of diesel consumption for three generators controlled by the Complex are extracted from the monthly maintenance records.

Towngas consumption is based on the bills issued by The Hong Kong and China Gas Company.

ii. Scope 1 - Mobile fuel combustion

The vehicle type of the three cars owned by the Commission has been specified as "Private Car" in the licenses. Fuel consumption records are summerised from the invoices issued by the suppliers. The type of fuel used is petrol, and quantities for each of these vehicles are listed.

iii. Scope 1 - Fugitive emissions

The amounts and specifications of CO_2 portable extinguishers and FM 200 have been summarised by the Secretariat. The types and amounts of refrigerant used in refrigerators and air-conditioning equipment solely controlled by the Complex are also provided. No allocation is made for the refrigerant used in the central chiller plant (CCP) which is shared use with the Chief Executive's Office and Central Government Offices.

iv. Scope 2 - Electricity

The electricity used by the Complex contains the part solely controlled by the Complex and the shared usage with the Chief Executive's Office and Central Government Offices. The shared facilities include CCP and seawater pump house (SWP) and the portion of electricity consumption by the Complex is calculated based on measured water consumption of each building in CCP and SWP.

v. Scope 3 - Water

The fresh water consumption of the Complex is based on the monthly records of the water metres' readings instead of water bills. And the sewage generated is calculated on the basis of the default conversion from fresh water amount, as identified in the EPD-EMSD Guidelines.

vi. Scope 3 - Paper

The data of paper inventory opening stocks for both the Secretariat and Legislative Council Members' Offices are available, which equal to the paper storage at the end of last reporting

period. Following the previous practice, the paper purchased and closing stocks are recorded for both, through monthly records and survey.

One ream of 75gsm A4 paper weighs 2.34 kg, while one ream of 75gsm A3 paper weighs 4.68 kg.

The practice of paper collection and recycling in the Complex had contained a mix of the newspaper and office paper (including recyclable confidential paper). Sampling was conducted separately to measure the daily newspaper recycling. Newspaper is not generated for the operation of the Complex, and is therefore out of the operational boundary. Projection was applied to calculate the newspaper recycling for the year.

vii. Scope 3 - General waste

The data of general waste disposal are calculated based on projection of the sample data. While the sampling process and projection method for both newspaper and general waste is consistent with the practice in the base year.

3.4 Data analysis

i. GHG emissions breakdown

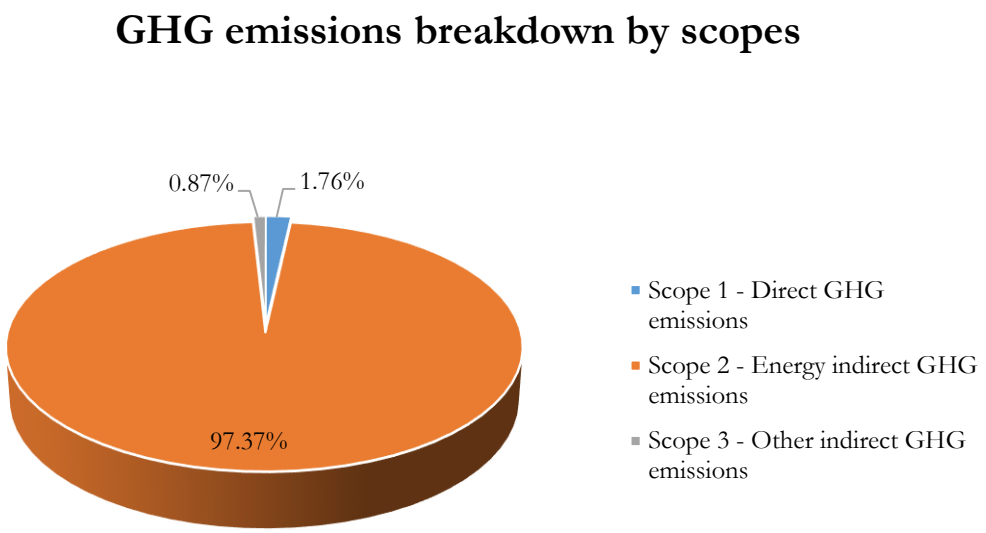


Figure 1. 2015-2016 GHG emission profile by scopes

Figure 1 breakdowns the 2015-2016 GHG emission profile by scopes. The Scope 2 indirect GHG emissions from purchased energy contributed the most, 97.37% (7,914.32 tonnes), to the total GHG emissions (8,127.84 tonnes). It is followed by Scope 1 direct GHG emissions, 1.76% (143.27 tonnes) and lastly, Scope 3 other indirect GHG emissions account for the least of the total, 0.87% (70.25 tonnes).

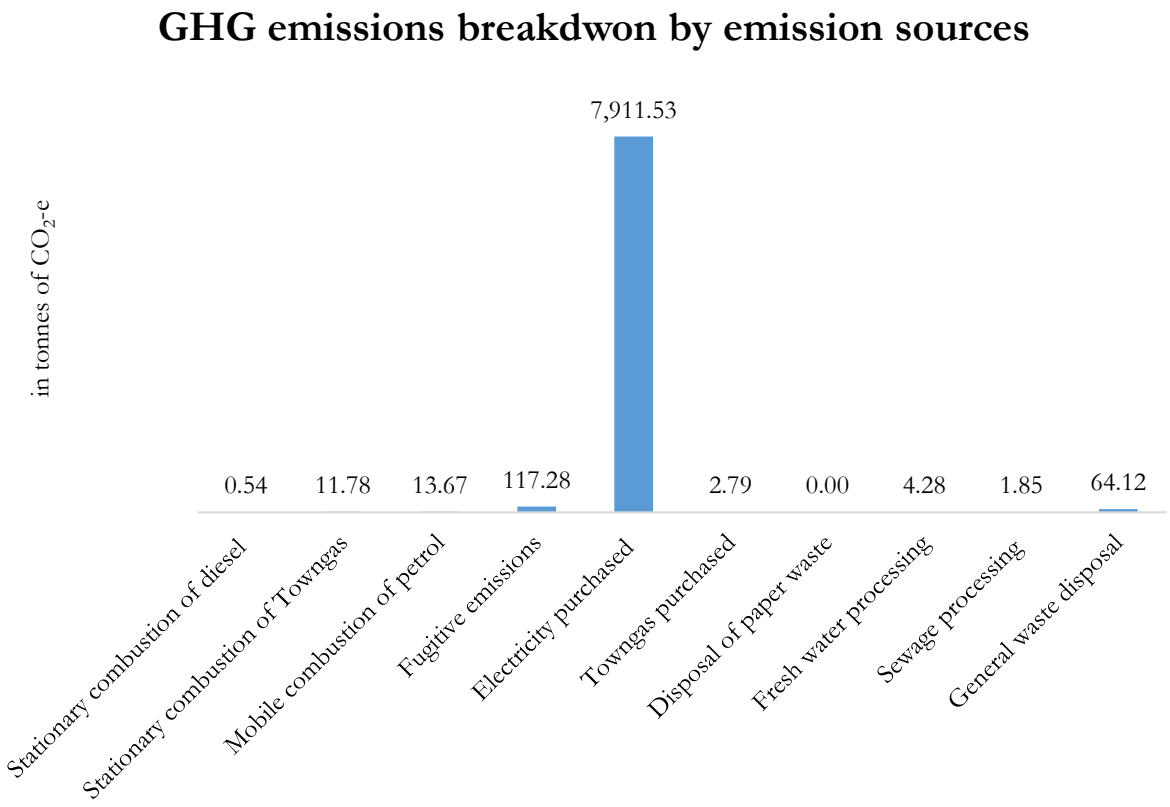


Figure 2. 2015-2016 GHG emission profile by emission sources

Figure 2 presents the distribution of different emission sources. Electricity consumption is the dominant carbon emitter of the Complex, accounting for 7,911.53 tonnes CO_2-e, equavlent to 97.34% of the reported emissions, followed by fugitive emissions and 117.28 tonnes, general waste disposal, 64.12 tonnes. The rest represents less than 0.5% of the total emission profile.

ii. GHG emissions comparison with the previous year and the base year

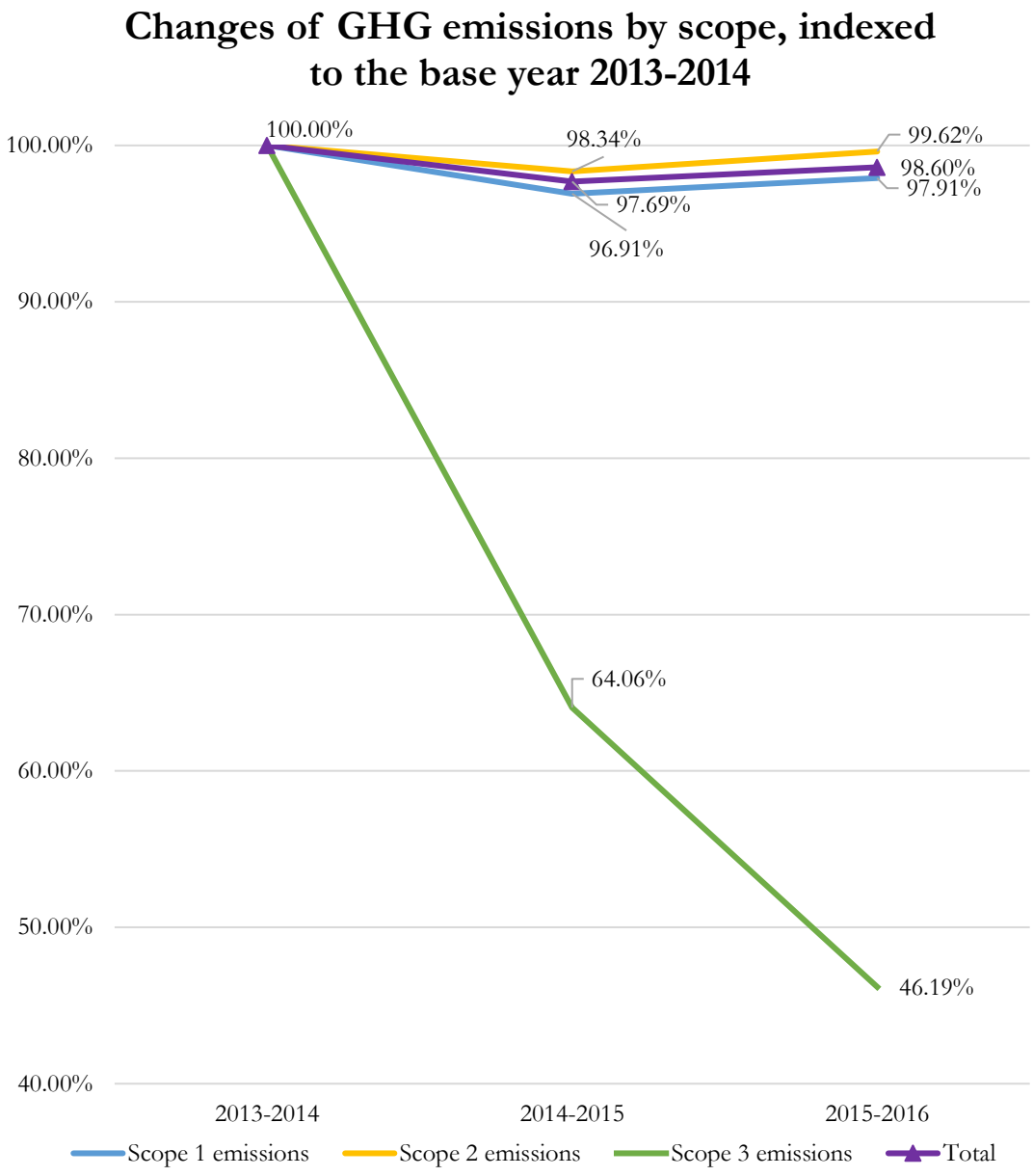


Figure 3. Changes of GHG emissions by scope, indexed to the base year 2013-2014

Figure 3 illustrates the overall trends of GHG emissions and annual changes for each scope: scope 1 – direct GHG emissions, scope 2 – energy indirect GHG emission and scope 3 – other indirect GHG emissions, which present decreases over the three-year time period, to varying extents. Scope 3 shows the most significant decrease and scope 1 also has a slightly higher decrement than the Total while scope 2, dominated by electricity consumotion has the least reduction. The detailed changes of each emission source are analysed and these results are summarized in the followed Figure 4.

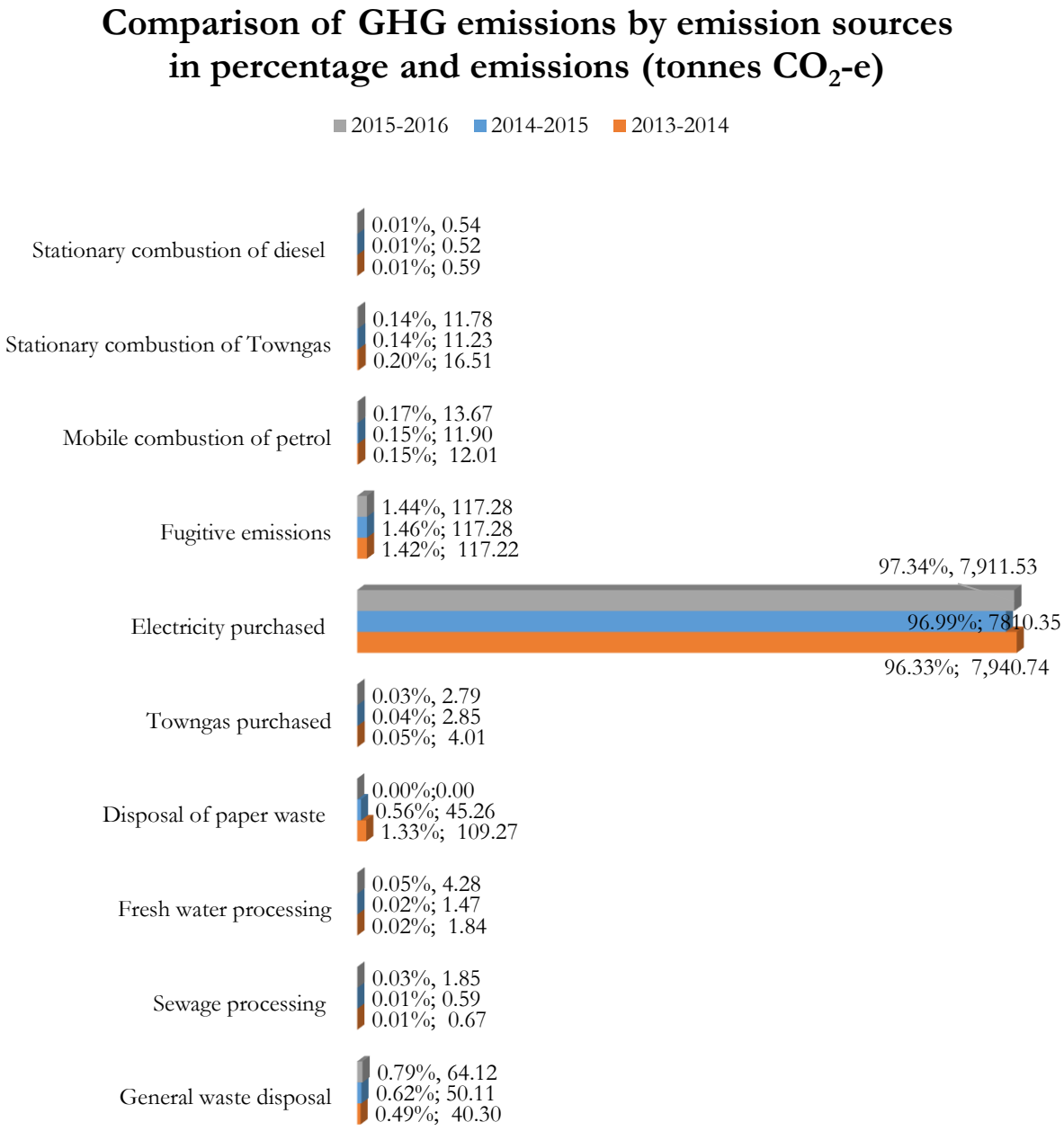


Figure 4. Comparison of GHG emissions between 2015-2016, 2014-2015 and 2013-2014

Figure 4 compares the distribution of different emission sources in tonnes of CO_2-e and in percentage terms between the current reporting year, the previous year and the base year. In the three consecutive periods, electricity consumption has been the largest contributor to total GHG emissions, where made up of 97.34% and 96.99% in the current year and the previous year, representing 7,911.53 and 7,810.35 tonnes CO_2-e. In base year, the electricity purchase has higher emission as 7,940.74 tonnes CO_2-e, though standing for lower percentage at 96.33%, which demonstrate the decreasing accounted GHG emissions in total in the following two years.

Compared to relatively stable performance of the other emissions sources, general waste disposal has been more significant from 0.49% to 0.62% and 0.79% over the three years, which are increasing from 40.30 tonnes to 50.11 tonnes and 64.12 tonnes CO_2-e in the current period; while fresh water processing and sewage treatment present the same trend. At the same time, GHG emissions attributable to stationary combustion of towngas, towngas purchased and disposal of paper waste show continues reductions in both absolute value and percentage in all three years. Some emission sources which are stationary diesel combustion, mobile petrol combustion and electricity purchased showed reduction in previous year compared to year before, but reverse the trend in the current year.

Table 2 summarises the differences of the accounted GHG emissions between the current reporting period, the previous year and the base year. It can be observed that except emission sources related to towngas cosumption and general waste sent to landfill, the other emission sources all show different levels of increase, compared to the previous year; though comparing with the base year, three scopes still presents reductions. In terms of realative change of each emission source, the sources in scope 3 show dramatic variantion, particularly the increase of emissions sources related to water and reduction of paper waste sent to landfill. Overall, the increase (75.40 tonnes CO_2-e) compared to the previous year is majorly resulted from the increase eletrcity consumption, GHG emissions of which is 101.18 tonnes CO_2-e.

Table 2: Summary of GHG emissions differences between 2015-2016, 2014-2015 and 2013-2014

Emission Source	Accounted GHG emissions in tonnes of CO_2-e			Differences in tonnes of CO_2-e		Differences in percentage	
	2015/16	2014/15	2013/14	2015/16 versus 2014/15	2015/16 versus 2013/14	2015/16 versus 2014/15	2015/16 versus 2013/14
Scope 1 Direct Emissions	**143.27**	**141.81**	**146.33**	**+1.46**	**-3.06**	**+1.03%**	**-2.09%**
Combustion of fuels in stationary sources – diesel used in generators	0.54	0.52	0.59	+0.02	-0.05	+3.85%	-8.47%
Combustion of fuels in stationary sources – Towngas consumption	11.78	12.11	16.51	-0.33	-4.73	-2.73%	-28.65%

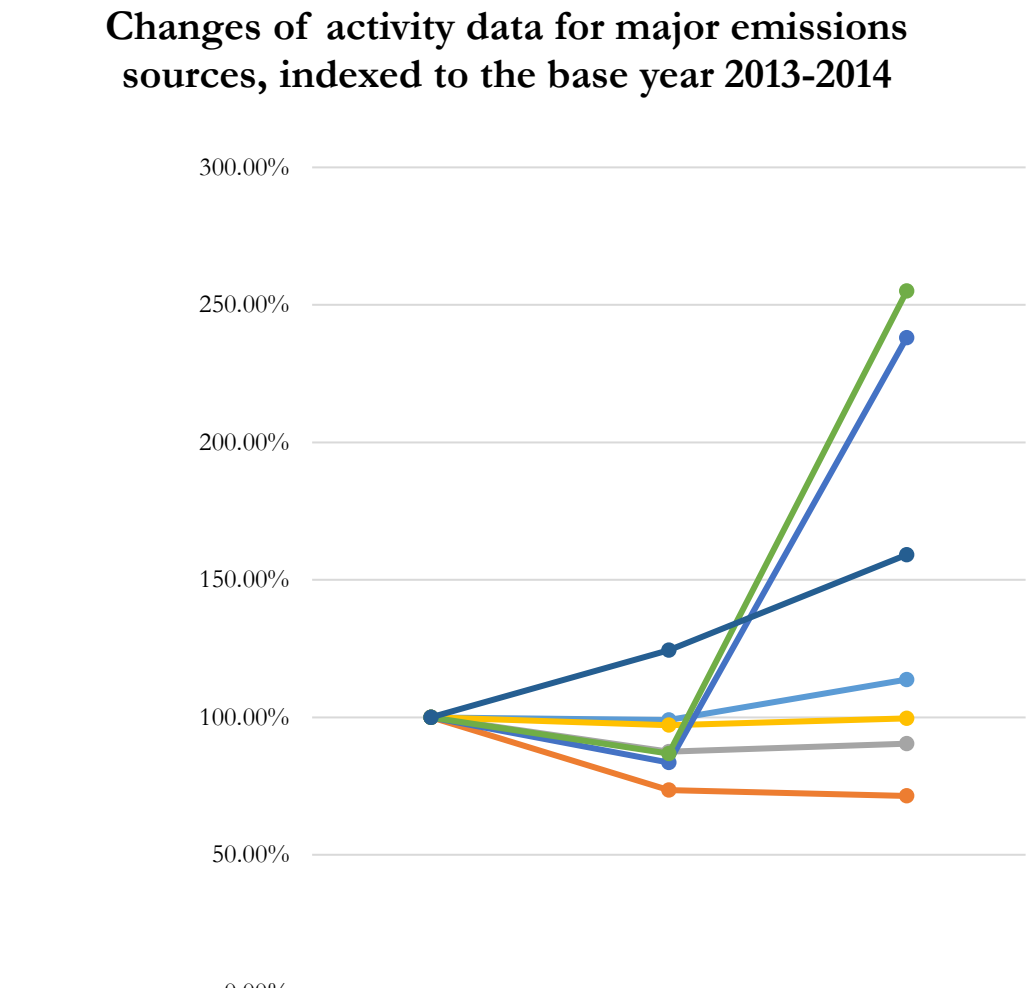
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	13.67	11.90	12.01[6]	+1.77	+1.66	+14.87%	+13.82%
Unintentional GHG release from equipment and system	117.28	117.28	117.22	0	+0.06	0	+0.05%
Scope 2 Energy Indirect Emissions	**7,914.32**	**7,813.20**	**7,944.75**	**+101.12**	**-30.43**	**+1.29%**	**-0.38%**
Electricity purchased from The Hongkong Electric Company	7,911.53	7,810.35	7,940.74	+101.18	-29.21	+1.30%	-0.37%
Towngas purchased from The Hong Kong and China Gas Company	2.79	2.85	4.01	-0.06	-1.22	-2.11%	-30.42%
Scope 3 Other Indirect Emissions	**70.25**	**97.43**	**152.08**	**-27.18**	**-81.83**	**-27.90%**	**-53.81%**
Methane gas generation at landfill in Hong Kong due to disposal of paper waste	0.00	45.26	109.27	-45.26	-109.27	-100.00%	-100.00%
GHG emissions due to electricity for fresh water processing by WSD	4.28	1.47	1.84[7]	+2.81	+2.44	+191.16%	+132.61%
GHG emissions due to electricity used for sewage processing by DSD	1.85	0.59	0.67	+1.26	+1.18	+213.56%	+176.12%
Methane gas generation at landfill in Hong Kong due to general waste disposal	64.12	50.11	40.30	+14.01	+23.82	+27.96%	+59.12%
Sum-total	**8,127.84**	**8,052.44**	**8,243.16**	**+75.40**	**-115.32**	**+0.94%**	**-1.40%**

[6] This figure in *The Legislative Council Complex Greenhouse Gas Accounting Report For the Period 1 April 2013 - 31 March 2014* was 12.02 and updated to 12.01 due to the rules for rounding off in the current reporting period.

[7] This figure in *The Legislative Council Complex Greenhouse Gas Accounting Report For the Period 1 April 2013 - 31 March 2014* was 1.83 and updated to 1.84 due to the rules for rounding off in the current reporting period.

3.5 Activity data comparison

Under the context of GHG emissions accounting, the activity data have dominant impact in general. Figure 5 present the overall changes of almost all emissions sources' activity data, except fugitive emission which is relatively stable over the three years; while Figure 6 demonstrate the detailed monthly variations of electricity consumption since it's the most important contributor of the overall GHG emissions.



	2013-2014	2014-2015	2015-2016
Diesel consumed	100.00%	87.49%	90.40%
Towngas consumed	100.00%	73.46%	71.39%
Petrol consumed	100.00%	99.01%	113.72%
Electricity consumed	100.00%	97.11%	99.63%
Fresh water consumed	100.00%	83.54%	238.07%
Sewage generated	100.00%	86.80%	254.99%
General waste disposal	100.00%	124.34%	159.12%

Figure 5. Changes of activity data for major emissions sources, indexed to the base year 2013-2014

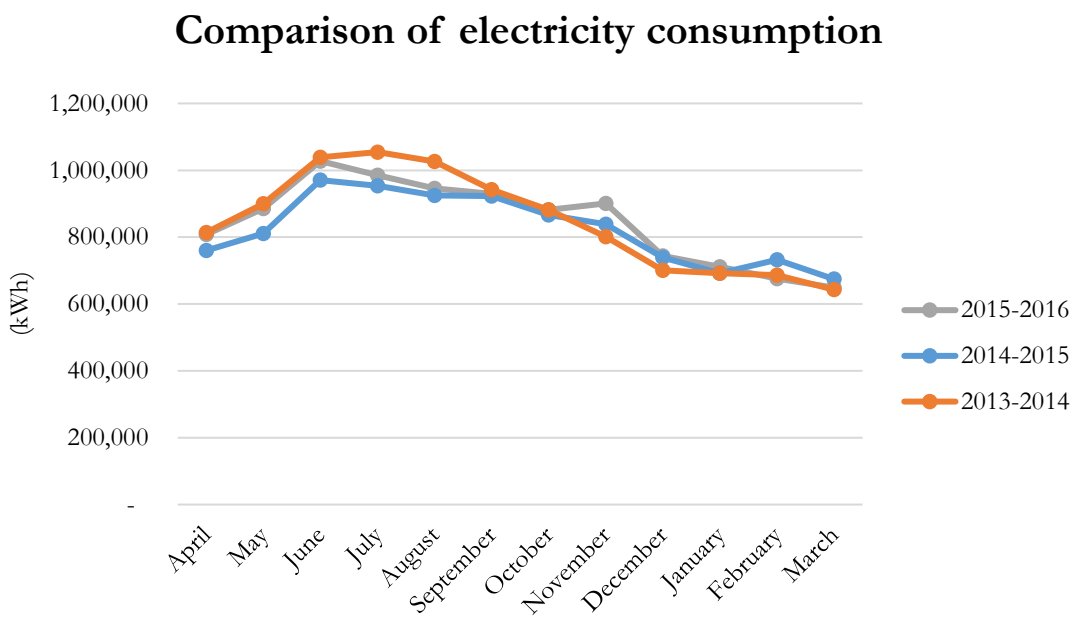


Figure 6. Comparison of electricity consumption between 2015-2016, 2014-2015 and 2013-2014

Figure 6 shows the monthly comparisons of electricity consumption, which enable further investigation on the changes of the most significant emission source. Except February 2016 and March 2016, the electricity consumption in 2015-2016 are all higher than the same period of the previous year. May 2015, November 2015 and June 2015 are the top 3 most significant increase months, thus, It's suggested to review the operations of the Complex, for instance, the meeting hours, and investigate the correlation.

3.6 GHG emission reduction measures implemented

Since the base year, the GHG emissions reduction measures has been summarised in the dedicated document - *Green Measures taken in the LegCo Complex* and annually reviewed and updated by the Secretariat. In the current reporting period, waste management has been the focus to reduce GHG emissions within the reported boundary, and details of which including:

- Participated in the "Waste Check Charter" launched by the Environment Bureau, the Commission pledges to regularly measure the quantity of waste disposal and recyclables generated in the Complex, making efforts to reduce waste, recycle the recyclables, and help to promote waste reduction to the public.

- To enhance awareness of the users of the Complex on waste reduction, the Secretariat will issue tips on handling general wastes and waste reduction at source regularly.

- Additional facilities for collecting recyclables (e.g. recycling bins for glass bottles) were provided.

4. DISCUSSION AND RECOMMENDATIONS

4.1 Discussion

4.1.1 Water consumption

GHG emissions due to fresh water processing and sewage treatment have been dramatically increased in the reporting period. The water usage for general use, the kitchen and fountain decreased while the rest increased; though one thing needed to point out is that the water meter for watering plants had been out of function for the previous year and the base year, which accounted for 43.19% of the total water usage. And for floor washing, the usage increased by 157.87%. It is suggested to review if there are any changes on the cleaning practice and also monitor the operation of water metres.

4.1.2 Paper consumption and recycling

Given that the reporting period has overlap with the final year of the term of fifth Legislative Council, paper recycling amount recorded has increased significantly, by 15.15% compared to the previous year and 115.29% compared to the base year; while the consistent sampling methodology has been applied during the three years. It is found that the consumption of office paper, as recorded by the Secretariat and the Members' Offices, is fewer than the amount of paper recycled in the current year. The calculation methodology is simplified with the assumption that the paper usage, paper recycling and paper waste disposal occurring in the same year. The basis of the assumption is that in the long term the practices in the reporting entity is stable, though it may raise errors when practices change in certain period, for instance, the demand of paper handling increase in the end of the term. The indirect emissions calculated by the formula can not be negative as the paper recycling are not carbon offsetting for other emission sources. The minimal value is zero for paper waste disposal in the Complex.

4.1.3 Waste reduction

The general waste amount in the current year has increased by 27.97% compared to the previous year and 59.12% compared to the base year. The overall GHG emissions from waste category, covering paper waste and general waste has reduced from 149.57 tonnes CO_2-e in 2013-2014 to 64.12 tonnes now. Though the emission of paper waste disposal has solely reduced by 109.27 tonnes, it is worthwhile to review the waste management operations and investigate reverse trends of the two emission sources.

4.1.4 Performance ratio indicator

Energy reduction measure have been implemented in the Complex and the fluctuation of electricity consumption needed to further discussion. As a 2.59% increase of usage compared to the previous reporting period 2014-2015, electricity purchased in the current period 2015-2016 was 10,142,981 kWh, while in 2014-2015 the data was 9,886,515 kWh. Though, it should be addressed at the same time the number of meetings has increased by

10.04% (833 versus 757) compared previous period, which would directly affect the electricity consumption. It is necessary to identify the ratio indicator to reflect the actual scenario and also the performance for long term analysis and management.

4.2 Recommendations

4.2.1 Carbon Roadmap Strategy Assessment

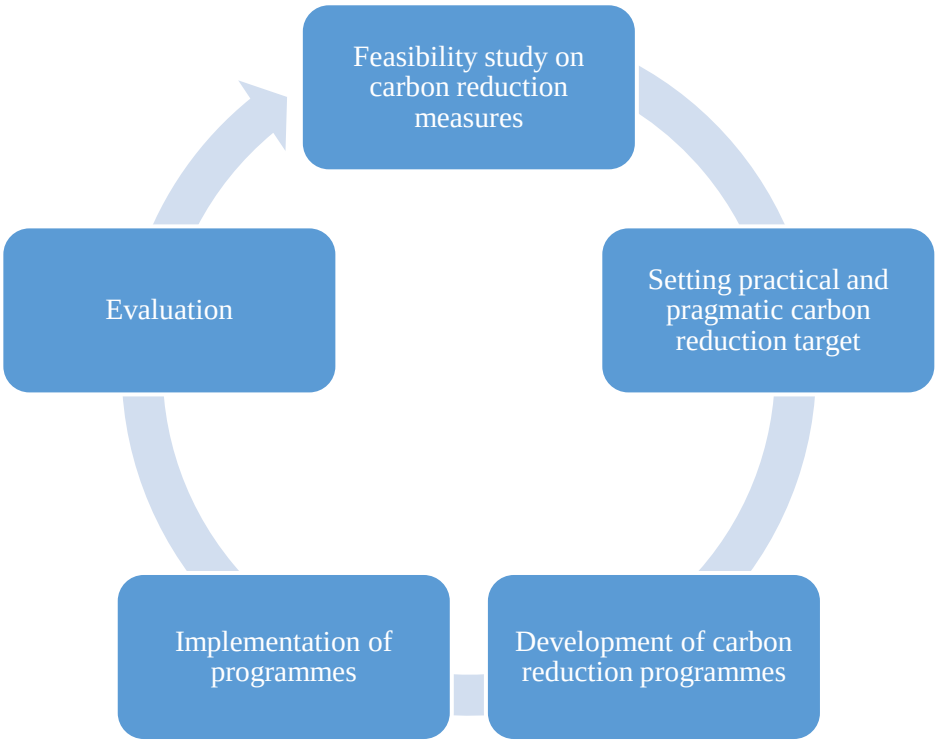


Figure 7. Carbon Roadmap Strategy Assessment

As the Government is reviewing its long-term carbon reduction target and strategy, aiming to announce the carbon reduction target for 2030 later this year[8]. It is recommended that the Commission may engage different stakeholders to develop its reduction targets in the short, medium and long term based on a review of internal capacity and the current performance.

4.2.2 GHG information management system

It is recommended to establish an internal instruction for data collection procedure which will be helpful and make the team well-prepared. Besides, as discussed is 4.1.4, energy consumption and accordingly the overall GHG emissions is suggested to link with (a) ratio indicator(s) which can reflect the actual scenario and trends. The ratio indicator should be

[8] Source: http://www.news.gov.hk/en/categories/environment/html/2016/06/20160607_153802.shtml

relevant to the nature of the Complex, for instance, a normalised indicator with parameters of meeting number, meeting duration.

4.2.3 Implementation of GHG emission reduction measures

- Refrigerant
  According to the international recognised references[9 & 10], a checklist/manual for maintenance of refrigeration and air-conditioning system could be considered for operation practice. Table 3 presents the estimates for charge, lifetimes and emission factors data extracted from IPCC, which could be taken as internal reference to check if the leakage rate is within the reasonable range and if there is any defection instead of aging problem.

Table 3 Estimates for charge, lifetime and emission factors for refrigeration and air-conditioning system[11]

Sub-application	Charge (kg)	Lifetimes (year)	Emission Factors (% of initial charge/year)		End-of-Life Emission (%)	
			Initial emission	Operation emission	Recovery efficiency	Initial charge remaining
Chillers	$10 \leq M \leq 2{,}000$	$15 \leq d \leq 30$	$0.2 \leq k \leq 1$	$2 \leq x \leq 15$	$0 < \eta_{rec,d} < 95$	$80 < P < 100$
Residential and commercial A&C, including Heat Pumps	$0.5 \leq M \leq 100$	$10 \leq d \leq 20$	$0.2 \leq k \leq 1$	$1 \leq x \leq 10$	$0 < \eta_{rec,d} < 80$	$0 < P < 80$

- Fresh water reduction
  As the fresh water consumption increased significantly, grey water usage can be considered and rainwater harvesting can also be explored for watering plants which currently takes 43.19% of the total fresh water usage.

[9] Source: US Environmental Protection Agency(EPA) http://www2.epa.gov/sites/production/files/2013-12/documents/gc_preventativemaintenance_20130913.pdf
[10] Source: Australian Institute of Refrigeration, Airconditioning and Heating http://www.airah.org.au/imis15_prod/Content_Files/UsefulDocuments/AIRAH_HFC_RefrigerantLevy_FactSheet3.pdf
[11] Source: Volume 3: Industrial Processes and Product Use - 2006 IPCC Guidelines for National Greenhouse Gas Inventories

- General waste reduction
  Since the paper waste sent to landfill has been significantly decreased and the general waste increased by 27.97% during the reporting period compared to the previous period, the general waste becomes the main contributor of the Scope 3 GHG emissions. It is recommended to review the waste composition and recycling rate of the total recyclables. Source reduction is also important, thus to engage suppliers to reduce packaging materials could be considered.

4.2.4 Communication and Engagement

Programs for engaging internal and external stakeholders to support and implement the GHG reduction actions should be planned and set up to promote sustainability awareness and support carbon care practices.

- *Engaging suppliers:* The Commission may also lead and influence its service providers to take actions for the environment, which could provide strong support to the Commission for introducing more innovative and efficient carbon reduction measures. For instance, Green Procurement Guidelines could be taken into consideration to provide guidance for suppliers and contractors to fulfill their responsibility in sustainability.

- *Engaging the Complex users:* In addition to the recommendations embedded in the base year GHG accounting report, more interactive engagement programme can be explored, for instance, gamification is an emerging approach to encourage involvement. Direct interaction, such as kinetic energy electricity generation that convert human power to electricity can be fun and clearly deliver the message of alternative energy to reduce the fossil fuel usage. It can be applied in the gym as cycling or running exercise, or even can be communal area pavement to light up the bulb over the head while some innovative technology are in the market. This is an example of the element that can be considered and it is recommended to launch the engagement programme to demonstrate a few more innovative and interactive elements in carbon management.

- *Engagement program for employees*: Best practice can be provided to the staff and users of the Complex through multi channels, which will help them implement GHG emission management in operations of the Complex. It is recommended to establish internal communication platform to engage staff with environmental information by the environmental team, and this can encourage the sharing of innovative initiatives among the staff on sustainability and carbon reduction.

//end of text//

APPENDIX 1: SUMMARY OF ACTIVITY DATA

Activity	Emission source	Activity data	Unit	Scope (1, 2, 3)
Stationary fuel combustion	Diesel	205.2	litre	1
Stationary fuel combustion	Towngas	4,616	unit	1
Mobile fuel combustion	Unleaded petrol (ULP)	5,046.7	litre	1
Fugitive emission – Portable extinguishers	CO_2	45.8	kg	1
Fugitive emission – FM 200	HFC-227ea	39.7	kg	1
Fugitive emission – Refrigerator	R-134a	0.0022	kg	1
Fugitive emission – Air-conditioning equipment	R-410A	1.2	kg	1
Electricity purchased	GHG emissions from the utility	10,142,981	kWh	2
Towngas purchased	GHG emissions from the utility	4,616	unit	2
Paper in storage at the beginning of the reporting period	Methane gas generation at landfill	7,765.3	kg	3
Paper purchased		46,117.4	kg	
Paper collected for recycling		49,182.7	kg	
paper in storage at the end of the reporting period		7,640.2	kg	
Fresh water processing	Electricity used for processing by WSD	10,531.6	m^3	3
Sewage discharge	Electricity used for processing by DSD	10,271.5	m^3	3
General waste disposal	Methane gas generation at landfill	42,749.6	kg	3

APPENDIX 2: CONVERSION FACTORS

A. Emission factors used

Scope	Emission source	Type	Unit	CO_2 (kg/unit)	CH_4 (g/unit)	N_2O (g/unit)	Data source
Scope 1	Stationary combustion	Diesel	litre	2.614	0.0239	0.0074	EPD-EMSD Guidelines
	Stationary combustion	Towngas	unit	2.549	0.0446	0.0099	EPD-EMSD Guidelines
	Mobile combustion	ULP – Passenger car	litre	2.360	0.253	1.105	EPD-EMSD Guidelines

Scope	Emission source	Unit	$kgCO_2$-e /unit	Data source
Scope 2	Electricity purchased from The Hongkong Electric Company	kWh	0.78	HK Electric Investments Sustainability Report 2015
	Towngas purchased from The Hong Kong and China Gas Company	unit	0.605	Towngas Sustainability Report 2015
Scope 3	Methane generation at landfill in Hong Kong due to Disposal of Paper Waste	kg	4.8	EPD-EMSD Guidelines (2010)
	Electricity used for fresh water processing by WSD	m^3	0.4067	WSD Annual Report 2014-2015
	Electricity used for sewage processing by DSD	m^3	0.181	DSD Sustainability Report 2014-2015
	General waste disposal	kg	1.5	Carbon Audit Toolkit for Small and Medium Enterprises in Hong Kong

B. GWP values used

Gas or Blend	GWP	Information source
HFC-227ea	2,900	IPCC Second Assessment Report (1995)
R-134a	1,300	IPCC Second Assessment Report (1995)
R-410A	1,725	"World Resources Institute (2005), Calculating HFC and PFC Emissions from the Manufacturing, Installation, Operation and Disposal of Refrigeration & Air-conditioning Equipment (Version 1.0) - Guide to calculation worksheets, World Business Council for Sustainable Development", in which the latter states that the source of reference is from ASHRAE Standard 34.

APPENDIX 3: DETAILED CALCULATION WORKSHEETS FOR GHG EMISSIONS

A. GHG emissions from stationary combustions

A	B	C	D	E	F	G	H	I
Source description	Amount of fuel used (litre/unit)	Fuel Type	CO_2 emission factor	CO_2 emissions in tonnes of CO_2-e ((B×D)/1000)	CH_4 emission factor	CH_4 emissions in tonnes of CO_2-e ((B × F)/(1000 × 1000) × GWP[Note 1])	N_2O emission factor	N_2O emissions in tonnes of CO_2-e ((B × H)/(1000 × 1000) × GWP[Note 1])
Generators	205.2	Diesel	2.614	0.54	0.0239	0.0001	0.0074	0.0005
Towngas consumption	4,616	Towngas	2.549	11.76	0.045	0.0045	0.0099	0.01
Total				12.30		0.004		0.015

Note 1: GWP of CH_4 is 21 while it is 310 for N_2O.

B. GHG emission from mobile combustions

A	B	C	D	E	F	G	H	I
Source description	Amount of fuel used (litre/unit)	Fuel Type	CO_2 emission factor	CO_2 emissions in tonnes of CO_2-e ((B × D)/1000)	CH_4 emission factor	CH_4 emissions in tonnes of CO_2-e ((B × F)/(1000 × 1000) × GWP[Note 1])	N_2O emission factor	N_2O emissions in tonnes of CO_2-e ((B × H)/(1000 × 1000) × GWP[Note 1])
LC1	1,931.9	ULP	2.36	4.56	0.253	0.010	1.105	0.66
LC2	1,304.7	ULP	2.36	3.08	0.253	0.007	1.105	0.45
LC3	1,810.1	ULP	2.36	4.27	0.253	0.010	1.105	0.62
Total				11.91		0.03		1.73

Note 1: GWP of CH_4 is 21 while it is 310 for N_2O.

C. GHG emission from fugitive emission

A	B	C	D	E
Type of agent	Amount of the agent at the beginning of the reporting period (kg)	IPCC default leakage rate / operation emission factor	GWP of the agent	GHG emissions in tonnes of CO_2-e ((B × C × D) /1000)
CO_2 - portable extinguishers	1,144	4%	1	0.05
HFC-227ea – FM 200 system	3,972	1%	2,900	115.19
R-134a - refrigerators	2.2	0.1%	1,300	0.00
R-410A – air-conditioning equipment	59	2%	1,725	2.04
			Total	117.28

D. GHG emission from purchased energy

a) Electricity

A	B	C	D
Facility / source description	Amount of electricity purchased (kWh)	Emission factor (kg CO_2-e/kWh)	Indirect GHG emissions in tonnes of CO_2-e (B × C/1000)
The Complex solely controlled	7,675,474	0.78	5,986.86
Share usage CCP and SWP	2,467,507	0.78	1,924.67
		Total	7,911.5

b) Towngas

A	B	C	D
Facility / source description	Amount of towngas purchased (unit)	Emission factor (kg CO_2-e/unit)	Indirect GHG emissions in tonnes of CO_2-e (B × C/1000)
Towngas consumption	4,616	0.605	2.79
		Total	2.79

E. GHG Emission from paper waste disposal sent to landfill

A	B	C	D	E	F	G
Source description	Amount of paper in storage at the beginning of the reporting period (kg)	Amount of paper purchased during the reporting period (kg)	Amount of paper collected for recycling during the reporting period (kg)	Amount of paper in storage at the end of the reporting period (kg)	Emission factor (kg CO_2-e/kg)	Indirect emissions in tonnes of CO_2-e ((B+C-D-E) × F/1000)
The Secretariat	5,431.61	39,661.36	49,182.66	5,246.87	4.8	0.00[Note 1]
Members' offices	2,333.68	6,456.06		2,393.35	4.8	
					Total	0.00

Note 1: The indirect emissions calculated by the formula can not be negative, since the paper recycling are not carbon offsetting for other emission sources. The minimal value is zero.

F. GHG emissions due to electricity used for fresh water processing by WSD

A	B	C	D
Source description	Amount of water consumed (m^3)	Emission factor (kg CO_2-e/m^3)	Emission in tonnes of CO_2-e (B × C/1000)
Fresh water usage	10,531.6	0.4067	4.28
		Total	4.28

G. GHG emissions due to electricity used for sewage processing by DSD

A	B	C	D
Source description	Amount of water consumed (m^3)	Default Emission factor [Note 1] (kg CO_2-e/m^3)	Emission in tonnes of CO_2-e (B × C /1000)
Sewage generation - General	9,644.6	0.181	1.74
Sewage generation - 1/F kitchen [Note 2]	867.0	0.127	0.11
		Total	1.85

Notes for GHG Emissions due to electricity used for sewage processing by DSD

Note 1: The default emission factor is determined according to the purpose of water used as follows:

Source description	Default emission factor (kg CO_2-e/m^3)
Restaurants and catering services	(0.7 × Emission factor) assuming 70% of the fresh water consumed will enter the sewage system.
Other commercial, residential and institutional purposes	(1.0 × Emission factor) assuming 100% of the fresh water consumed will enter the sewage system.

Note 2: "Restaurants and catering services" category is applied to the sewage generation in 1/F kitchen.

H. GHG emissions from general waste disposal

A	B	C	D
Source description	Amount of general waste sent to landfill (kg)	Emission factor (kg CO_2-e/kg)	Emissions in tonnes of CO_2-e (B × C /1000)
General waste disposal	42,749.6	1.5	64.12
		Total	64.12

APPENDIX 4: GHG EMISSIONS SUMMARY IN THE BASE YEAR

Summary of GHG emissions accounted for the Complex from 1 April 2013 to 31 March 2014

Emission source	in tonnes of CO_2-e						
	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Sub-total
Scope 1 Direct Emissions							
Combustion of fuels in stationary sources – diesel used in generators	0.59	0.00	0.00	N/A	N/A	N/A	0.59
Combustion of fuels in stationary sources – Towngas consumption	16.48	0.01	0.02	N/A	N/A	N/A	16.51
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	10.47	0.02	1.52	N/A	N/A	N/A	12.01
Unintentional GHG release from equipment and system	0.05	N/A	N/A	117.17	N/A	N/A	117.22
Scope 2 Energy Indirect Emissions (To be reported in general without being classified into specific gas type)							
Electricity purchased from The Hongkong Electric Company							7,940.74
Towngas purchased from The Hong Kong and China Gas Company							4.01
Scope 3 Other Indirect Emissions (GHG emission from fresh water processing and sewage discharge disposal to be reported in general without being classified into specific gas type)							
Methane gas generation at landfill in Hong Kong due to disposal of paper waste	N/A	109.27	N/A	N/A	N/A	N/A	109.27
GHG emissions due to electricity for fresh water processing by WSD							1.84
GHG emissions due to electricity used for sewage processing by DSD							0.67
Methane gas generation at landfill in Hong Kong due to general waste disposal	N/A	40.30	N/A	N/A	N/A	N/A	40.30