The Legislative Council Complex
Greenhouse Gas Accounting Report
For the Period 1 April 2016 - 31 March 2017

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1. EXECUTIVE SUMMARY

1.1 Key findings from the GHG accounting project

i. The reported greenhouse gas (GHG) emissions of the Legislative Council Complex (the Complex) during the period from 1 April 2016 to 31 March 2017 are 8,193.35 tonnes CO_2 equivalent (CO_2-e), with Scope 2 emissions contributing to 97.04% 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 1.81% while Scope 3 other indirect emissions, including fresh water processing, sewage processing, waste paper and general waste sent to landfill, account for 1.15% of reported emissions.

ii. The GHG emission intensity of the Complex is calculated at 155.38 kg CO_2-e/m^2, based on the included construction floor area at 52,731 m^2, and 9.33 tonnes CO_2-e/person based on 878 building users.

iii. Absolute GHG emissions show a 0.6 % reduction compared to the base year (1 April 2013 - 31 March 2014), though a 0.43% increase compared to the previous year (1 April 2015 - 31 March 2016). The GHG performance in terms of construction floor area presents a 1.41% reduction compared to the base year, but an increase at 0.43% compared to the previous year.

1.2 Recommendations on carbon reduction and information management

i. The Legislative Council Commission (the Commission) should preferably appoint an independent professional to evaluate regularly the operational practice and settings of the air conditioning system and the energy efficiency performance of the centralized chiller plants by taking account of the cooling water requirements from all connected buildings in the Government Headquarters. On the other hand, proper maintenance is required in order to ensure good energy efficiency.

ii. Feasibility should be continuously explored for the replacement of the existing lighting system with the more energy-efficient LED lighting. The illumination requirements of different offices and venues of the Complex should be regularly reviewed.

iii. The operation of the water meters should be closely monitored.

iv. Regular maintenance of the diesel-fueled generator is to be provided to ensure proper energy efficiency.

v. Proper maintenance of refrigeration and air conditioning system by making reference to internationally recognized standards.

vi. Waste auditing for the Complex to facilitate the review of different waste streams produced from the Complex and formulation of waste reduction measures.

vii. Carbon Road Map: 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 current performance.

viii. 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.

- 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 Employees and Users: More engagement exercises, such as incentive programmes, would encourage greater stakeholder involvement.

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 2016 - 31 March 2017[1], and this is the fourth 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. The construction floor area of the Complex is 52,955 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 an area of 224 m^2, is operated by an outsourced contractor. The Complex, one of the buildings of the Tamar Development Project, has achieved the Platinum rating under the Hong Kong Building Environment Assessment Method (HK-BEAM).

(d) Description of areas excluded from the GHG accounting

The operation of the Cafeteria (floor area: 224 m^2) via the contractor is not under control of the Commission and therefore the Cafeteria is excluded from this GHG

[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.

accounting report. The total floor area of the Complex covered by the GHG accounting is 52,731 m^2.

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 Limited
- Towngas purchased from The Hong Kong and China Gas Company Limited

(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 where 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 go into the atmosphere within the same reporting period as the paper waste is 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%. Considering the periodical pressure tests 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 is 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. Estimating 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 revised from 0.78 kg CO_2-e/kWh (2015) to 0.79 kg CO_2-e/kWh (2016) according to the "*HK Electric Investments Sustainability Report 2016*".

- The GHG Emission Factor of Towngas purchased within Scope 2 has been revised from 0.605 kg CO_2-e/unit (2015) to 0.599 kg CO_2-e/unit (2016) according to the "*Towngas Sustainability Report 2016*".

- The GHG Emission Factor for Fresh Water Processing by WSD within Scope 3 has been revised from 0.407 kg CO_2-e/m^3 (2015) to 0.402 kg CO_2-e/m^3 (2016) according to the recent "*WSD Annual Report 2015-2016*".

- The GHG Emission Factor for Sewage Processing by DSD within Scope 3 has been revised from 0.181 kg CO_2-e/m^3 (2015) to 0.19 kg CO_2-e/m^3 (2016) according to the recent "*DSD Sustainability Report 2015-2016*".

(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 in corresponding sections of this report.

3. GHG EMISSIONS DATA

3.1 Information on GHG emissions and removals

Summary of Results

Scope 1 Emissions:	148.65	tonnes of CO_2-e
Scope 1 Removals:	Nil	tonnes of CO_2-e
Scope 2 Emissions:	7,950.71	tonnes of CO_2-e
Scope 3 Emissions:	93.99	tonnes of CO_2-e
Other GHG Offsets / Removals:	Nil	tonnes of CO_2-e
Accounted GHG Emissions in total:	8,193.35	**tonnes of CO_2-e**

In terms of absolute GHG emission, the reported emissions of the Complex in the reporting period increases 0.43% compared to 8,158.54 tonnes CO_2-e in 2015-2016 (the previous year), by 34.81 tonnes CO_2-e; which corresponds to a 0.6% reduction versus 8,243.16[4] tonnes CO_2-e in 2013-2014 (the base year), by 49.81 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 155.38 kg CO_2-e/m^2, also indicating a 0.43% increase compared to previous year and a 1.41% reduction compared to the base year's 157.60 kg CO_2-e/m^2.

Based on 878 building users, the GHG emission intensity of the Complex in terms of number of building users is 9.33 tonnes CO_2-e/person, also indicating a 2% decrease compared to previous year and a 9.77% reduction compared to the base year's 10.34 tonnes CO_2-e/person.

3.2 Total and breakdown of the GHG emissions

The GHG emissions of the Complex accounted for the reporting period from 1 April 2016 to 31 March 2017 are 8,193.35 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, which was later revised to 8,243.16 in accordance with the rules for rounding off in the 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	6.36	0.001	0.006	N/A	N/A	N/A	6.37
Combustion of fuels in stationary sources – Towngas consumption	11.68	0.004	0.014	N/A	N/A	N/A	11.70
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	11.59	0.025	1.680	N/A	N/A	N/A	13.30
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 Limited							7,947.97
Towngas purchased from The Hong Kong and China Gas Company Limited							2.74
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	28.41	N/A	N/A	N/A	N/A	28.41
GHG emissions due to electricity for fresh water processing by WSD[5]							3.79
GHG emissions due to electricity used for sewage processing by DSD							1.73
Methane gas generation at landfill in Hong Kong due to general waste disposal	N/A	60.06	N/A	N/A	N/A	N/A	60.06

[5] The fresh water usage includes plants watering, floor washing, fountain, kitchen, pantry operation and toilets.

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 Limited.

ii. Scope 1 - Mobile fuel combustion

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

iii. Scope 1 - Fugitive emissions

The quantities and specifications of the CO2 portable and FM 200 extinguishers are provided by the Secretariat. The types and amounts of refrigerant used in the refrigerators and the air-conditioning equipment solely managed by the Complex are also provided. The quantity of the refrigerant used in the central chiller plant (CCP), which is shared with the Chief Executive's Office and Central Government Offices, was excluded from this report.

iv. Scope 2 - Electricity

The electricity used by the Complex is measured by two meters. One meter records the electricity consumption of the building services installation solely controlled by the Complex, such as the lighting system and the fresh water pumping system. The other meter records the electricity consumption of the shared facilities in the Complex, the Chief Executive's Office and the Central Government Offices, including CCP and the seawater pump house (SWP). The electricity consumed by the Complex in air conditioning is calculated by measuring the water consumption of the CCP and SWP of each building.

v. Scope 3 - Water

The fresh water consumption of the Complex is based on the readings from five freshwater meters as recorded by the Secretariat and the Water Supplies Department (WSD) on a monthly basis. As some of the water meters did not operate properly during the reporting period, the fresh water consumption of the Complex was estimated by WSD by referring to the water consumption data of the same meters from previous years. The sewage generated is calculated on the basis of the default conversion from fresh water amount, as specified in the EPD-EMSD Guidelines.

vi. Scope 3 - Paper

The paper consumption data for the Complex operation includes the paper procured by the Secretariat and the Legislative Council Members' offices. The paper consumption data of the Secretariat is determined by making reference to the monthly inventory and the procurement records. The paper consumption data of the Legislative Council Members' Offices is estimated according to the response submitted by the Council Members' Offices in a general survey.

As the current practice of paper collection and recycling in the Complex covers both newspaper and office paper (including recyclable confidential paper), the quantity of paper recycling of the Complex per year is estimated based on sampling conducted on a quarterly basis. As newspapers do not form part of the Complex's operation, their quantity has not been included in the calculation.

vii. Scope 3 - General waste

Owing to the fact that the Complex does not maintain weight measurement records of general waste disposals, the Secretariat agrees that the quantity of its general waste disposal during the reporting period is to be estimated based on projection of sample data. Such sampling process and projection method for both newspapers and the general waste have been adopted consistently since the base-year study.

3.4 Data analysis

i. GHG emissions breakdown

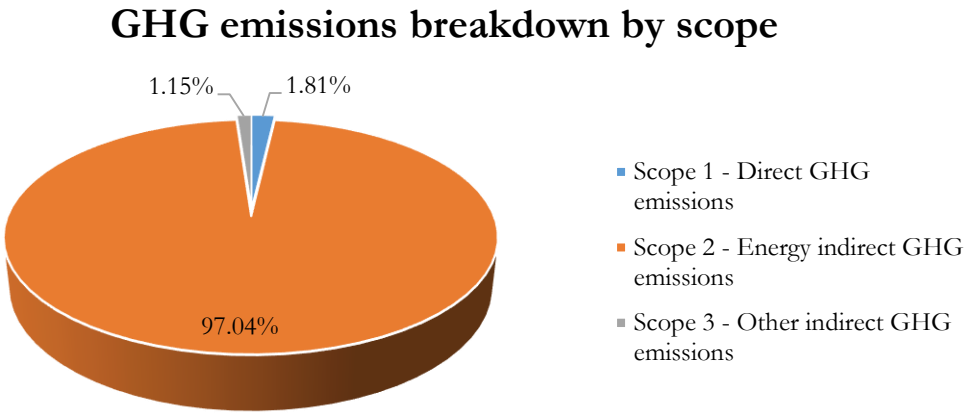


Figure 1. 2016-2017 GHG emissions profile by scope

Figure 1 summarizes the 2016-2017 GHG emissions profile of the Complex. Scope 2, being the indirect GHG emissions from purchased energy, constitutes 97.04% (7,950.71 tonnes) of the total GHG emissions (8,193.35 tonnes). Scope 1 and Scope 3, being the direct GHG emissions and indirect GHG emissions, account for 1.81% (148.65 tonnes) and 1.15% (93.99 tonnes) of the total GHG emissions respectively.

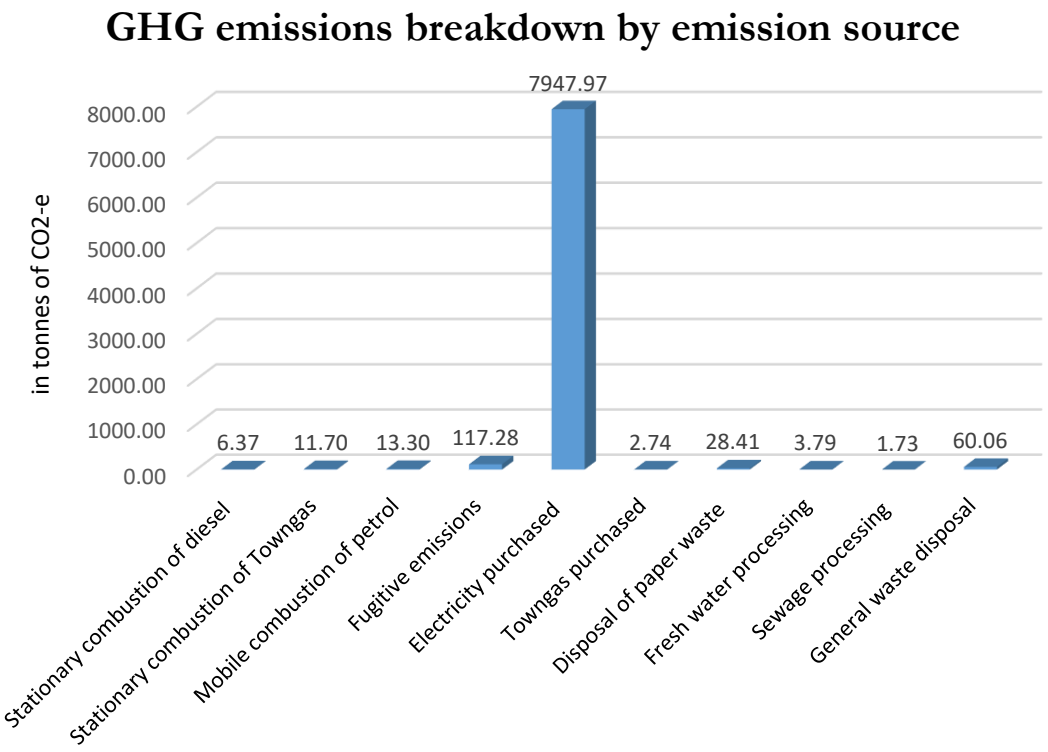


Figure 2. 2016-2017 GHG emissions profile by emission source

Figure 2 presents the distribution of the GHG emissions from different emission sources. Electricity consumption is the dominant carbon emissions source of the Complex, accounting for 7,947.97 tonnes CO_2-e (97%of the reported emissions), followed by fugitive emissions (117.28 tonnes), general waste disposal (60.06 tonnes) and disposal of paper waste (28.41 tonnes). The rest represents less than 0.5% of the total emissions profile.

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

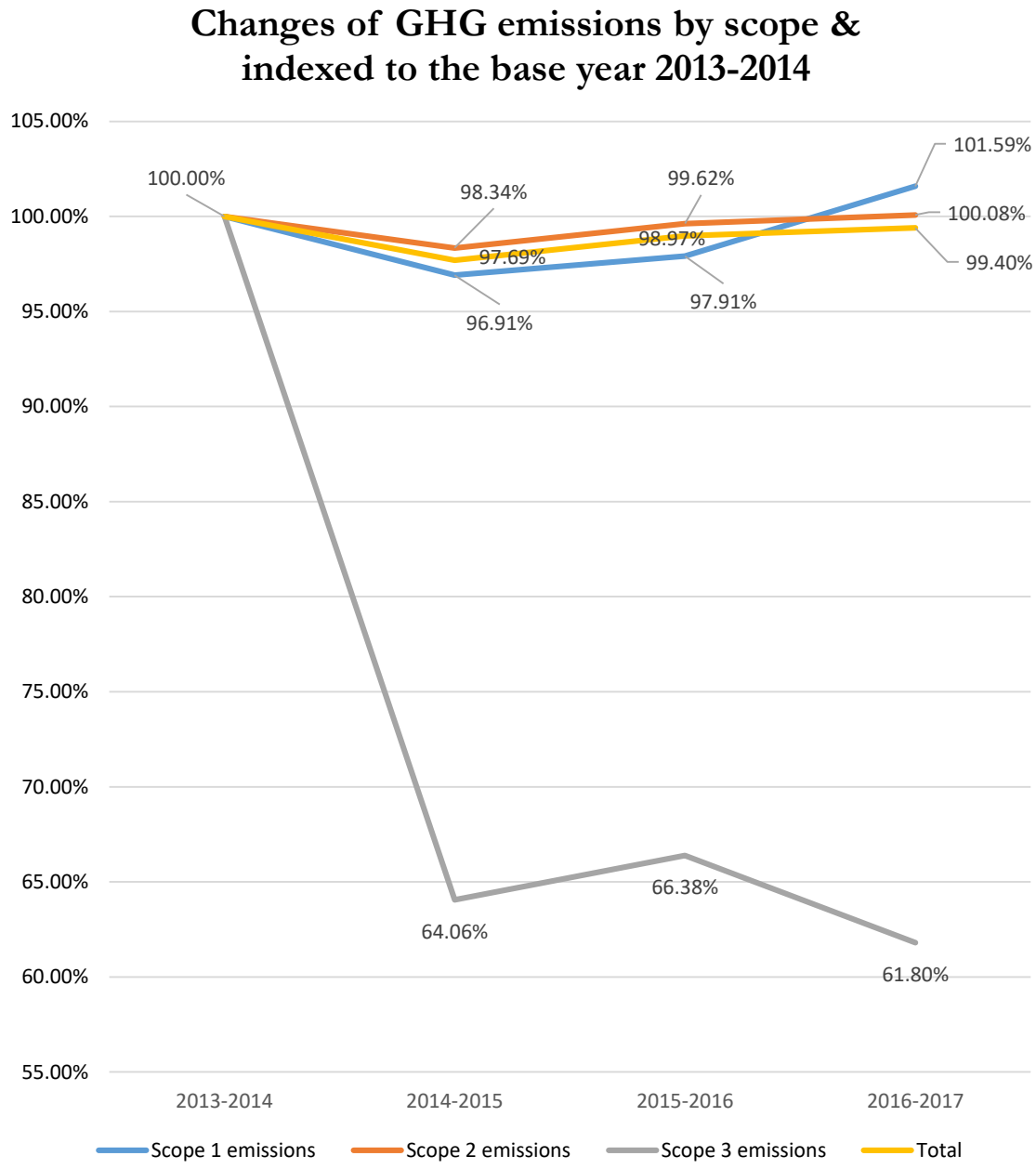


Figure 3. Changes of GHG emissions by scope and indexed to the base year 2013-2014

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. Scope 3 reflects significant decrease over the past four years. Scope 1 has a mild decrement from 2014-2015 (96.91%) and 2015-2016 (97.91%) but reaches a noticeable increase in 2016-2017 (101.59%). Meanwhile, Scope 2, dominated by electricity consumption, shows no significant changes when compared with the the base year.

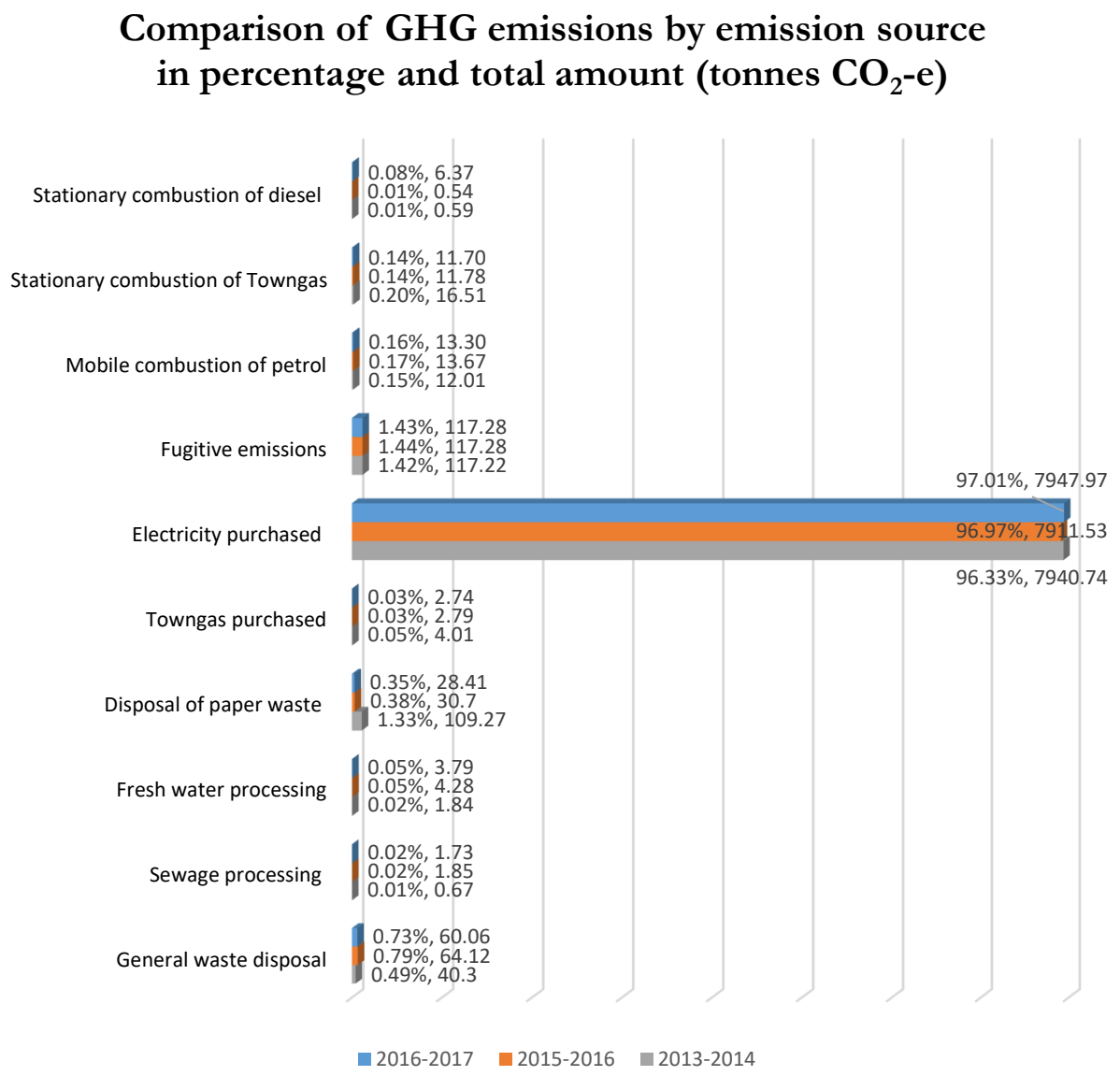


Figure 4. Comparison of GHG emissions between 2016-2017, 2015-2016 and 2013-2014

Figure 4 compares the distribution of different emission sources in tonnes of CO_2-e and in percentage terms between the reporting year (2016-2017), the previous reporting year (2015-2016) and the base year (2013-2014). Electricity consumption has been the largest contributor to the total GHG emissions of the Complex, which made up 97%, 96.97%, and 96.33% of the total GHG emissions in the reporting period, the previous year, and the base year, representing 7,947.97, 7,911.53, and 7,940.74 tonnes CO_2-e respectively. The percentage of the electricity purchase contributing to the total carbon emissions has been increased mildly in the three reporting periods.

Table 2: Summary of GHG emissions differences between 2016-2017, 2015-2016 and 2013-2014

Emission Source	Accounted GHG emissions in tonnes of CO_2-e			Differences in tonnes of CO_2-e	
	2016/17	2015/16	2013/14	2016/17 versus 2015/16	2016/17 versus 2013/14
Scope 1 Direct Emissions	**148.65**	**143.27**	**146.33**	**+5.38 (+3.76%)**	**+2.32 (+1.59%)**
Combustion of fuels in stationary sources – diesel used in generators	6.37	0.54	0.59	+5.83	+5.78
Combustion of fuels in stationary sources – Towngas consumption	11.70	11.78	16.51	-0.08	-4.81
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	13.30	13.67	12.01[6]	-0.37	+1.29
Unintentional GHG release from equipment and system	117.28	117.28	117.22	0	+0.06
Scope 2 Energy Indirect Emissions	**7,950.71**	**7,914.32**	**7,944.75**	**+36.39 (+0.46%)**	**+5.96 (+0.08%)**
Electricity purchased from The Hongkong Electric Company Limited	7,947.97	7,911.53	7,940.74	+36.44	+7.23
Towngas purchased from The Hong Kong	2.74	2.79	4.01	-0.05	-1.27

[6] This figure in "*The Legislative Council Complex Greenhouse Gas Accounting Report For the Period 1 April 2013 - 31 March 2014*" was 12.02, which was later revised to 12.01 in accordance with the rules for rounding off in the reporting period.

and China Gas Company Limited					
Scope 3 Other Indirect Emissions	**93.99**	**100.95**	**152.08**	**-6.96 (-6.89%)**	**-58.09 (-38.20%)**
Methane gas generation at landfill in Hong Kong due to disposal of paper waste	28.41	30.70	109.27	-2.29	-80.86
GHG emissions due to electricity for fresh water processing by WSD	3.79	4.28	1.84[7]	-0.49	+1.95
GHG emissions due to electricity used for sewage processing by DSD	1.73	1.85	0.67	-0.12	+1.06
Methane gas generation at landfill in Hong Kong due to general waste disposal	60.06	64.12	40.30	-4.06	+19.76
Sum-total	**8,193.35**	**8,158.54**	**8,243.16**	**+34.81 (+0.43%)**	**-49.81 (-0.60%)**

Table 2 summarises the difference of the accounted GHG emissions between the reporting period (2016-2017), the previous year (2015-2016) and the base year (2013-2014). When compared to the previous year and the base year, both Scope 1 and Scope 2 present a mild increment while Scope 3 presents a noticeable decrement. In terms of relative change of each emission source as compared with the previsous year, it can be observed that except for emission sources related to stationary combustion of diesel, unintentional release from equipment and system, and electricity purchase, the other emission sources all show different levels of decrease. All of the emission sources in Scope 3 show different degrees of reduction, contributing to 6.96 tonnes CO_2-e of reduction in Scope 3 compared to the previsous year. However, emissions from stationary combustion of diesel was significantly increased by 5.83 tonnes CO_2-e. The elevated diesel fuel consumption was caused by

[7] This figure in "The *Legislative Council Complex Greenhouse Gas Accounting Report For the Period 1 April 2013 - 31 March 2014*" was 1.83, which was later revised to 1.84 in accordance with the rules for rounding off in the reporting period.

periodic inspections, testing and certification for fixed electricial installations in August 2016 in which additional power supply for generators was needed. Overall speaking, the emissions increase of 34.81 tonnes CO_2-e as compared to the previous year is mainly resulted from additional electricity consumption.

3.5 Activity data comparison

Activity data refer to the data on the magnitude of those activities at the Complex resulting in carbon emissions or carbon removals during a given period of time.

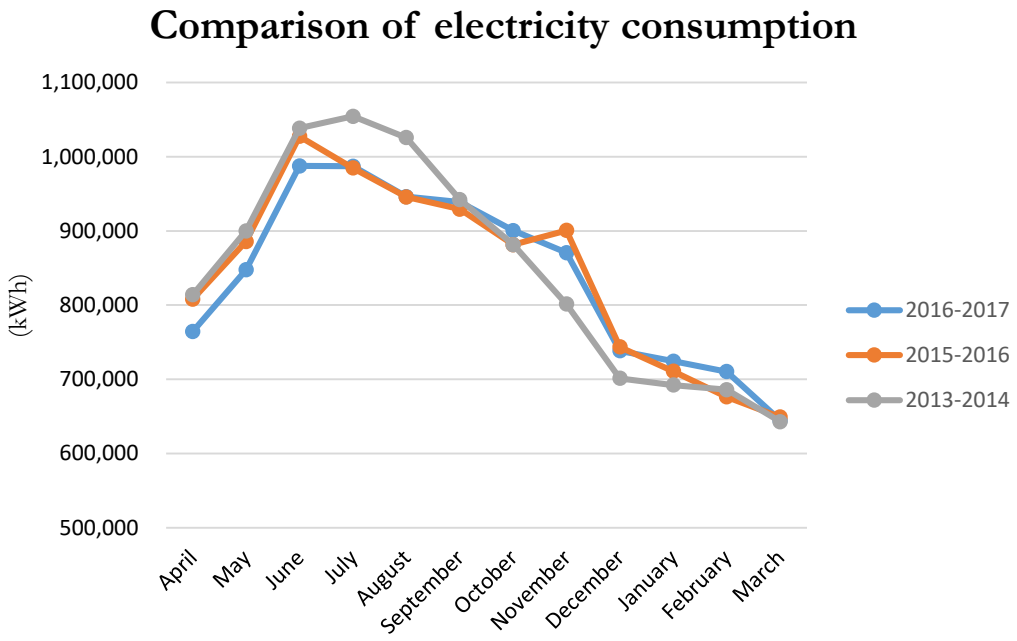


Figure 5. Comparison of electricity consumption between 2016-2017, 2015-2016 and 2013-2014

Figure 5 shows the monthly comparison of electricity consumption, the most significant emission source of the Complex. The electricity consumption of the Complex increases from the month of April and peaks in the month of July. It then declines from the month of August to March of the following year, reflecting the elevated energy consumption required for air conditioning during the summer season. There is no noticeable difference in electricity consumption variation in the reporting year between the previous year or base year.

3.6 Implementation of the GHG emission reduction measures

Since the base year, the GHG emissions reduction measures have been summarised in the dedicated document – "*Green Measures taken in the Complex*", which is reviewed and updated annually by the Secretariat. The details of the reduction measures include:

- Recycling bins for glass bottles were provided at designated locations to promote recycling;
- Preparation of useful tips for handling general waste and waste reduction for dissemination to the LegCo Secretariat's staff and Members' offices, in support of the "Waste Check Charter" issued by the Environment Bureau;
- Indoor temperature is set at 25.5°C;
- Staff are encouraged to use double-sided printing; and
- Softcopies of meeting papers are sent to non-members of all LegCo committees.

4. DISCUSSION AND RECOMMENDATIONS

4.1 Discussion

4.1.1 Scope 1 - Direct Emissions

The carbon emissions from Scope 1 which include the stationary and mobile combustion as well as fugitive emissions are found to be 148.65 tonnes CO_2-e which are similar to the figure in the previous reporting year (143.27 tonnes CO_2-e).

For stationary sources, the elevated diesel consumption as recorded during the reporting period is due to the scheduled periodic inspection, testing and certification for fixed electrical installations in August 2016, during which backup electricity was used for the operation of the essential equipment of the Complex. The percentage of carbon emissions from diesel consumption contributed to the whole Complex was 0.08%, which was not considered significant when compared with other sources of emission. For mobile sources, fuel consumption is similar to the past reporting years. The magnitude of carbon emissions from fugitive emissions during the reporting period is quite consistent when compared with past reporting years.

4.1.2 Scope 2 – Indirect Emissions from Purchase of Energy

The carbon emissions from Scope 2 which include the procurement of electricity and Towngas are found to be 7,950.71 tonnes CO_2-e, which records a slight increment as compared with the previous reporting year (7,914.32 tonnes CO_2-e).

The consumption of electricity and Towngas during the reporting period (Electricity:10,060,723 kwh; Towngas: 4,585 unit) have been decreased as compared with the previous reporting year (Electricity:10,142,981 kwh; Towngas: 4,616 unit). The increase in the total carbon consumption is due to the upward adjustment of the GHG emission factor for purchased electricity from 0.78 to 0.79. On the other hand, it is worth mentioning that as the number of building users in the Complex has increased from 857 to 878, the GHG emission intensity of the Complex in terms of building users is 9.33 tonnes CO_2-e/person, indicating a 2% decrease compared to previous year. As remarked by the LegCo Secretariat, the air conditioning system is operated in summer mode and winter mode respectively in order to minimize energy consumption. Besides, maintenance work was conducted in the Chamber during the summer break from 18 July to 8 October 2016. The carbon emission reduction performance of the Complex would have been further enhanced, if it had not been for the use of air-conditioning system during the maintenance, which resulted in the electricity consumption.

4.1.3 Scope 3 – Other Indirect Emissions

The carbon emissions from Scope 3 which include the disposal of paper waste and general waste together with the energy used for the processing of fresh water and sewage treatment are found to be 93.99 tonnes CO_2-e, showing a mild decrease when compared with the figure in the previous reporting year (100.95 tonnes CO_2-e).

Carbon emissions from the disposal of paper waste has significantly reduced from 30.70 tonnes CO_2-e to 28.41 tonnes CO_2-e (reduced by 7.46%). In estimating paper recycling which is carried out using the same sampling methodology throughout the four years, it was found that the consumption of office paper is fewer than the paper recycled. The reasons for such discrepancy may possibly be that the amount of the recycled paper as collected in the Complex may have included those paper not procured by the Secretariat nor the LegCo Member's Offices, and that it may also be due to some random error of the statistical results obtained from the waste sampling conducted on quarterly basis. The indirect emissions for the paper consumption and recycling under the control of the Secretariat cannot be presented as negative values and the paper recycling cannot be offset for other emission sources, therefore the value was adjusted to zero.

Carbon emissions caused by the energy used for fresh water processing were found to be 3.79 tonnes CO_2-e. Of the five freshwater meters at the Complex, the meters recording water used for watering plants, floor washing and water fountains broke down. New meters have been installed to resume the recording of freshwater consumption. On the other hand, the carbon emissions caused by the energy used for sewage treatment were found to be 1.73 tonnes CO_2-e, a figure close to that of the previous reporting year.

The amount of general waste found in the reporting period is 60.06 tonnes CO_2-e, a decrease of 6.3% compared with the previous reporting year.

4.2 Recommendations

4.2.1 Operational Improvement

Air Conditioning System

The operation of the air conditioning system dominates the overall electricity consumption of the LegCo Complex although no breakdown of electricity use for different areas of the building or specific equipment has been provided for the study. It has been noted that energy efficient sea-water cooled chiller plants have been used for the air conditioning system of the Complex. As the cooling water produced from the centralized chiller plants is going to serve other buildings in the Government Headquarters, it is recommended that the Commission should preferably appoint independent professionals to evaluate regularly the operation practice and settings of the air conditioning system and the energy efficiency performance of the centralized chiller plants by taking into account the cooling water requirements from all connected buildings in the Government Headquarters. In addition, proper maintenance is required in order to ensure good energy efficiency. At the time of the reporting, it was noted that the LegCo Secretariat intended to carry out large-scale maintenance work on the system in 2017 in order to enhance the energy efficiency of the centralized water chiller plants.

Lighting System

The green features of the lighting system in the Complex include the use of a natural light funnel which directs daylight into the Chamber, thus helping to minimize the use of artificial lighting. Further improvements are provided by daylight sensors and a computerized lighting control system. The Commission should continue to explore the feasibility of replacing the existing lighting system with energy efficient LED lights, and regularly review the illumination requirements of different offices and venues in the Complex.

Fresh Water Meters

Of the five fresh water meters at the Complex, three sets were not operating properly during the reporting period. As problems with the fresh water meters also occurred during the previous reporting year, the existing maintenance system may be unsatisfactory. As the uncertainty of water consumption measurement may affect the accuracy of GHG accounting, it is recommended that the Commission should closely monitor the operation and maintenance of the water meters.

Diesel Generator

The diesel generator backs up electricity supply to the Complex when regular electricity cannot be provided by the Hongkong Electric Company Limited. As a standby power system, the frequency of operation is low and its contribution to the GHG emissions of the entire Complex is minimal. The elevated diesel consumption as recorded in August 2016 was due to the periodic inspection, testing and certification for fixed electrical installations during which power supply from the generator was required. However, regular maintenance for the generator is still needed in order to ensure its energy efficiency should the system be required to operate under emergency.

Maintenance of Refrigeration and Air Conditioning System

In accordance with internationally recognised standards [8&9] , a checklist or manual for maintenance of refrigeration and air-conditioning systems should be considered for operation practice.

Table 3 presents the estimates for charge, lifetime and emission factors for the refrigerant used in air conditioners, which are extracted from the Intergovernmental Panel on Climate Change (IPCC). This information can be used as a reference to check if the leakage rate is within the reasonable range and if there is any defect or aging problem.

[8] Source: US Environmental Protection Agency(EPA)
http://www2.epa.gov/sites/production/files/2013-12/documents/gc_preventativemaintenance_20130913.pdf
[9] Source: Australian Institute of Refrigeration, Air conditioning and Heating
http://www.airah.org.au/imis15_prod/Content_Files/UsefulDocuments/AIRAH_HFC_RefrigerantLevy_FactSheet3.pdf

Table 3 Estimates for charge, lifetime and emission factors for refrigeration and air-conditioning systems[10]

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

4.2.2 Waste Audit

Guidance has been provided to the staff and users of the Complex to encourage recycling, reduction and reuse of paper and glass in order to reduce the carbon footprint from waste. Waste audit for the entire operation of the Complex is recommended in order to facilitate the review of the different types of waste produced and to formulate effective waste reduction measures. This will also be a timely preparation for the introduction of the forthcoming waste-charging system in Hong Kong.

[10] Source: *"Volume 3: Industrial Processes and Product Use - 2006 IPCC Guidelines for National Greenhouse Gas Inventories"*,IPCC.

4.2.3 Carbon Roadmap Strategy Assessment

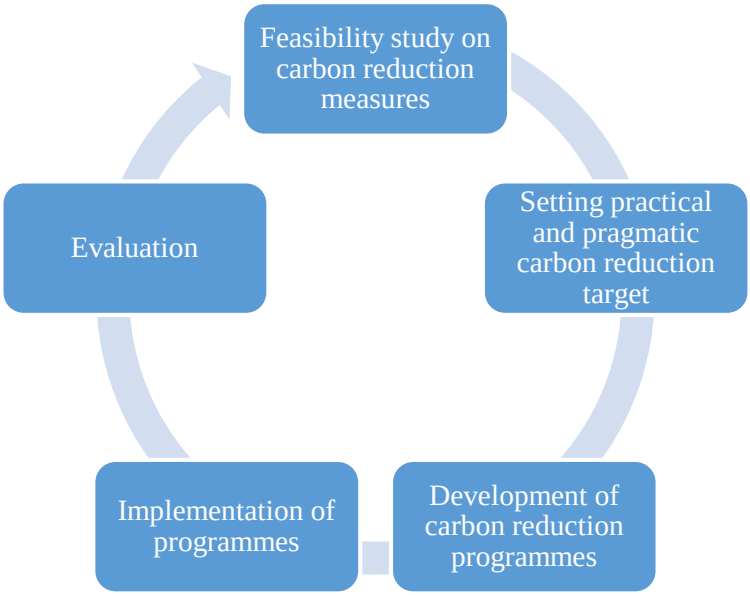


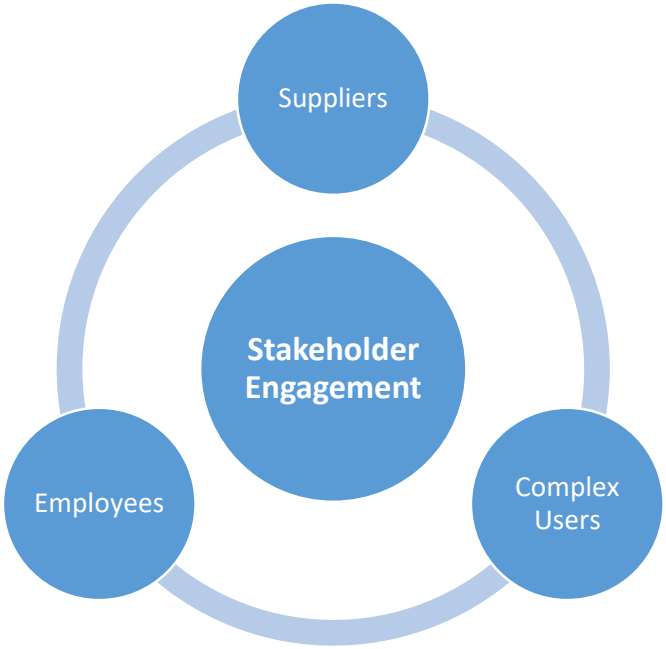
Figure 6. Carbon Roadmap Strategy Assessment

The Government has announced the *Hong Kong Climate Action Plan 2030+*, which outlines the Government's mid and long-term action in combating climate change. The plan sets out a carbon intensity reduction target of reducing 65% to 70% by 2030, using 2005 as the base[11]. This is equivalent to an absolute reduction of 26% to 36% in that period, resulting in per capita emissions of 3.3 to 3.8 tonnes by 2030. It is recommended that the Commission should engage different stakeholders to develop reduction targets in the short, medium and long term based on a review of the Complex's internal capacity and the current performance to ensure, at the minimum, accordance with the government's targets for the territory as a whole.

[11] http://www.policyaddress.gov.hk/2017/eng/pdf/Leaflet_Climate.pdf
http://gia.info.gov.hk/general/201701/20/P2017012000736_251945_1_1484911087018.pdf

4.2.4 Communication and Engagement

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



- *Engaging Suppliers:* The Commission should also encourage and influence its service providers to care for the environment. More engagement with the suppliers would mean stronger support to the Commission for introducing more innovative and effective carbon reduction measures.

- *Engaging the Complex Employees and Users:* In addition to the recommendations contained in the previous GHG accounting report, the Commission can explore further engagement programmes. Incentive programmes, for example, are new ways to encourage participation in energy efficiency and waste reduction projects. Competitions can also be organised to encourage green office practices amongst the Complex users. Monthly reports can be used to track, compare and benchmark the performance of participants. Awards will then be given to the best performing individual or department. A carbon innovation competition can also be held to encourage suggestions on innovative carbon reduction solutions from Complex users, through giving out prizes or other forms of recognition. The Commission is also recommended to set up an internal communications platform to encourage the sharing of innovative ideas 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	2,431.9	litre	1
Stationary fuel combustion	Towngas	4,585	unit	1
Mobile fuel combustion	Unleaded petrol (ULP)	4,909.3	litre	1
Fugitive emission – Portable extinguishers	CO_2	45.8	kg	1
Fugitive emission – FM 200 system	HFC-227ea	39.7	kg	1
Fugitive emission – Refrigerator	R-134a	0.004	kg	1
Fugitive emission – Air-conditioning equipment	R-410A	1.2	kg	1
Electricity purchased	GHG emissions from the utility	10,060,723	kWh	2
Towngas purchased	GHG emissions from the utility	4,585	unit	2
Paper waste disposal	Methane gas generation at landfill	5,917.9	kg	3
Fresh water processing	Electricity used for processing by WSD	9,442	m^3	3
Sewage discharge	Electricity used for processing by DSD	9,113	m^3	3
General waste disposal	Methane gas generation at landfill	40,040	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	kg CO_2-e /unit	Data source
Scope 2	Electricity purchased from The Hongkong Electric Company Limited	kWh	0.79	HK Electric Investments Sustainability Report 2016
	Towngas purchased from The Hong Kong and China Gas Company Limited	unit	0.599	Towngas Sustainability Report 2016
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	0.402	WSD Annual Report 2015-2016
	Electricity used for sewage processing by DSD	m^3	0.19	DSD Sustainability Report 2015-2016
	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	2,431.9	Diesel	2.614	6.36	0.0239	0.001	0.0074	0.006
Towngas consumption	4,585	Towngas	2.549	11.68	0.045	0.004	0.0099	0.014
Total				18.04		0.005		0.020

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

B. GHG emissions 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	1,756.7	ULP	2.36	4.15	0.253	0.009	1.105	0.60
LC2	1,209.9	ULP	2.36	2.86	0.253	0.006	1.105	0.41
LC3	1,942.7	ULP	2.36	4.58	0.253	0.010	1.105	0.67
Total				11.59		0.025		1.68

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

C. GHG emissions from fugitive emissions

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	3.7	0.1%	1,300	0.00
R-410A – air-conditioning equipment	59	2%	1,725	2.04
			Total	117.28

D. GHG emissions 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	7,566,187	0.79	5,977.30
Share usage CCP and SWP	2,494,536	0.79	1,970.67
		Total	7,947.97

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	4,585	0.599	2.74
		Total	2.74

E. GHG Emissions 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)
LegCo Secretariat	5,246.87	36,996.62	54,480	4,414.32	4.8	0.00[Note 1]
Members' offices	2,393.35	5,140.98	0	1,616.47	4.8	28.41
					Total	28.41

Note 1: The indirect emissions calculated by the formula cannot 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)	Emissions in tonnes of CO_2-e (B × C/1000)
Fresh water usage	9,442	0.402	3.79
		Total	3.79

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)	Emissions in tonnes of CO_2-e (B × C /1000)
Sewage generation - General	8,344	0.190	1.58
Sewage generation - 1/F kitchen [Note 2]	1,098	0.133	0.15
		Total	1.73

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	40,040	1.5	60.06
		Total	60.06

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	6.36	0.00	0.01	N/A	N/A	N/A	6.37
Combustion of fuels in stationary sources – Towngas consumption	11.68	0.00	0.01	N/A	N/A	N/A	11.70
Combustion of fuels in mobile sources – petrol used in the Commission owned vehicles	11.59	0.03	1.68	N/A	N/A	N/A	13.30
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 Limited							7,947.97
Towngas purchased from The Hong Kong and China Gas Company Limited							2.74
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	28.41	N/A	N/A	N/A	N/A	28.41
GHG emissions due to electricity for fresh water processing by WSD							3.79
GHG emissions due to electricity used for sewage processing by DSD							1.73
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	60.06