

**Seminar:**

# Carbon Footprint Analysis of Hotels in Hong Kong

**Funded by:**

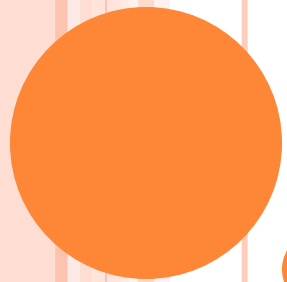
**Environment and Conservation Fund, HKSAR**

**Study team:**

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**Department of Building Services Engineering, PolyU**

**27 April 2012**



# **INTRODUCTION**



# Purpose and Scope of the Study

- primarily an **empirical study** intended to:
  - probe into the **sources and levels** of GHG emissions and removals from selected hotels in Hong Kong,
  - **analyse their carbon footprints** in detail, and
  - investigate into the **factors and practices** that can help mitigate GHG emissions or enhance their removals.



# Purpose and Scope of the Study

- Based on the data of the hotels, analyses were carried out on the following areas of **GHG emissions/removals** for a reporting period of 12 months (or for a period as long as possible for which data can be provided):
  - **Direct emissions/removals** due to:
    - Stationary sources combustion
    - Mobile sources combustion
    - Fugitive emissions
    - Assimilation of carbon dioxide into biomass through planting of trees

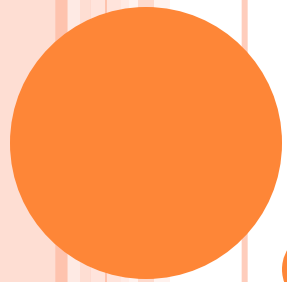


# Purpose and Scope of the Study

- **Energy indirect emissions** due to:
  - Consumption of purchased electricity
  - Consumption of town gas



- **Other indirect emissions** due to:
  - Methane gas generation at landfill due to disposal of paper waste
  - Consumption of fresh water
  - Treatment of waste water



# **DATA COLLECTION**



# The collection process

## ○ The Study Team

- made arrangements with the hotels for conduction of a **site visit** and a **kick-off meeting**
- paid a visit to each of the hotels and met with their representatives
- **briefed the hotel's representatives** about the kinds and extents of data needed
- provided the hotel with **two data templates**, namely Form A and Form B

# Form A

**Form A**

## 1. Hotel Information

Name of Hotel:			
Star rating:			
Age of building (years):			
Total no. of floors: (including basement floors)			
Construction floor area (m <sup>2</sup> ):			
No. of regular employees:			
No. of casual labor-days	Yearly:		Monthly average:

	Capacity	Type
Chiller plant	(kW/TR)	<input type="checkbox"/> Water-cooled / <input type="checkbox"/> Air-cooled
Heating plant	(kW)	<input type="checkbox"/> Boiler / <input type="checkbox"/> Heat pump  <input type="checkbox"/> Others: _____

	No.	Total area (m <sup>2</sup> ):
Guestroom		
F&B outlet		
Ballroom		
Function room		
Business centre		
Laundry		
Gymnasium		
Swimming pool (Cold)		
Swimming pool (Heated)		
Car park		



# Form A (cont'd)

## 2.1 Liquid fuel for emergency power generator

Month	Year	Consumption (Litre)	Fuel Type
			<input type="checkbox"/> Diesel
			<input type="checkbox"/> Others: _____

## 2.2 Liquid fuel for boiler

Month	Year	Consumption (Litre)	Fuel Type
			<input type="checkbox"/> Diesel
			<input type="checkbox"/> Others: _____

# Form B

## Staff travel survey form

Form B

Name of hotel:	
Staff name (optional):	

Please fill in your travel information in the two tables below based on a typical working day. An example is shown at the bottom.

### From Home to Work:

Trip No.	From	To	Travel by	Fare (\$)	Route No.
1			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
2			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
3			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
4			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		

### From Work to Home:

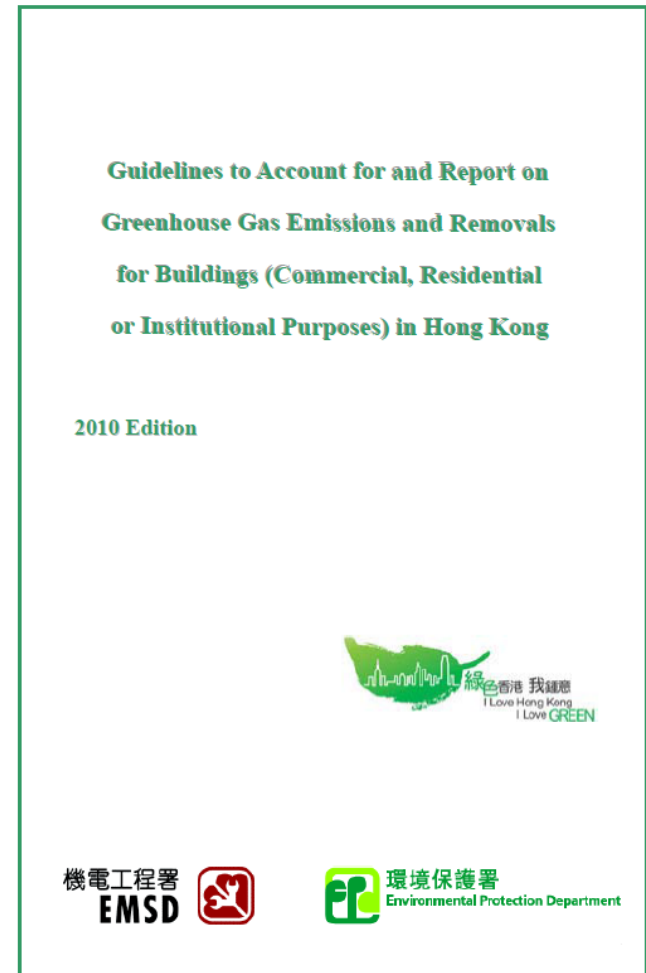
Trip No.	From	To	Travel by	Fare (\$)	Route No.
1			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
2			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
3			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		
4			<input type="checkbox"/> MTR / <input type="checkbox"/> Bus / <input type="checkbox"/> Mini Bus <input type="checkbox"/> Tram / <input type="checkbox"/> Taxi / <input type="checkbox"/> Ferry <input type="checkbox"/> Others: _____		



# **ANALYSIS AND FINDINGS**

# Scope 1 – Direct Emissions

- All the data collected were analyzed mainly based on the “Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong”
- As and when necessary, analysis was made with reference to **other literary sources or web-based information.**



# Scope 1 – Direct Emissions

For calculating CO<sub>2</sub> emissions:

*Emission (CO<sub>2</sub>)*

*=  $\Sigma$  Amount of fuel consumed x Emission factor of CO<sub>2</sub>*

where

Emission, in terms of tonnes of CO<sub>2</sub>-equivalent, is summed over all types of fuel used;

Amount of fuel consumed is in terms of volume (e.g. litre) or mass (e.g. kg) for particular fuel;

Emission Factor of CO<sub>2</sub>

= Net Calorific Value of the Fuel x Carbon Factor of Fuel  
x Fraction of Carbon Oxidised x (44 / 12)

# Scope 1 – Direct Emissions

For calculating CH<sub>4</sub> / N<sub>2</sub>O emissions:

$$\begin{aligned} & \textit{Emission (CH}_4\text{ / N}_2\text{O)} \\ & = \Sigma \textit{ Amount of fuel consumed} \\ & \times \textit{ Emission factor of (CH}_4\text{ / N}_2\text{O)} \times \textit{ Relative GWP} \end{aligned}$$

where

Emission, in terms of tonnes of CO<sub>2</sub>-equivalent, is summed over all types of fuel used;

Amount of fuel consumed is in terms of volume (e.g. litre) or mass (e.g. kg) for particular fuel;

Emission Factor of (CH<sub>4</sub> / N<sub>2</sub>O) = Net Calorific Value of the Fuel x Specific (CH<sub>4</sub> / N<sub>2</sub>O) Conversion Factor

Relative GWP = Relative Global Warming Potential (GWP) of CH<sub>4</sub> / N<sub>2</sub>O

# Scope 1 – Direct Emissions

<b>Fuel Type:</b> Diesel (Stationary combustion sources)			
	Emission Factor*	Unit	GWP - Relative Global Warming Potential*
CO <sub>2</sub>	2.614	kg / litre	-
CH <sub>4</sub>	0.0239	g / litre	21
N <sub>2</sub> O	0.0074	g / litre	310
<b>Fuel Type:</b> LPG (Stationary combustion sources)			
	Emission Factor*	Unit	GWP - Relative Global Warming Potential*
CO <sub>2</sub>	3.017	kg / kg	-
CH <sub>4</sub>	0.002	g / kg	21
N <sub>2</sub> O	0	g / kg	310
<b>Fuel Type:</b> Diesel (Mobile combustion sources - Diesel Van)			
	Emission Factor*	Unit	GWP - Relative Global Warming Potential*
CO <sub>2</sub>	2.614	kg / kg	-
CH <sub>4</sub>	0.072	g / kg	21
N <sub>2</sub> O	0.506	g / kg	310
<b>Fuel Type:</b> Unleaded petrol (Mobile combustion sources - ULP Passenger Car)			
	Emission Factor*	Unit	GWP - Relative Global Warming Potential*
CO <sub>2</sub>	2.360	kg / kg	-
CH <sub>4</sub>	0.253	g / kg	21
N <sub>2</sub> O	1.105	g / kg	310

# Scope 1 – Direct Emissions

## Liquid fuel for **emergency power generator**

A diesel emergency power generator was used and the associated GHG emissions are as tabulated below (take one of the participating hotels as an example):

Month	Year	Consumption (litre)	CO <sub>2</sub> (kg)	CH <sub>4</sub> (kg)	N <sub>2</sub> O (kg)
1	2011	1.5	3.92	0.0008	0.0034
2	2011	1.5	3.92	0.0008	0.0034
:					
:					
:					
12	2011	1.5	3.92	0.0008	0.0034
	Total:	18.0	47.05	0.0090	0.0413



# Scope 1 – Direct Emissions

## Transportation provided for hotel guests

The hotel provides shuttle services for its guests and the corresponding GHG emissions are as tabulated below:

<b>Diesel mini-bus</b>					
<b>Month</b>	<b>Year</b>	<b>Consumption (litre)</b>	<b>CO<sub>2</sub> (kg)</b>	<b>CH<sub>4</sub> (kg)</b>	<b>N<sub>2</sub>O (kg)</b>
1	2011	239.85	626.97	0.36	37.62
:					
:					
:					
12	2011	329.97	862.54	0.50	51.76
	<b>Total:</b>	2971.56	7767.66	4.49	466.12



# Scope 1 – Direct Emissions

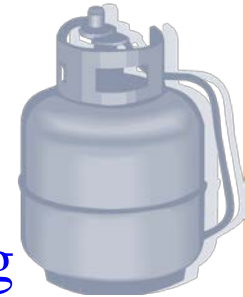
## Transportation provided for hotel guests (cont'd)

<u>2400c.c. passenger car (Unleaded petrol)</u>					
Month	Year	Consumption (litre)	CO <sub>2</sub> (kg)	CH <sub>4</sub> (kg)	N <sub>2</sub> O (kg)
1	2011	46.34	109.36	0.25	15.87
:					
:					
:					
12	2011	41.17	97.16	0.22	14.10
	<b>Total:</b>	993.86	2345.51	5.28	340.45



# Scope 1 – Direct Emissions

## Cylinder LPG consumption



Cylinder LPG was used as the fuel for the outdoor heating lamps of the hotel and the corresponding GHG emissions were calculated, as tabulated below:

Month	Year	Consumption summary	Consumption (kg)	CO <sub>2</sub> (kg)	CH <sub>4</sub> (kg)	N <sub>2</sub> O (kg)
12	2010	10.5kg x 38bot	399	1203.78	0.0168	0.00
:						
2	2011	10.5kg x 100bot	1050	3167.85	0.0441	0.00
	<b>Total:</b>	-	2454	7403.72	0.1031	0.00

# Scope 1 – Direct Emissions

For calculating emissions for refrigeration/air-conditioning:

$$\text{HFC/PFC emission} = \Sigma(C_s + C_i - C_d - C_e) \times GWP$$

where

- $C_s$  : Refrigerant **inventory at beginning** of the reporting period (in storage, not equipment) (kg)
- $C_i$  : Refrigerant **added** to the inventory during the reporting period (kg)
- $C_d$  : Refrigerant **disposed** of through environmentally responsible means (e.g. collected by contractor for recycling) during the reporting period (kg)
- $C_e$  : Refrigerant **inventory at end** of the reporting period (in storage, not equipment) (kg)
- GWP : 100-year global warming potential of the corresponding refrigerant

# Scope 1 – Direct Emissions

## HFC/PFC emissions

<b>Refrigerant 1</b>		<b>R-404A</b>		
Amount at the beginning: 22 kg				
Amount at the end: 22 kg				
Month	Year	Purchased (kg)	Disposed (kg)	GWP
7	2011	11	-	3260
<b>Total Emission (kg):</b>				11
<b>CO<sub>2</sub>-e emission (kg):</b>				35860

<b>Refrigerant 2</b>		<b>R-134A</b>		
Amount at the beginning: 22 kg				
Amount at the end: 22 kg				
Month	Year	Purchased (kg)	Disposed (kg)	GWP
7	2011	11	-	1300
<b>Total Emission (kg):</b>				11
<b>CO<sub>2</sub>-e emission (kg):</b>				16900

## Scope 2 – Energy Indirect Emissions

Indirect GHG emissions were resulted from the consumption of **purchased electricity / Towngas** in the hotel.

### GHG emission due to electricity consumption

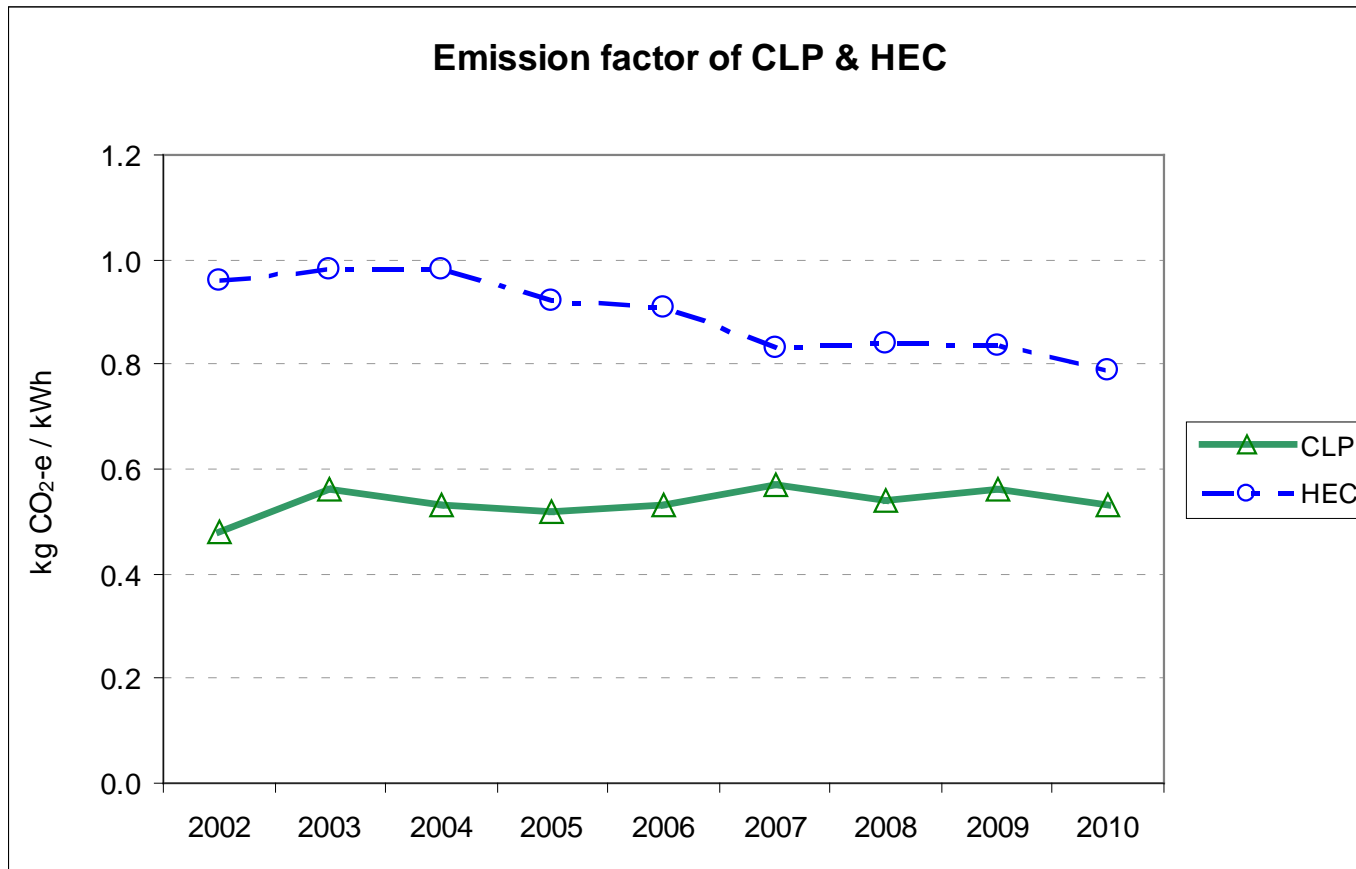
For determining the amount of GHG emission due to electricity consumption, the following equation was used:

***GHG emission =***

***Quantity of purchased electricity x Emission factor***

# Scope 2 – Energy Indirect Emissions

GHG emissions factors for the two power companies:



# Scope 2 – Energy Indirect Emissions

Emissions determined based on electricity submeter readings:

Meter 1				
Area: Kitchen (Chinese)				
Month	Year	Consumption (kWh)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	3330	0.53	1764.90
2	2011	2760	0.53	1462.80
:				
:				
12	2011	3270	0.53	1733.10
<b>Total:</b>		37290	<b>Total:</b>	19763.70



# Scope 2 – Energy Indirect Emissions

Emissions determined based on electricity submeter readings:

Meter 10				
Area: Guest Room Floor 16/F				
Month	Year	Consumption (kWh)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	21520	0.53	11405.60
2	2011	17080	0.53	9052.40
:				
:				
12	2011	21020	0.53	11140.60
<b>Total:</b>		253380	<b>Total:</b>	134291.40

# Scope 2 – Energy Indirect Emissions

<u>Total electricity consumption (Sum of submeter readings)</u>				
Month	Year	Consumption (kWh)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	607041	0.53	321731.73
2	2011	540084	0.53	286244.52
:				
:				
:				
11	2011	608085	0.53	322285.05
12	2011	646039	0.53	342400.67
<b>Total:</b>		7281992	<b>Total:</b>	3859455.76

## Scope 2 – Energy Indirect Emissions

### GHG emission due to Towngas consumption

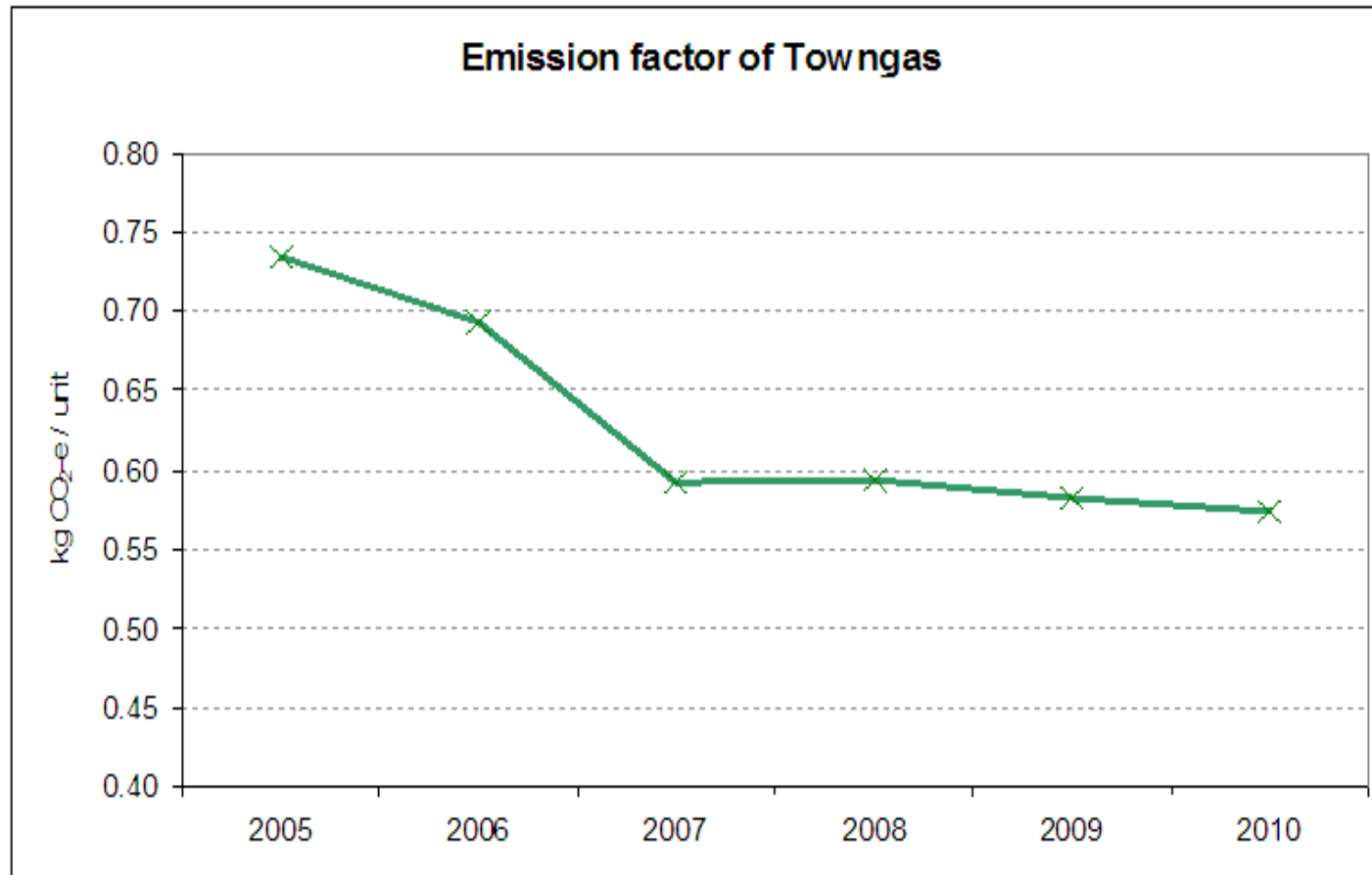
For determining the amount of GHG emission due to Towngas consumption, the following equation was used:

***GHG emission =***

***Quantity of purchased Towngas x Emission factor***

# Scope 2 – Energy Indirect Emissions

GHG emission factor of Towngas:



# Scope 2 – Energy Indirect Emissions

Emissions determined based on Towngas submeter readings:

Meter 1				
Area: Food labs, baker/ pastry, changing room, water heaters				
Month	Year	Consumption (unit)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	2793.6	0.5741	1603.75
2	2011	631.2	0.5741	362.36
:				
:				
12	2011	396.0	0.5741	227.34
<b>Total:</b>		3424.8	<b>Total:</b>	1966.11

# Scope 2 – Energy Indirect Emissions

Emissions determined based on Towngas submeter readings:

Meter 10				
Area: 10/F-22/F <a href="#">guestroom hot water heaters</a>				
Month	Year	Consumption (kWh)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	5413.0	0.5741	3107.50
2	2011	4840.0	0.5741	2778.55
:				
:				
12	2011	5846.0	0.5741	3356.07
<b>Total:</b>		38343.0	<b>Total:</b> 22011.95	

# Scope 2 – Energy Indirect Emissions

<u>Total Towngas consumption (Sum of submeter readings)</u>				
Month	Year	Consumption (unit)	Emission factor (kg /kWh)	CO <sub>2</sub> -e emission (kg)
1	2011	20244.6	0.5741	11622.02
2	2011	18106.2	0.5741	10394.41
:				
:				
:				
11	2011	26336	0.5741	15118.97
12	2011	28955	0.5741	16622.49
<b>Total:</b>		159940.80	<b>Total:</b>	91818.81

# Scope 3 – Other Indirect Emissions

## GHG emission due to paper waste disposed at landfills

Data including those about the inventory of paper (kg), the amount of paper purchased (kg) and the amount of paper recycled (kg) were needed. The equation used for calculating such emission:

$$E = (P_s + P_i - P_r - P_e) \times \text{Emission Factor (estimated at } 4.8 \text{ kg CO}_2\text{-e / kg)}$$

where

- E: Emissions from paper waste disposed at landfills
- $P_s$ : 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)

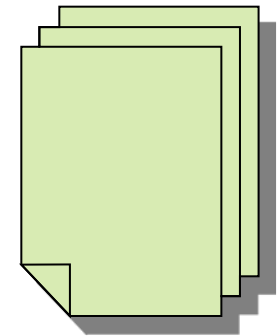




# Scope 3 – Other Indirect Emissions

Paper purchased for office use:

Size:	A4	Substance:	75 g/m <sup>2</sup>
Weight of 1 ream of A4 paper (g):		2338.875*	
Month	Year	Ream	Weight (kg)
5	2011	0	0.00
6	2011	190	444.39
:			
:			
10	2011	235	549.64
		<b>Total:</b>	2736.48



\* Calculation for the weight of 1 ream of A4 paper:

$\text{Weight} = \text{area of A4 sheet} \times \text{weight per unit area} \times \text{sheets per ream}$

# Scope 3 – Other Indirect Emissions

Paper purchased for office use:

Size:	A3	Substance:	75 g/m <sup>2</sup>
Weight of 1 ream of A3 paper (g):		4677.75**	
Month	Year	Ream	Weight (kg)
5	2011	0	0.00
6	2011	5	23.39
:			
:			
10	2011	0	0.00
		<b>Total:</b>	23.39

\*\* Calculation for the weight of 1 ream of A3 paper:

Weight = area of A3 sheet x weight per unit area x sheets per ream

# Scope 3 – Other Indirect Emissions

Newspaper ordered:

Weight of newspaper (g):		281*	
Month	Year	Quantities (No.)	Weight (kg)
5	2011	5423	1523.86
:			
:			
10	2011	6206	1743.89
		<b>Total:</b>	10505.47



\* Source: Chan, W. and Wong, K. (2006), Estimation of Weight of Solid Waste: Newspapers in Hong Kong Hotels. Journal of Hospitality & Tourism Research, 30(2): 231-245.

# Scope 3 – Other Indirect Emissions

Magazine ordered:

Weight of magazine (g):		250**	
Month	Year	Quantities (No.)	Weight (kg)
5	2011	385	96.25
:			
:			
10	2011	395	98.75
<b>Total:</b>			582.50

\*\* Assumed to be equivalent to the weight of a “Time” magazine issued in October 2011

# Scope 3 – Other Indirect Emissions

Paper collected for recycling:

Month	Year	Weight (kg)
4	2011	1028.00
:		
:		
10	2011	1245.00
	<b>Total:</b>	7070.00



# Scope 3 – Other Indirect Emissions

GHG emissions from paper waste disposed at landfills:

Month	Year	Amount of paper purchased (kg) $P_i$	Amount of paper collected for recycling (kg) $P_r$	Emission factor (kg CO <sub>2</sub> -e / kg of waste)	CO <sub>2</sub> -e emission (kg) E
5	2011	1620.11	986.00	4.80	3043.74
:					
11	2011	350.83	0.00	4.80	1683.99
<b>Total:</b>		13847.84	6042.00	-	37468.02

# Scope 3 – Other Indirect Emissions

## GHG emissions due to electricity used for fresh water supplies and sewage processing

The indirect GHG emissions due to electricity used for processing fresh water by the Water Supplies Department (WSD) and that used for processing sewage by the Drainage Services Department (DSD) were calculated using the following equation:

$$E = \text{Amount of water consumed} \times (EF_W + EF_D)$$

where

E: Emission due to electricity used for processing fresh water and sewage by the WSD and the DSD respectively

$EF_W$ : Emission factor of GHG emissions due to electricity used for processing fresh water

= Unit electricity consumption of fresh water (from WSD) x Territory-wide default value of purchased electricity (0.7kg / kWh)

$EF_D$ : Emission factor of GHG emissions due to electricity used for processing sewage

= Unit electricity consumption of processing sewage (from DSD) x Territory-wide default value of purchased electricity (0.7kg / kWh)

# Scope 3 – Other Indirect Emissions

The **steps taken for determining the emission factors:**

- retrieval from the reports of WSD\* and DSD\*\* the relevant figures on power consumption and sewage flow; and
- multiplying the unit power consumption by the territory-wide default value of purchased electricity.



\* *Source: WSD annual report 2009/10, WSD.*

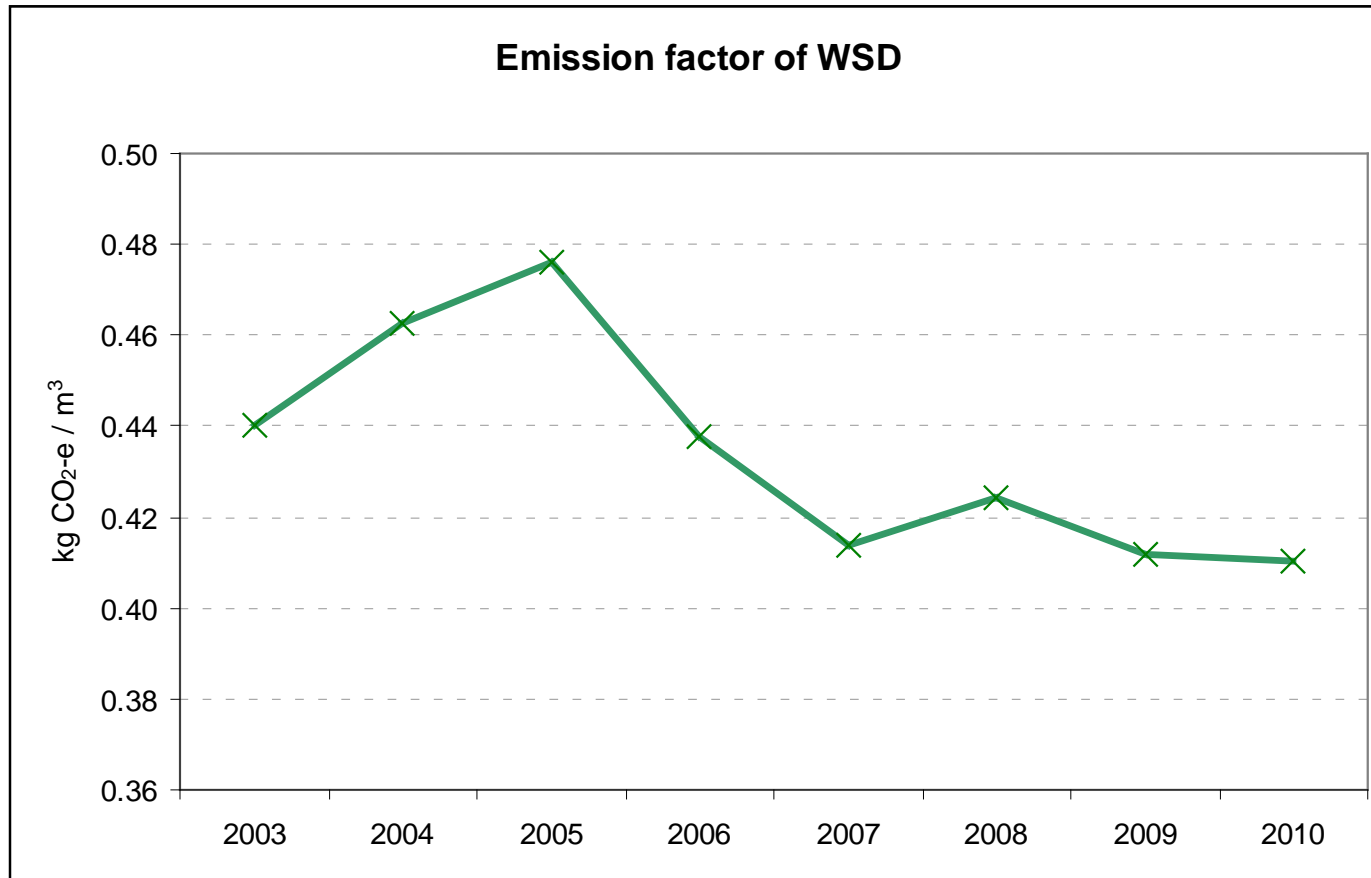
\*\* *Source: Environmental report 2010, DSD.*

The results obtained in this way are as plotted in the following graphs:



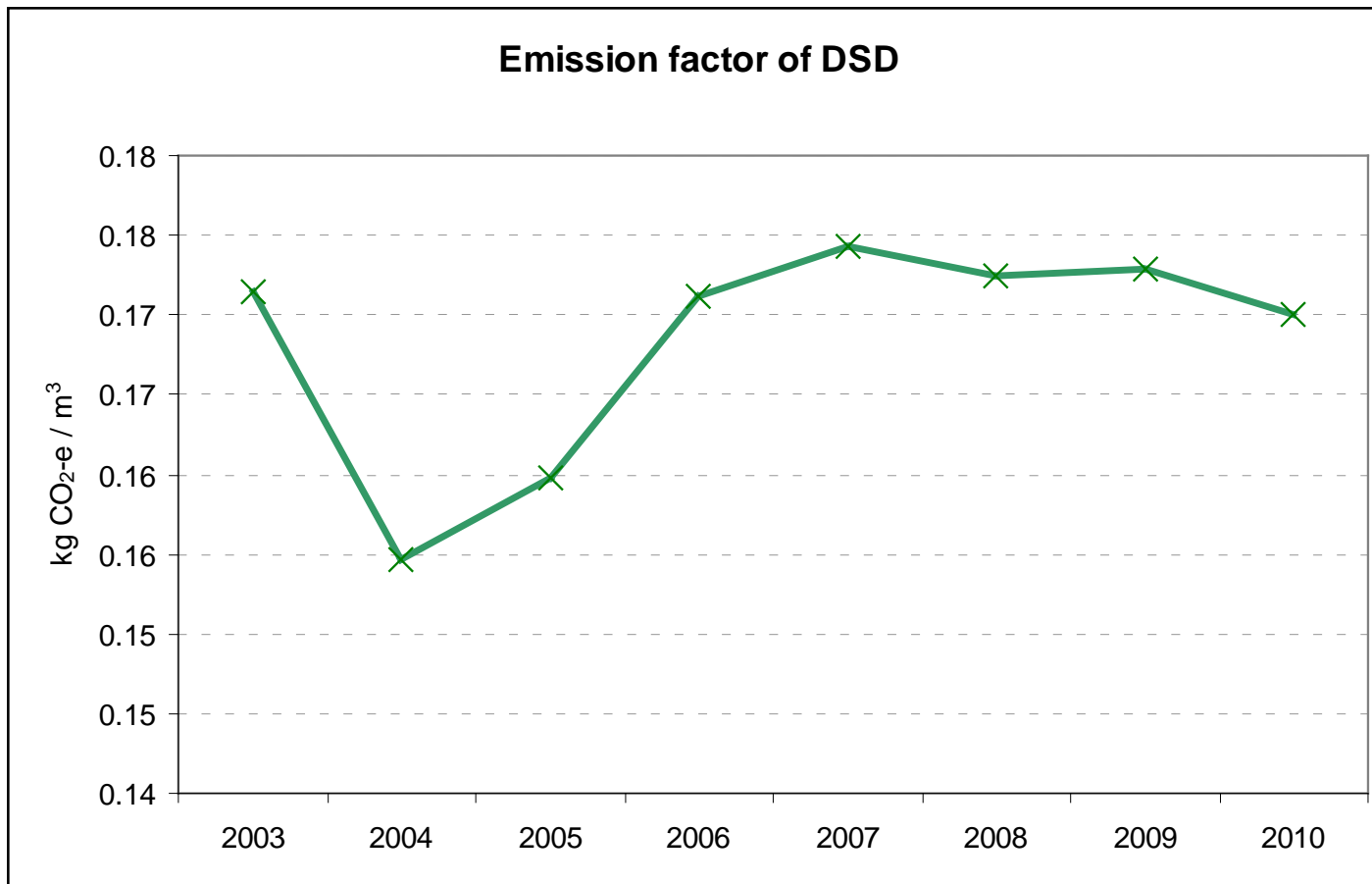
# Scope 3 – Other Indirect Emissions

Emission factors of **WSD**:



# Scope 3 – Other Indirect Emissions

Emission factors of **DSD**:



# Scope 3 – Other Indirect Emissions

According to the Guidelines, the default emission factor for sewage processing, is dependent on the purpose of water used:

Source description	Default emission factor (kg/m <sup>3</sup> )
Restaurants and catering services	(0.7 x Emissions Factor) assuming 70% of the fresh water consumed will enter the sewage system.
Other commercial, residential and institutional purposes	(1.0 x Emissions Factor) assuming 100% of the fresh water consumed will enter the sewage system.

# Scope 3 – Other Indirect Emissions

Emissions determined based on water submeter readings:

Meter 1					
Area: <b>Kitchen</b>			Catering (Y / N): Y		
Month	Year	Water Consumption (m <sup>3</sup> )	Emission factor for processing fresh water (kg CO <sub>2</sub> -e / m <sup>3</sup> ) EF <sub>w</sub>	Emission factor for processing sewage (kg CO <sub>2</sub> -e / m <sup>3</sup> ) EF <sub>D</sub>	CO <sub>2</sub> -e emission (kg) E
5	2011	487.0	0.4102	0.1190	257.71
:					
11	2011	957.0	0.4102	0.1190	506.43
				Total:	2929.57

# Scope 3 – Other Indirect Emissions

Emissions determined based on water submeter readings:

Meter 11					
Area: <b>Swimming Pool</b>			Catering (Y / N): N		
Month	Year	Water Consumption (m <sup>3</sup> )	Emission factor for processing fresh water (kg CO <sub>2</sub> -e / m <sup>3</sup> ) EF <sub>W</sub>	Emission factor for processing sewage (kg CO <sub>2</sub> -e / m <sup>3</sup> ) EF <sub>D</sub>	CO <sub>2</sub> -e emission (kg) E
5	2011	49.1	0.4102	0.1700	28.49
:					
11	2011	263.0	0.4102	0.1700	152.59
				Total:	678.81

# Scope 3 – Other Indirect Emissions

Total water consumption		
Month	Year	Water consumption (m <sup>3</sup> )
1	2011	1998.4
:		
:		
12	2011	4994.6
	<b>Total:</b>	22322.20

Total CO <sub>2</sub> equivalent emission		
Month	Year	CO <sub>2</sub> -e emission (kg)
1	2011	1123.12
:		
:		
12	2011	2820.41
	<b>Total:</b>	12537.25

# Scope 3 – Other Indirect Emissions

## GHG emissions due to business travels of hotel staff

Referring to the “Carbon audit toolkit for small and medium enterprises in Hong Kong”, the GHG emission due to business travels of the hotel’s staff was calculated using the following equations:

$$E_{CO_2-e, flight} = D_{flight} \times EF_{CO_2-e, flight} \times BEF$$



$$EF_{CO_2-e, flight} = \begin{cases} 0.15 & \text{for short haul } (\leq 500 \text{ km}) \\ 0.12 & \text{for medium haul } (> 500, < 1600 \text{ km}) \\ 0.11 & \text{for long haul } (\geq 1600 \text{ km}) \end{cases}$$

$$BEF = \begin{cases} 0.9 & \text{for economy class} \\ 1.4 & \text{for business class} \end{cases}$$

where

$EF_{CO_2-e, flight}$ : Emission factor of GHG emissions for different flight distances

BEF: Business-economic factor

$D_{flight}$ : Distance travelled between Hong Kong and the destination city

# Scope 3 – Other Indirect Emissions

## GHG emissions due to [business travels](#) of hotel staff

Month	Year	Origin	Destination	Distance (km) $D_{flight}$	Trip (Single / Round)	Class (Business / Economy)	$EF_{CO2-e,flight}$	BEF	$E_{CO2-e,flight}$
6	2011	HK	Shanghai	1254	Round	Economy	0.12	0.9	270.86
:									
:									
:									
11	2011	HK	London	9647	Round	Economy	0.11	0.9	1910.11
<b>Total:</b>									6845.59



# Scope 3 – Other Indirect Emissions

## GHG emissions due to daily travel of the staff

With reference to the “Carbon audit toolkit for small and medium enterprises in Hong Kong”, the GHG emission due to the daily travel of the staff (between their home and the hotel) can be calculated using the following equation:

$$E_{CO_2-e, trans} = C_{trans} \times EF_{CO_2-e, trans|cost}$$

where

$C_{trans}$ : Sum of cost for travelling

$EF_{CO_2-e, trans|cost}$ : Emission factor of GHG emissions per dollar spent on transportation

# Scope 3 – Other Indirect Emissions

## Emission factors for transportations

Transportation type	(kg CO <sub>2</sub> -e / HK\$)
MTR	0.0115
Bus	0.0493
Mini bus (LPG)	0.0944
Tram	0.0685
Taxi	0.0210
Ferry	1.478



# Scope 3 – Other Indirect Emissions

“Staff travel survey form” (i.e. Form B) were collected from the hotel. Based on the above emission factors where the **daily travel data** of the hotel’s staff are summarized, the total daily travelling costs and the GHG emissions corresponding to the different types of transportations used by the staff were calculated:

	<b>Total daily travelling cost (\$)</b>	<b>CO<sub>2</sub>-e emission (kg)</b>
Bus	1886.4	93.00
MTR	2832.2	32.57
Van	582.0	54.94
Taxi	1868.0	39.23
	<b>Total:</b>	<b>219.74</b>

Total emission for a year due to daily travel of the staff

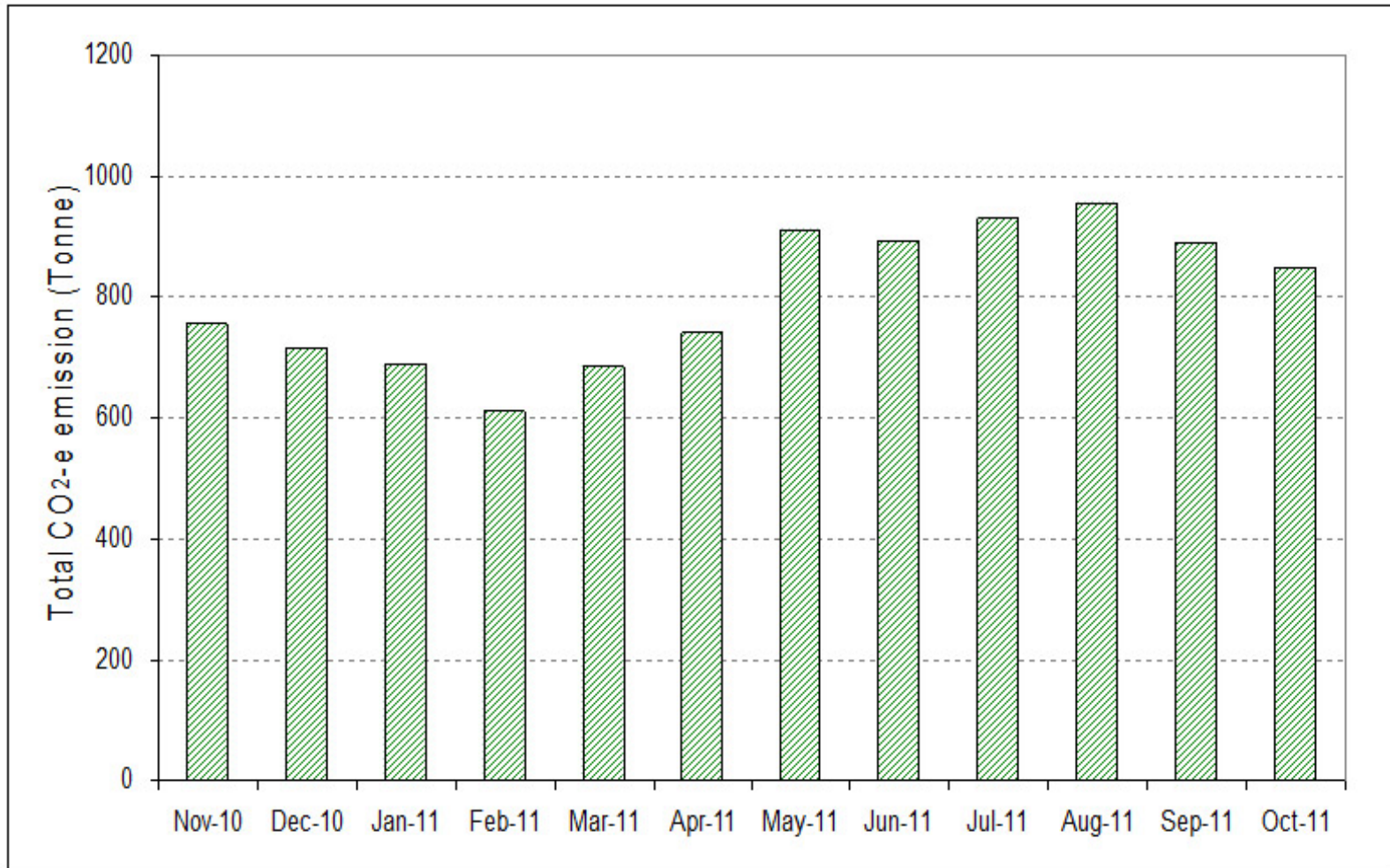
= Total daily emission x number of working days per year\*

\* Working days per year = 365 – (statutory holidays) – (average number of annual leaves) – (1 rest day per week)

# Summary of GHG Emissions and Removals (an example)

Reporting period: Nov 2010 – Oct, 2011	Emission by gas type (kg) CO <sub>2</sub> -e emission			
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total
<b>Scope 1: Direct Emissions</b>				
Liquid fuel for emergency power generator:	219.58	0.04	0.19	219.81
Transportation provided for hotel guests:	27198.53	61.23	3947.82	31207.58
Cylinder LPG consumption:	7403.72	0.1031	0.0000	7403.82
FC and PFC emission:	-	-	-	52760.00
			Total:	91591.21
<b>Scope 2: Energy indirect emissions</b>				
Electricity consumption:	-	-	-	9839130.12
Towngas consumption:	-	-	-	318041.47
			Total:	10157171.59
<b>Scope 3 – Other indirect emissions</b>				
Paper waste disposed at landfills:	-	52540.49	-	52540.49
Electricity used for fresh water supplies and processing sewage:	-	-	-	114100.16
Business travels of hotel staff:	-	-	-	23635.07
Staff daily travel from home to work:	-	-	-	180046.95
			Total:	370322.67
<b>Total emission (kg CO<sub>2</sub>-e):</b>			10619085.47	
<b>Total emission (Tonne CO<sub>2</sub>-e):</b>			10619.09	
Normalized GHG emission				
<b>Monthly emission (Tonne CO<sub>2</sub>-e):</b>			884.92	
<b>Monthly emission per room (Tonne CO<sub>2</sub>-e/room):</b>			2.21	

# Summary of GHG Emissions and Removals (an example)





# **Further Analysis & Comparisons**

# Further analysis & comparisons

## GHG emissions summary (Hotel A)

Name of Hotel:	Hotel A				
Reporting period	1/11/2010 to 31/10/2011				
	Emission by gas type (kg CO <sub>2</sub> -e emission)				
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total	%
<b>Scope 1 - Direct emissions and removals</b>					
1.1 - Liquid fuel for emergency power generator	219.58	0.04	0.19	219.81	0.0023%
1.2 - Liquid fuel for boiler	0.00	0.00	0.00	0.00	0.0000%
1.3 - Transportation provided for hotel staff	0.00	0.00	0.00	0.00	0.0000%
1.4 - Transportation provided for hotel guests	27198.53	61.23	3947.82	31207.58	0.3244%
1.5 - Cylinder LPG consumption	7403.72	0.10	0.00	7403.82	0.0770%
1.6 - Refrigerants consumption	-	-	-	52760.00	0.5485%
1.7 - Planting of additional trees	-	-	-	0.00	-
	<b>Total (Scope 1):</b>			91591.21	0.95%
<b>Scope 2 - Energy indirect emissions</b>					
2.1 - Electricity purchased	-	-	-	8839130.12	91.8916%
2.2 - Towngas purchased	-	-	-	318041.47	3.3064%
	<b>Total (Scope 2):</b>			9157171.59	95.20%
<b>Scope 3 - Other Indirect Emissions</b>					
3.1 - Paper consumption & recycling	-	52540.49	-	52540.49	0.5462%
3.2 - Water consumption	-	-	-	114100.16	1.1862%
3.3 - Staff transportation	-	-	-	180046.95	1.8718%
3.4 - Business travels of hotel staff	-	-	-	23635.07	0.2457%
	<b>Total (Scope 3):</b>			370322.67	3.85%
<b>Total emission (kg CO<sub>2</sub>-e):</b>				9619085.47	
<b>Total emission (Tonne CO<sub>2</sub>-e):</b>				9619.09	
<b>Monthly emission (Tonne CO<sub>2</sub>-e):</b>				801.59	

# Further analysis & comparisons

## GHG emissions summary (Hotel B)

Name of Hotel:	Hotel B				
Reporting period	1/11/2010 to 31/10/2011				
	Emission by gas type (kg CO <sub>2</sub> -e emission)				
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total	%
<b>Scope 1 - Direct emissions and removals</b>					
1.1 - Liquid fuel for emergency power generator	47.05	0.01	0.04	47.10	0.0021%
1.2 - Liquid fuel for boiler	0.00	0.00	0.00	0.00	0.0000%
1.3 - Transportation provided for hotel staff	0.00	0.00	0.00	0.00	0.0000%
1.4 - Transportation provided for hotel guests	10113.17	9.77	806.57	10929.51	0.4926%
1.5 - Cylinder LPG consumption	0.00	0.00	0.00	0.00	0.0000%
1.6 - Refrigerants consumption	-	-	-	49358.70	2.2246%
1.7 - Planting of additional trees	-	-	-	0.00	-
	<b>Total (Scope 1):</b>			60335.31	2.72%
<b>Scope 2 - Energy indirect emissions</b>					
2.1 - Electricity purchased	-	-	-	1937998.02	87.3444%
2.2 - Towngas purchased	-	-	-	81306.38	3.6644%
	<b>Total (Scope 2):</b>			2019304.40	91.01%
<b>Scope 3 - Other Indirect Emissions</b>					
3.1 - Paper consumption & recycling	-	59162.20	-	59162.20	2.6664%
3.2 - Water consumption	-	-	-	19046.13	0.8584%
3.3 - Staff transportation	-	-	-	60952.29	2.7471%
3.4 - Business travels of hotel staff	-	-	-	0.00	0.0000%
	<b>Total (Scope 3):</b>			139160.62	6.27%
<b>Total emission (kg CO<sub>2</sub>-e):</b>				2218800.33	
<b>Total emission (Tonne CO<sub>2</sub>-e):</b>				2218.80	
<b>Monthly emission (Tonne CO<sub>2</sub>-e):</b>				184.90	



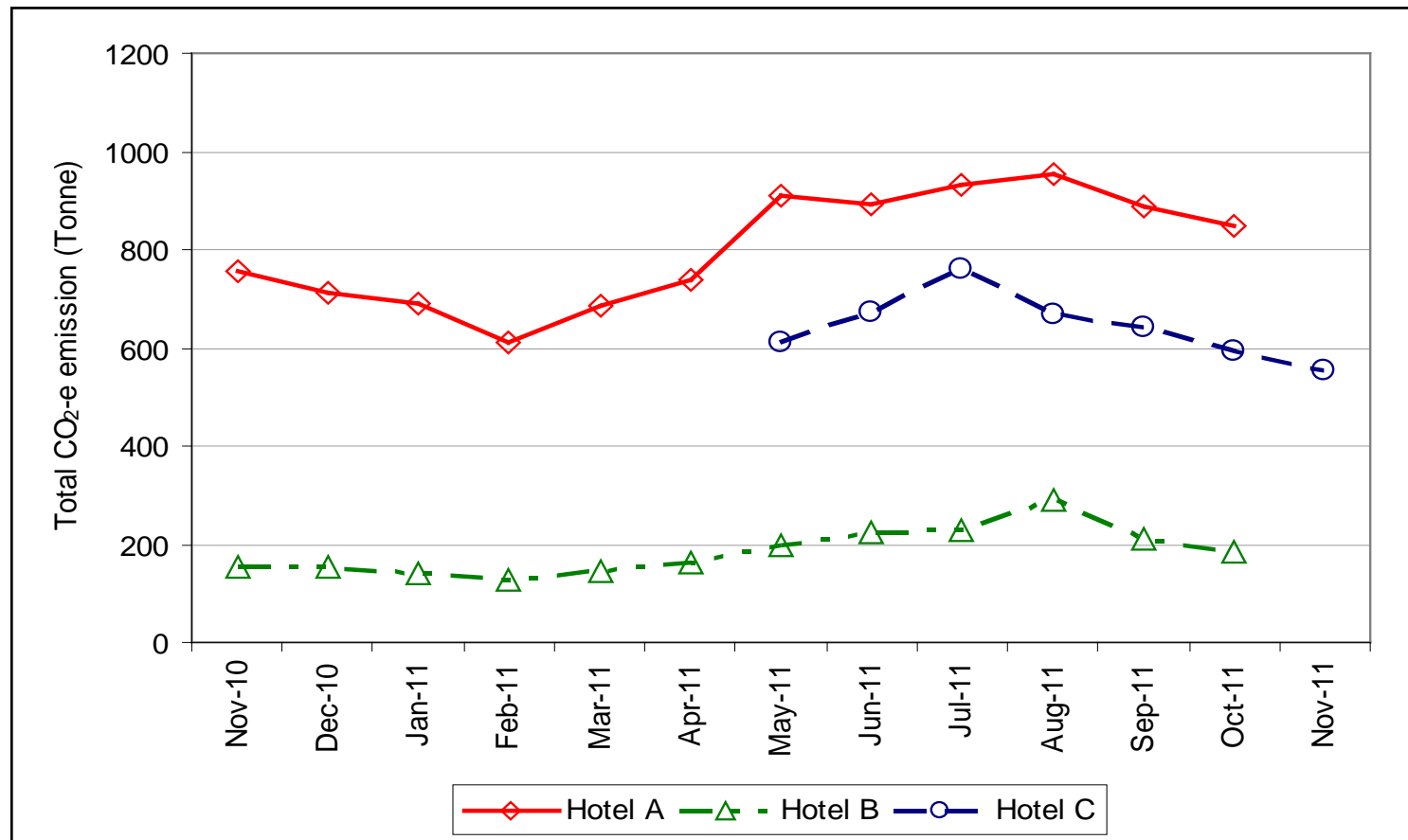
# Further analysis & comparisons

## GHG emissions summary (Hotel C)

Name of Hotel:	Hotel C				
Reporting period	1/5/2010 to 31/10/2011				
	Emission by gas type (kg CO <sub>2</sub> -e emission)				
	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total	%
<b>Scope 1 - Direct emissions and removals</b>					
1.1 - Liquid fuel for emergency power generator	941.04	0.18	0.83	942.05	0.0209%
1.2 - Liquid fuel for boiler	0.00	0.00	0.00	0.00	0.0000%
1.3 - Transportation provided for hotel staff	0.00	0.00	0.00	0.00	0.0000%
1.4 - Transportation provided for hotel guests	16527.83	9.56	991.80	17529.18	0.3889%
1.5 - Cylinder LPG consumption	0.00	0.00	0.00	0.00	0.0000%
1.6 - Refrigerants consumption	-	-	-	0.00	0.0000%
1.7 - Planting of additional trees	-	-	-	0.00	-
	<b>Total (Scope 1):</b>			18471.23	0.41%
<b>Scope 2 - Energy indirect emissions</b>					
2.1 - Electricity purchased	-	-	-	4280938.45	94.9737%
2.2 - Towngas purchased	-	-	-	91818.81	2.0370%
	<b>Total (Scope 2):</b>			4372757.26	97.01%
<b>Scope 3 - Other Indirect Emissions</b>					
3.1 - Paper consumption & recycling	-	37468.02	-	37468.02	0.8312%
3.2 - Water consumption	-	-	-	12537.25	0.2781%
3.3 - Staff transportation	-	-	-	59419.06	1.3182%
3.4 - Business travels of hotel staff	-	-	-	6845.59	0.1519%
	<b>Total (Scope 3):</b>			116269.92	2.58%
<b>Total emission (kg CO<sub>2</sub>-e):</b>				4507498.41	
<b>Total emission (Tonne CO<sub>2</sub>-e):</b>				4507.50	
<b>Monthly emission (Tonne CO<sub>2</sub>-e):</b>				643.93	

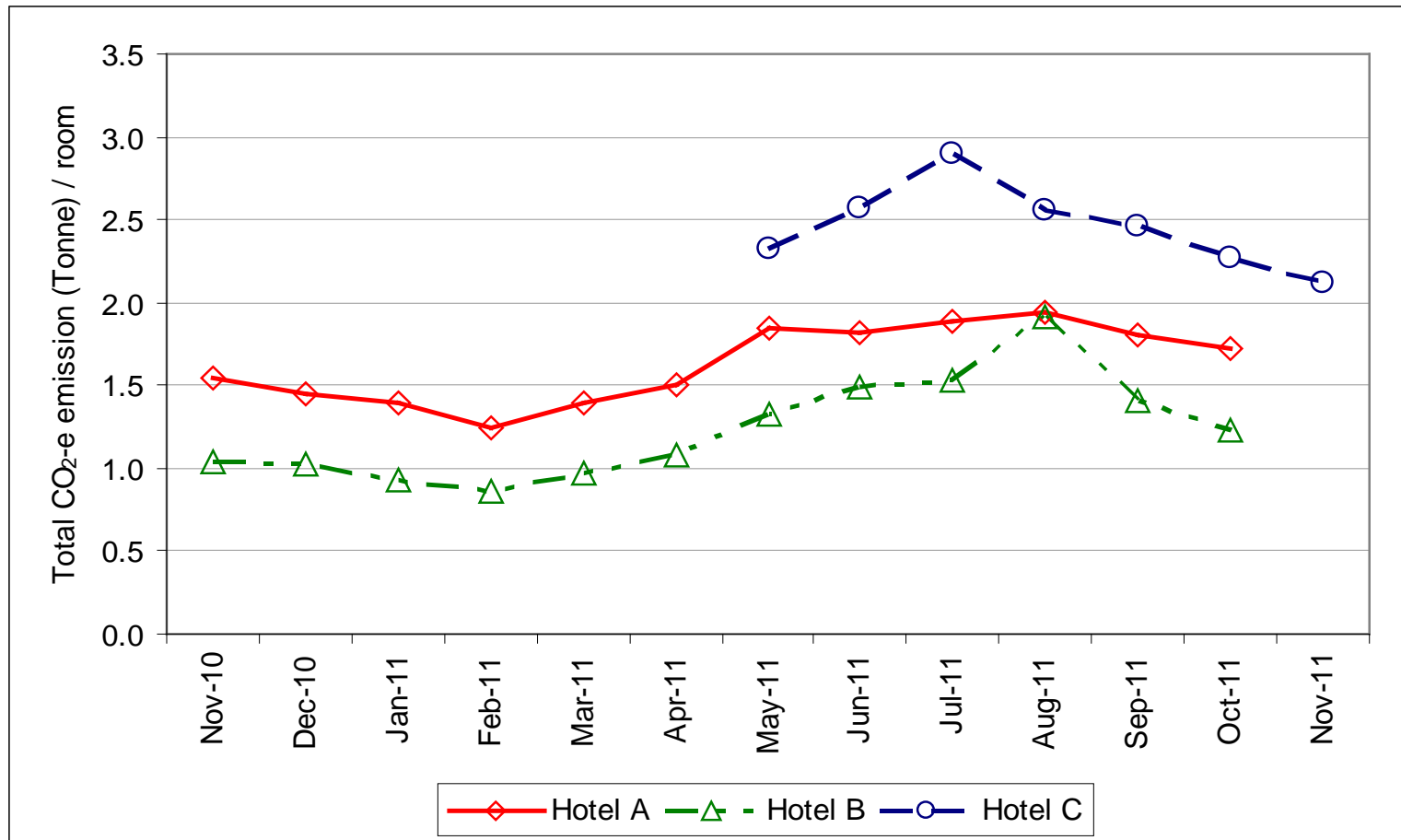
# Further analysis & comparisons

## Monthly GHG emissions (Hotels A, B & C)



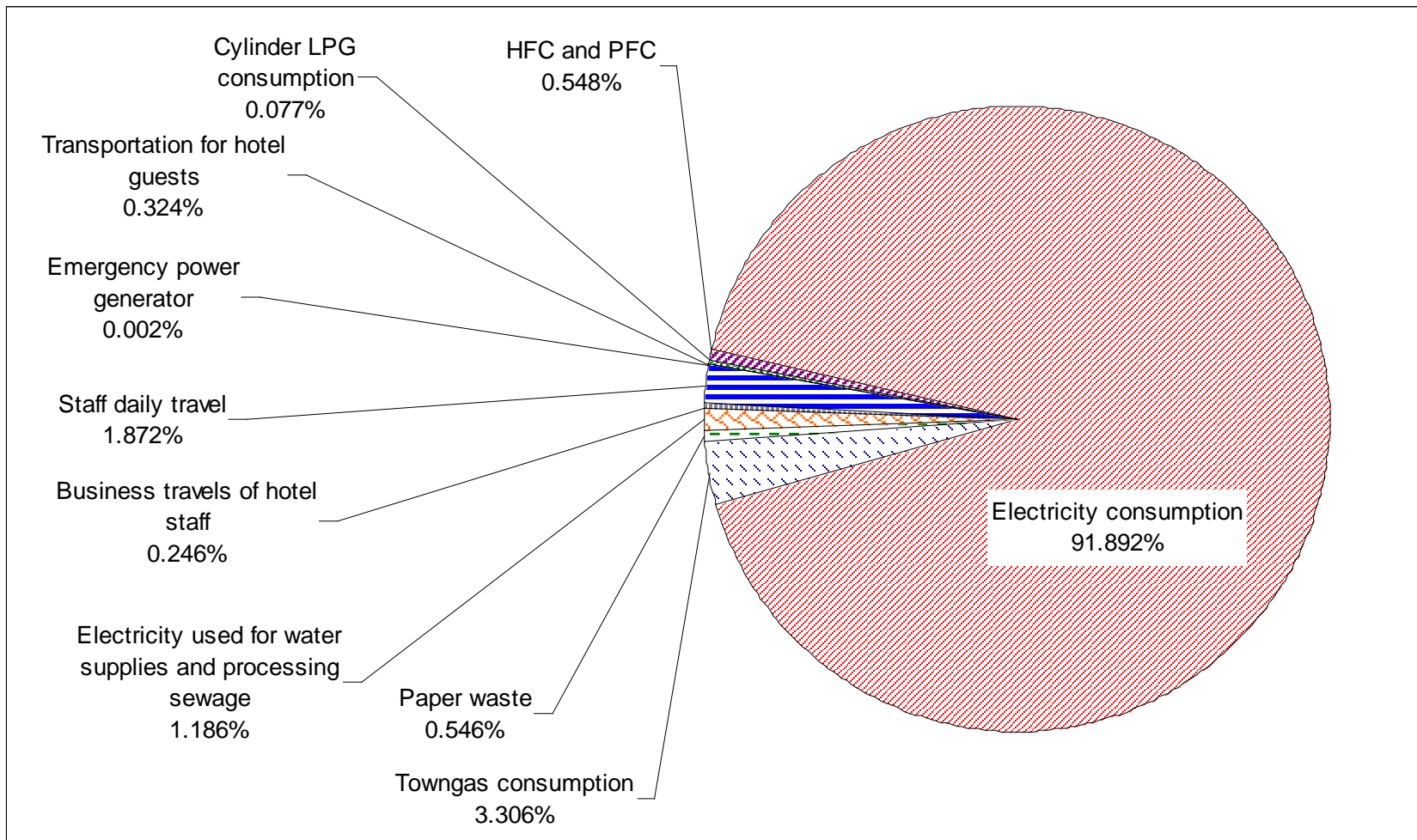
# Further analysis & comparisons

## Monthly GHG emissions per room (Hotels A, B & C)



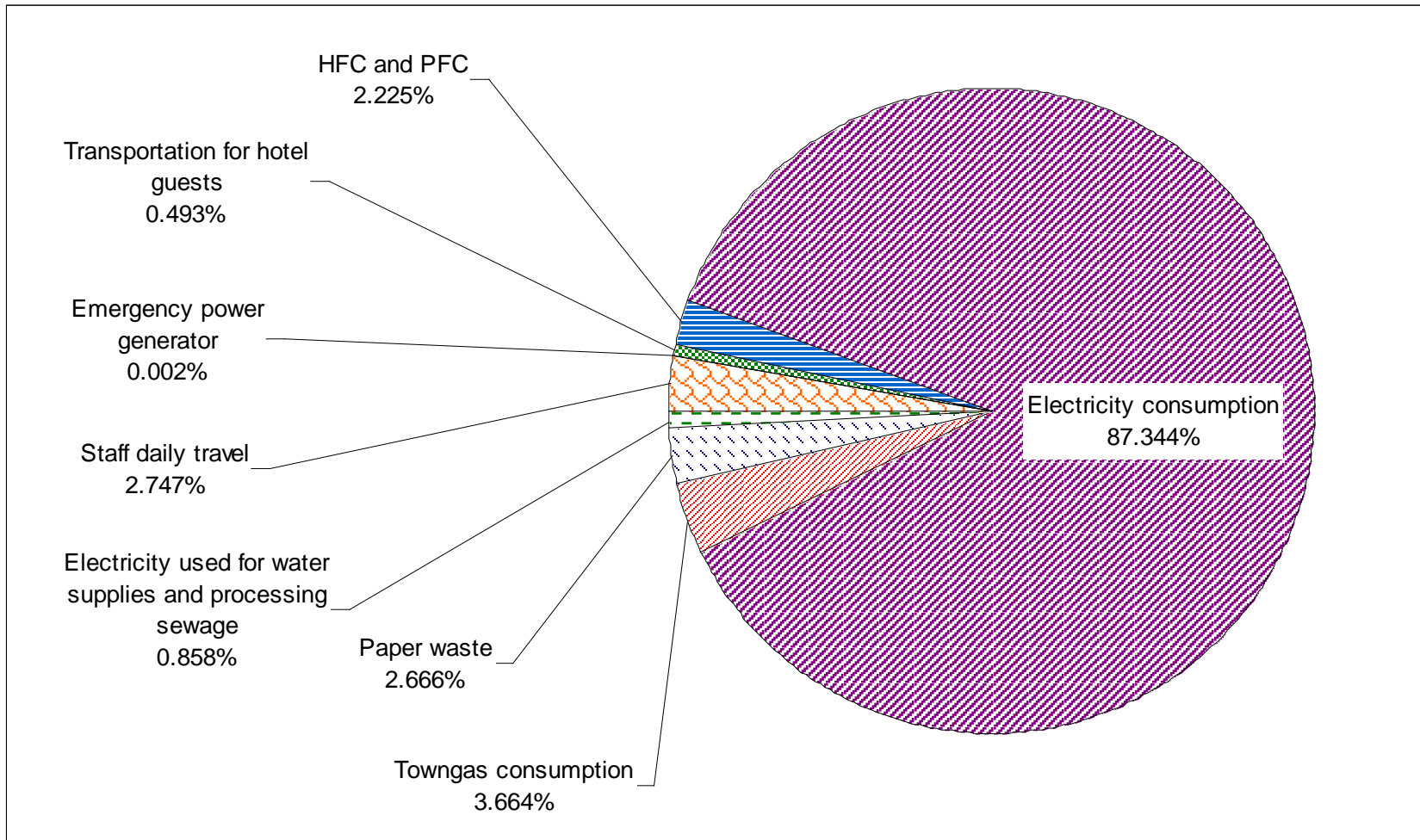
# Further analysis & comparisons

## GHG emissions by activities (Hotel A)



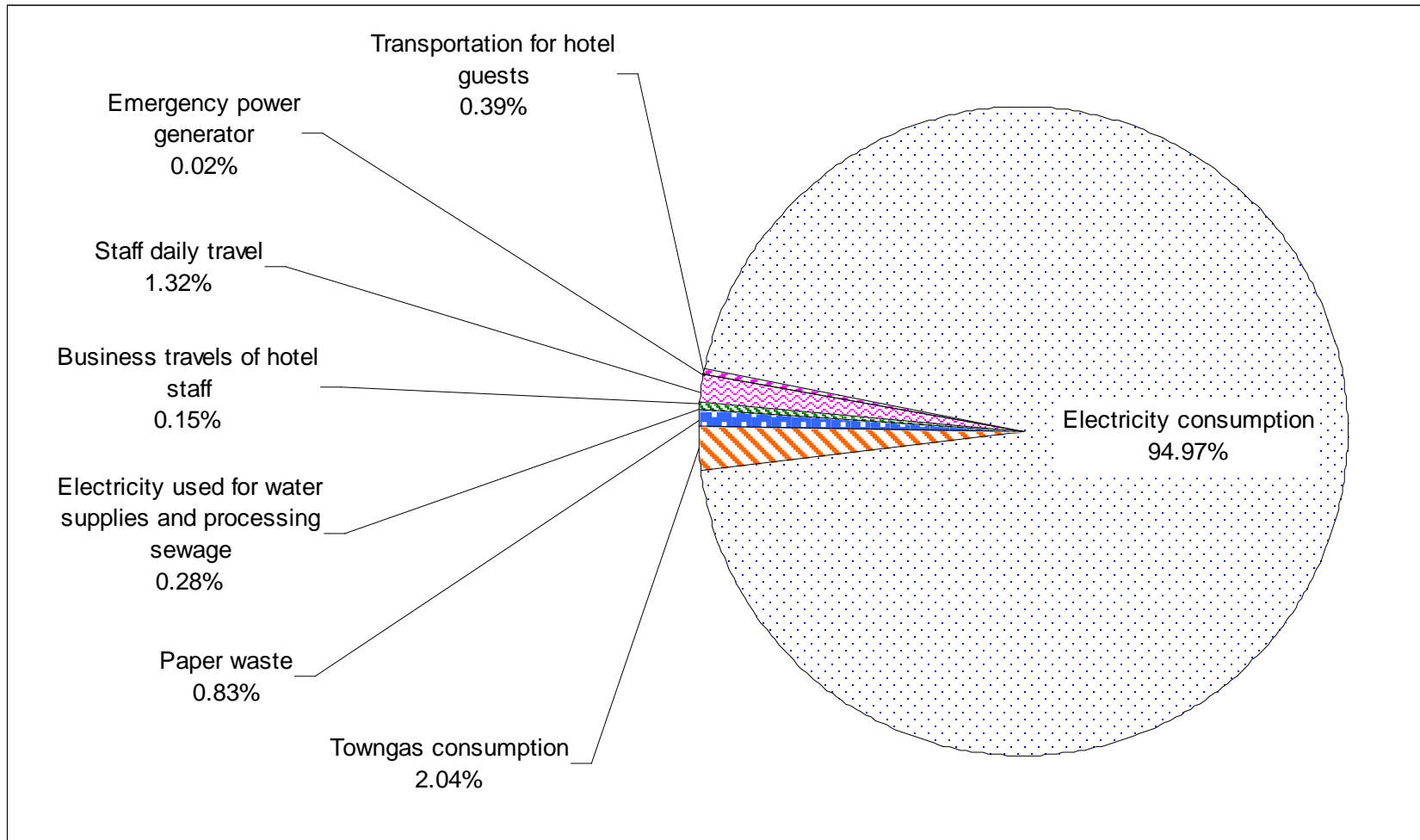
# Further analysis & comparisons

## GHG emissions by activities (Hotel B)



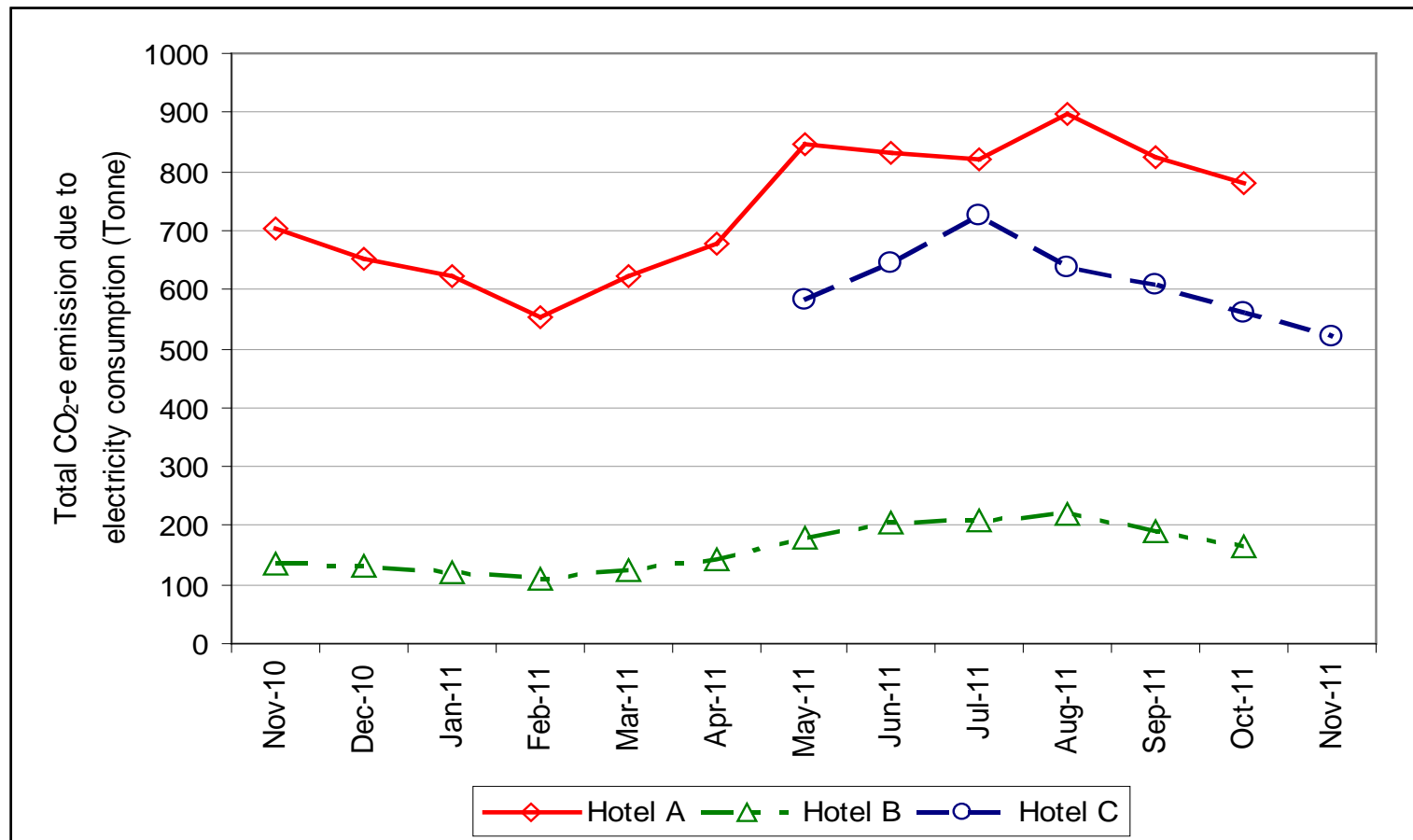
# Further analysis & comparisons

## GHG emissions by activities (Hotel C)



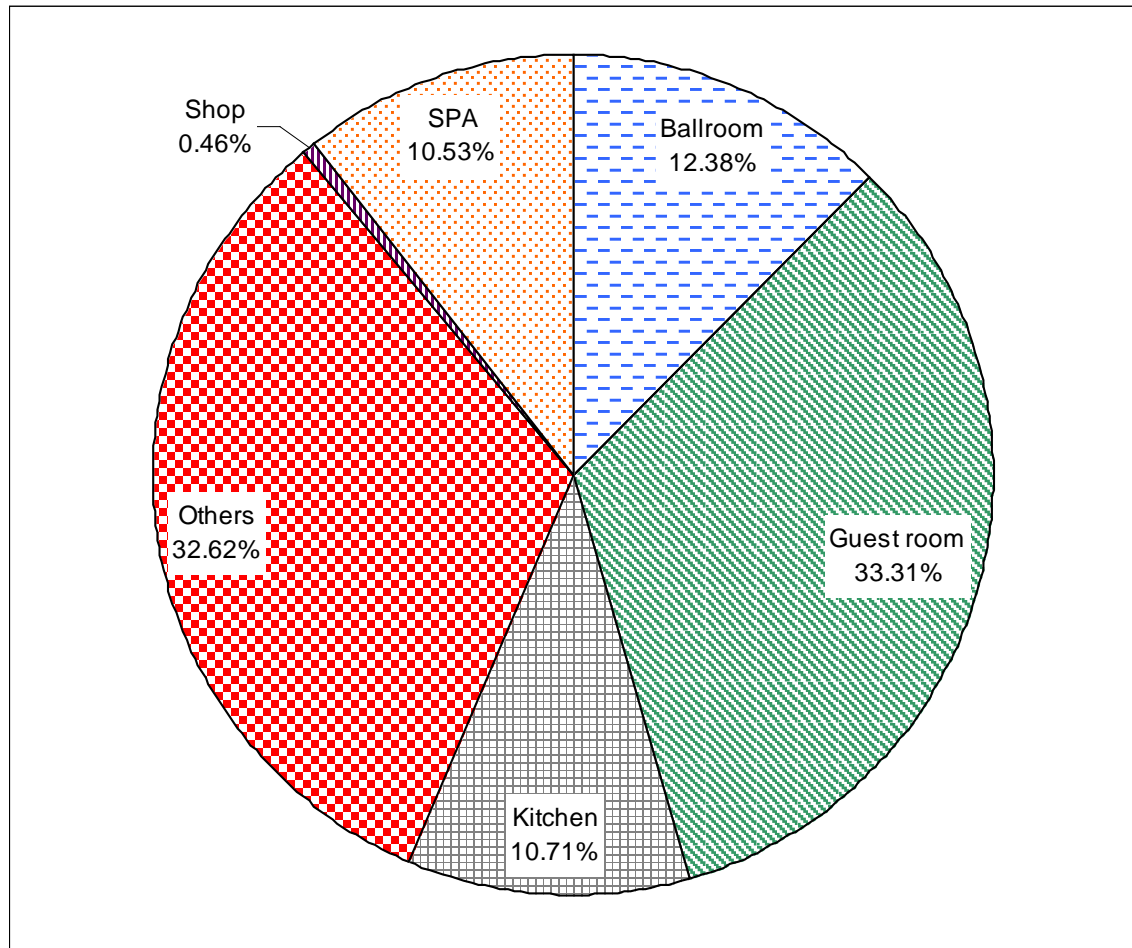
# Further analysis & comparisons

## Monthly GHG emissions due to electricity consumption



# Further analysis & comparisons

## GHG emissions due to **electricity consumptions** - Hotel A

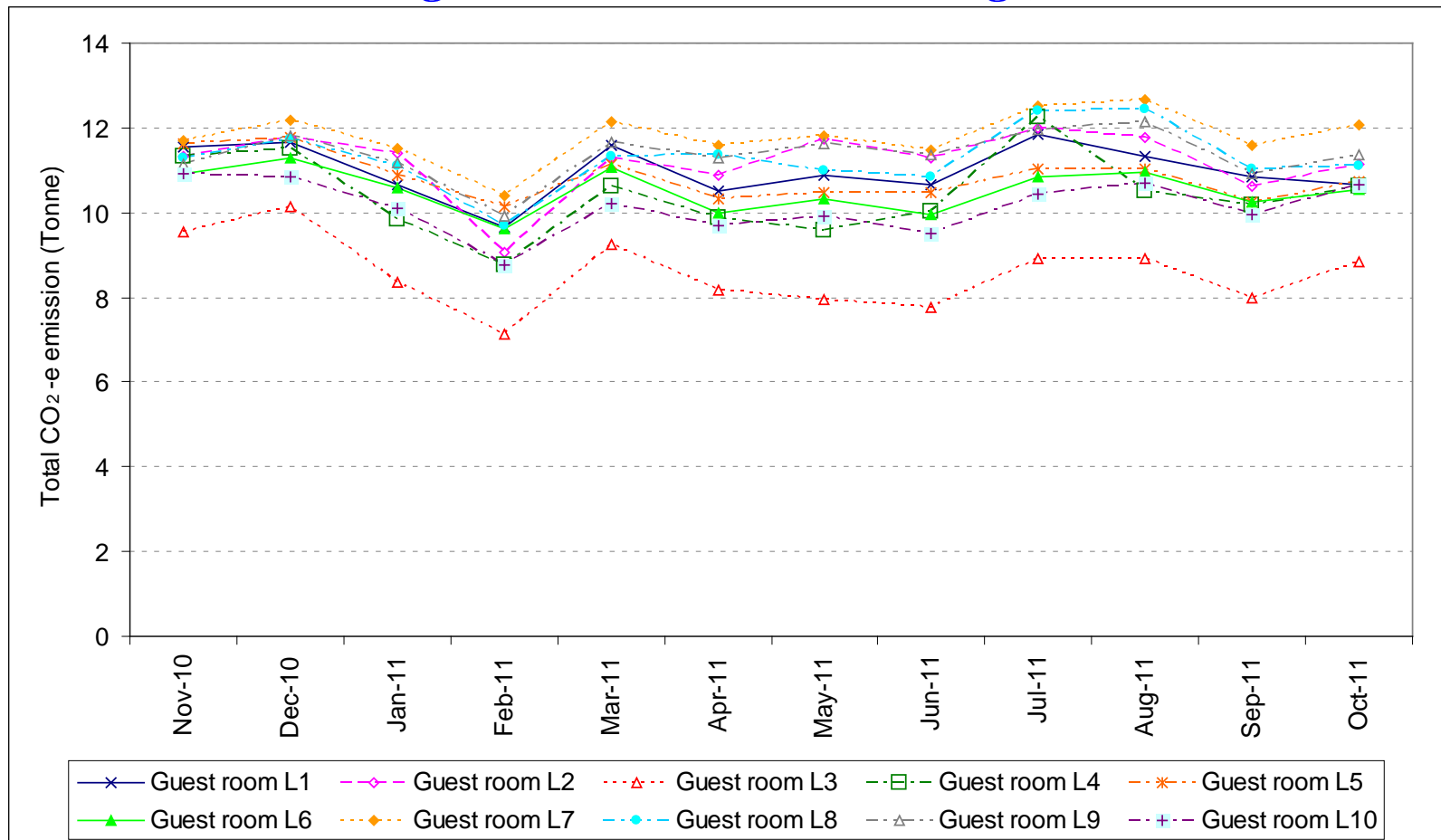




# Further analysis & comparisons

## Monthly GHG emissions due to electricity consumption

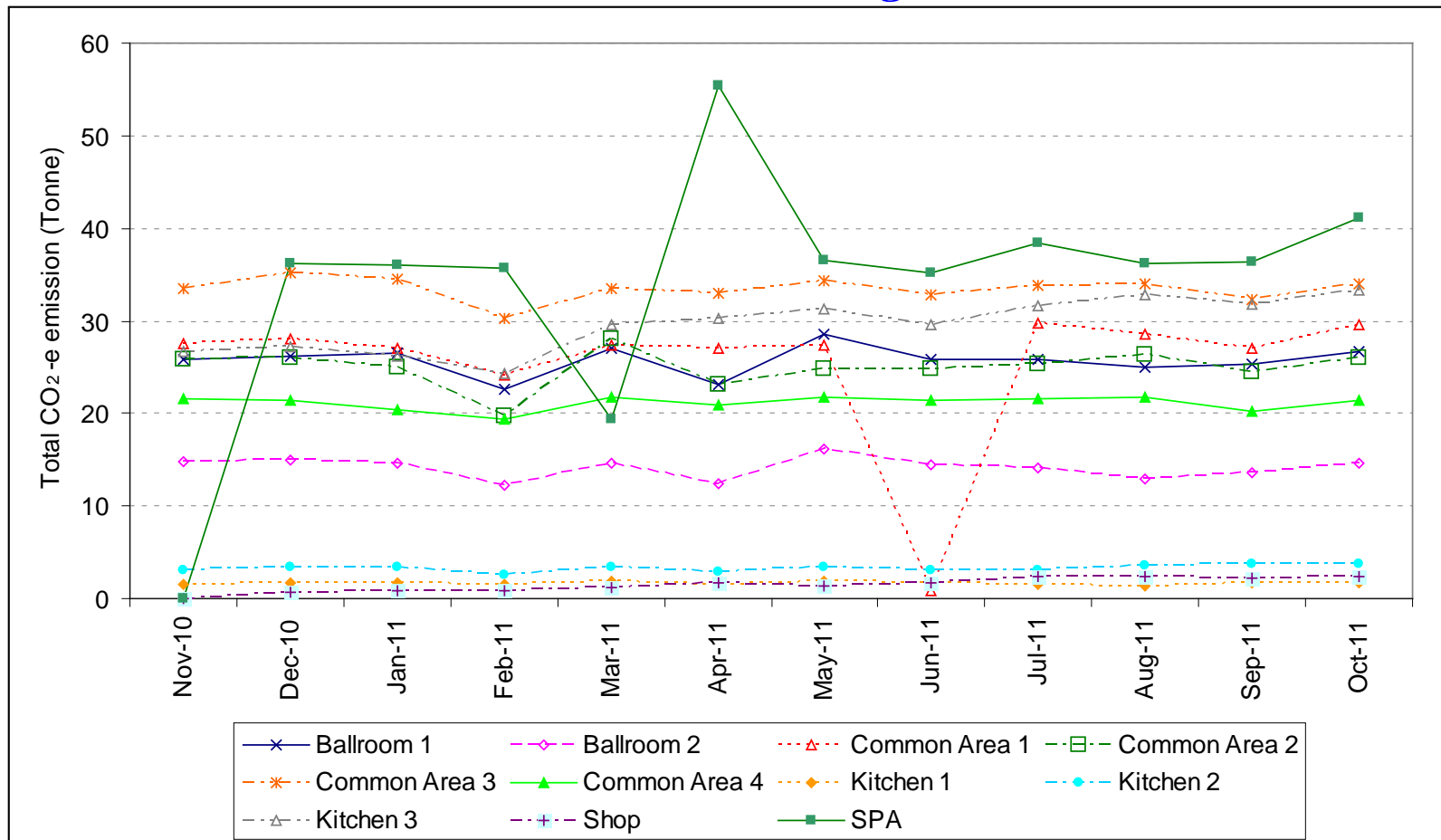
(Hotel A – based on guestroom submeter readings)



# Further analysis & comparisons

## Monthly GHG emissions due to electricity consumption

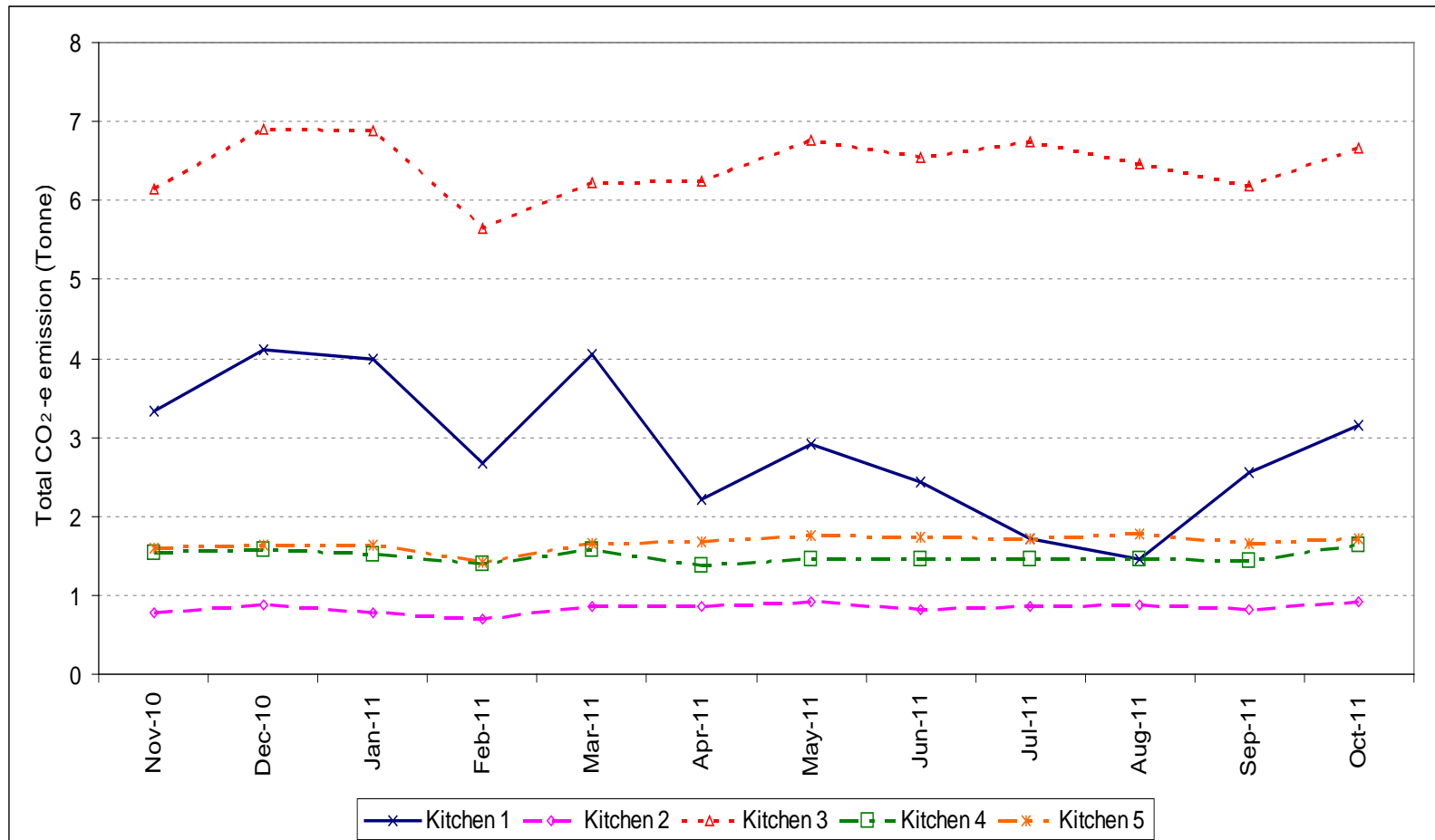
(Hotel A – based on other submeter readings)



# Further analysis & comparisons

## Monthly GHG emissions due to Towngas consumption

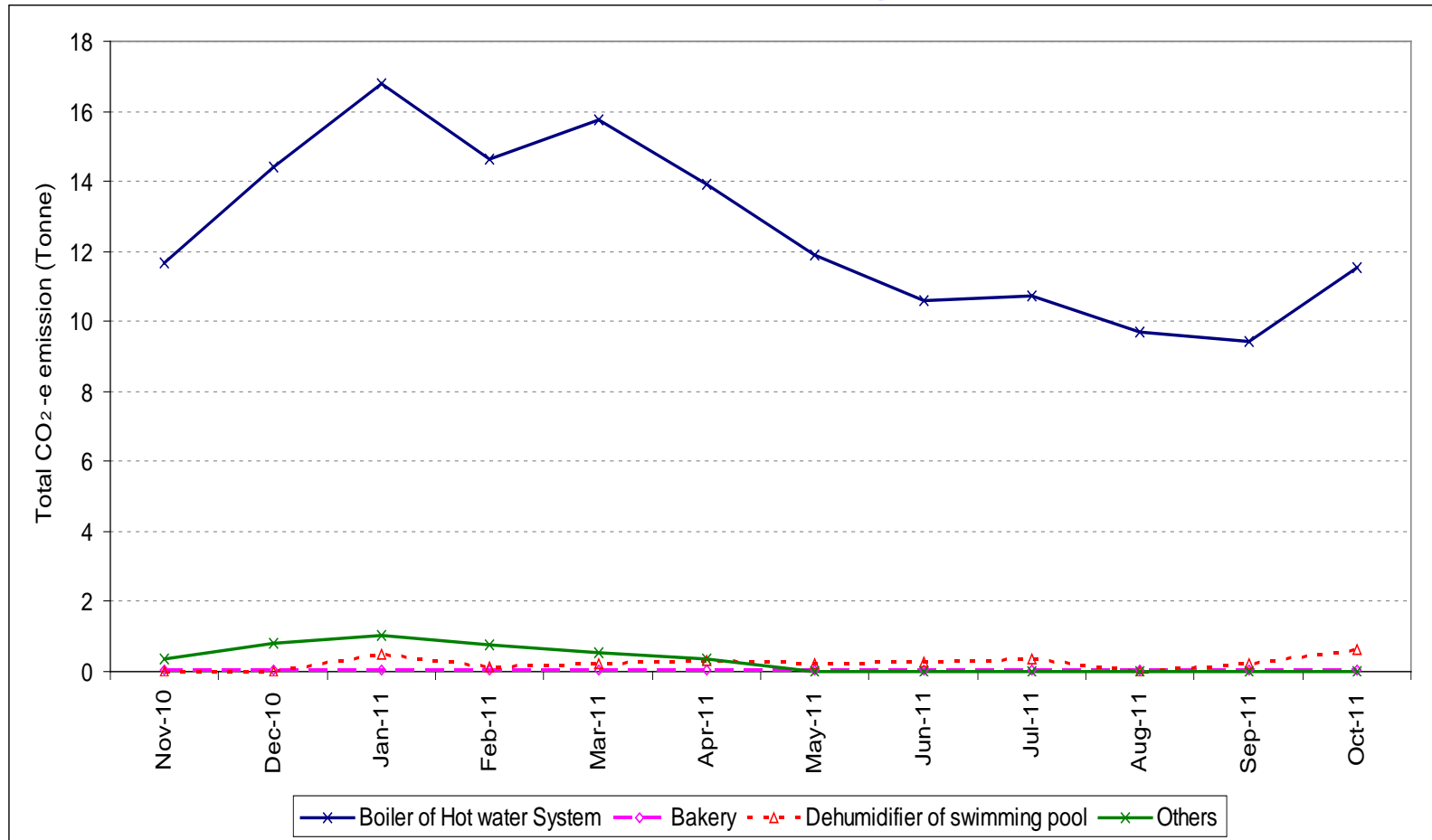
(Hotel A – based on kitchen submeter readings)



# Further analysis & comparisons

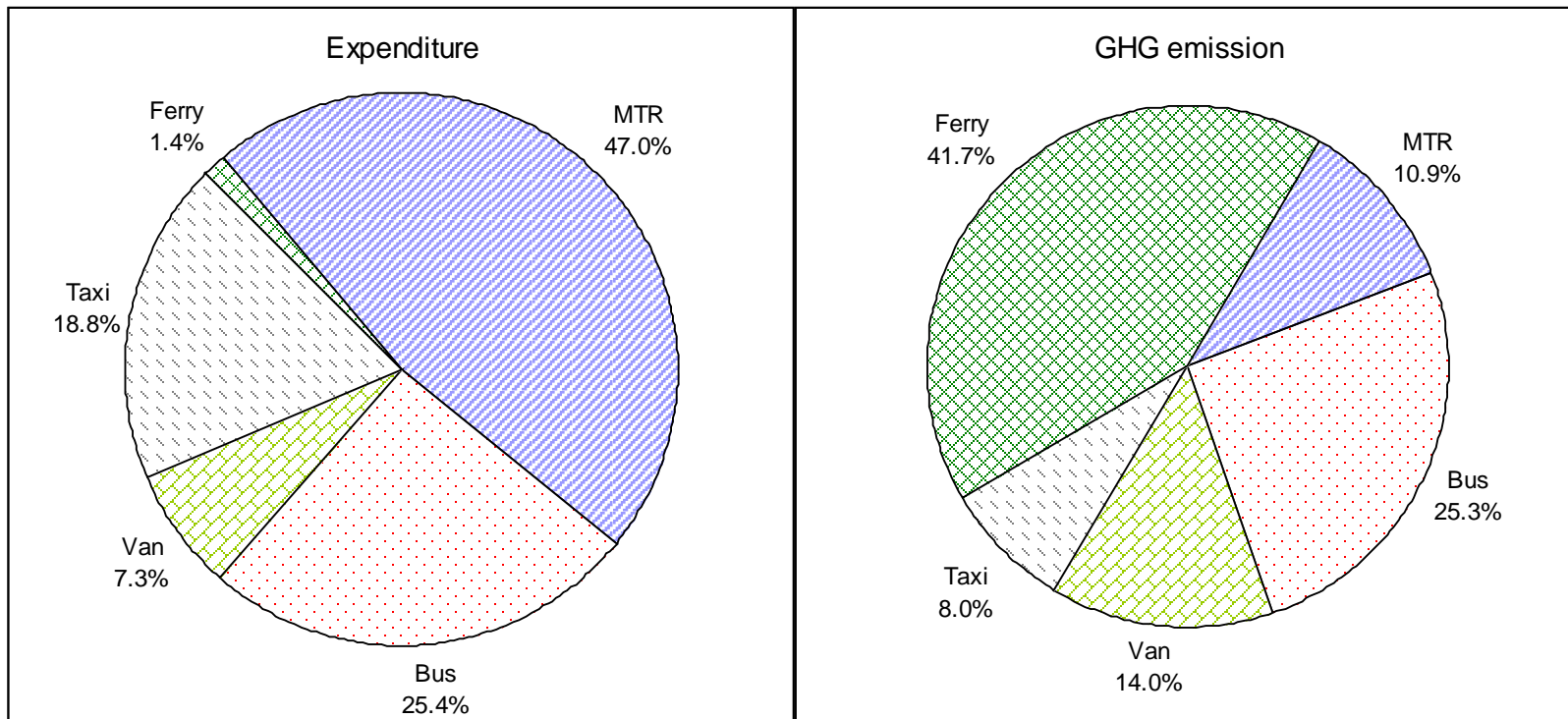
## Monthly GHG emissions due to Towngas consumption

(Hotel A – based on other submeter readings)



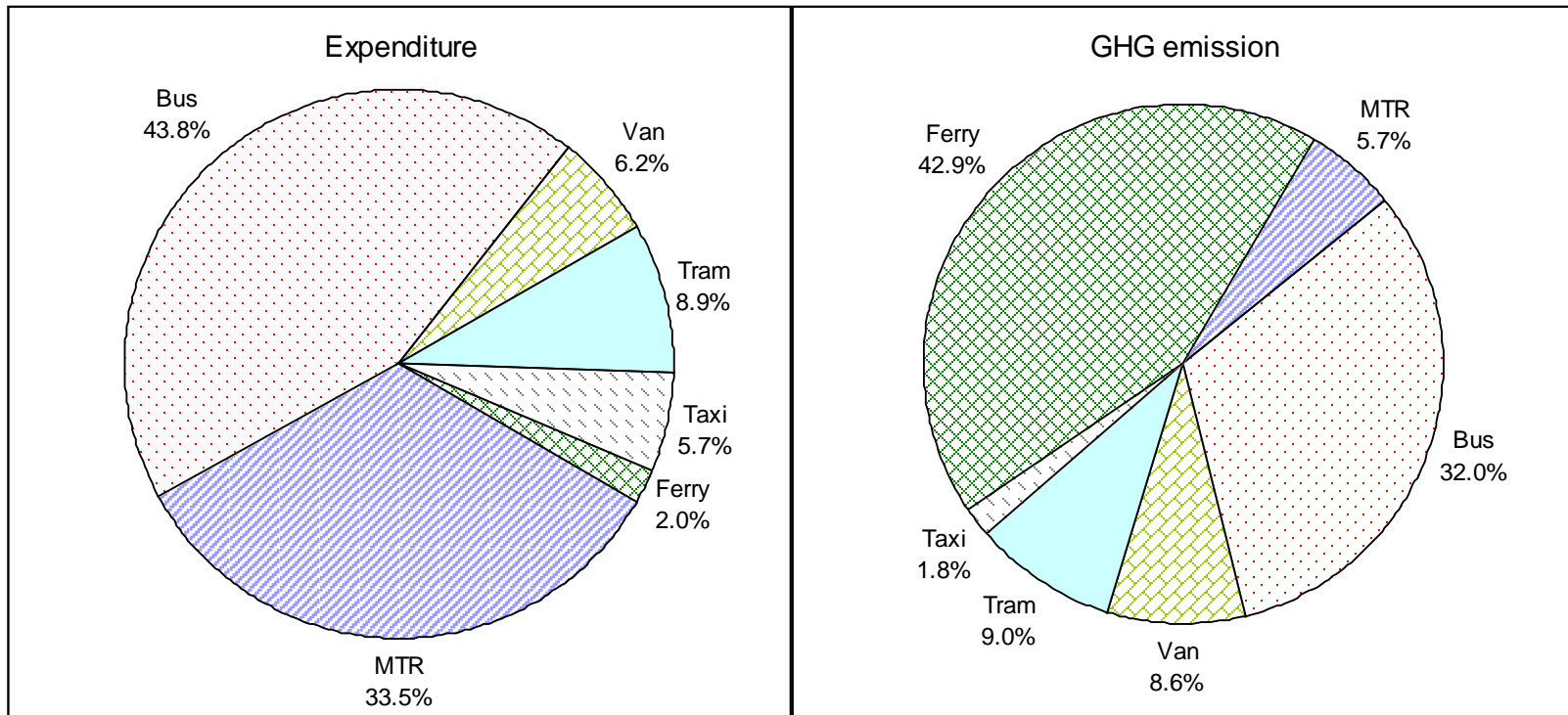
# Further analysis & comparisons

Expenditure & GHG emission due to **staff travelling** between home and workplace (**Hotel A**)



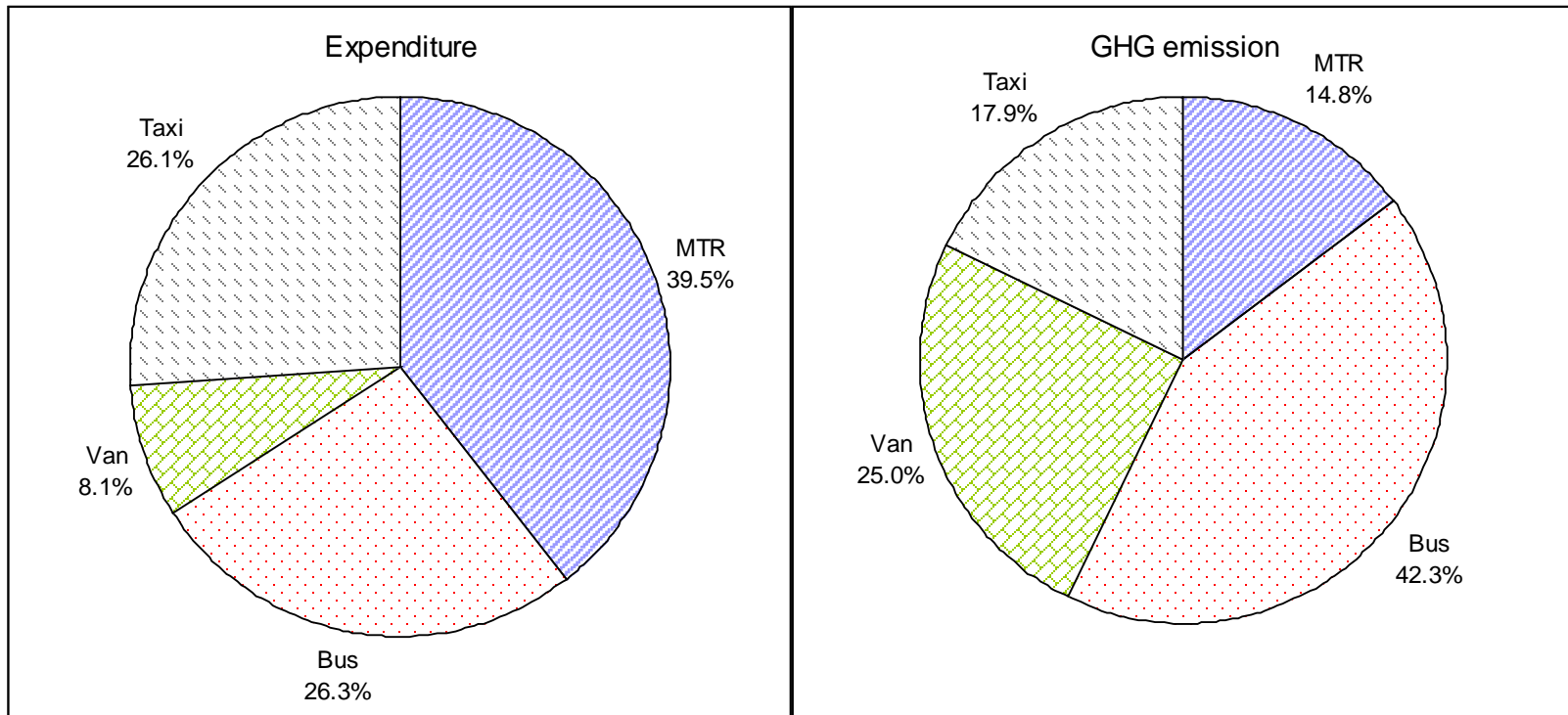
# Further analysis & comparisons

Expenditure & GHG emission due to **staff travelling** between home and workplace (**Hotel B**)



# Further analysis & comparisons

Expenditure & GHG emission due to **staff travelling** between home and workplace (**Hotel C**)





# **Carbon Footprint Calculator for Hotels in Hong Kong**



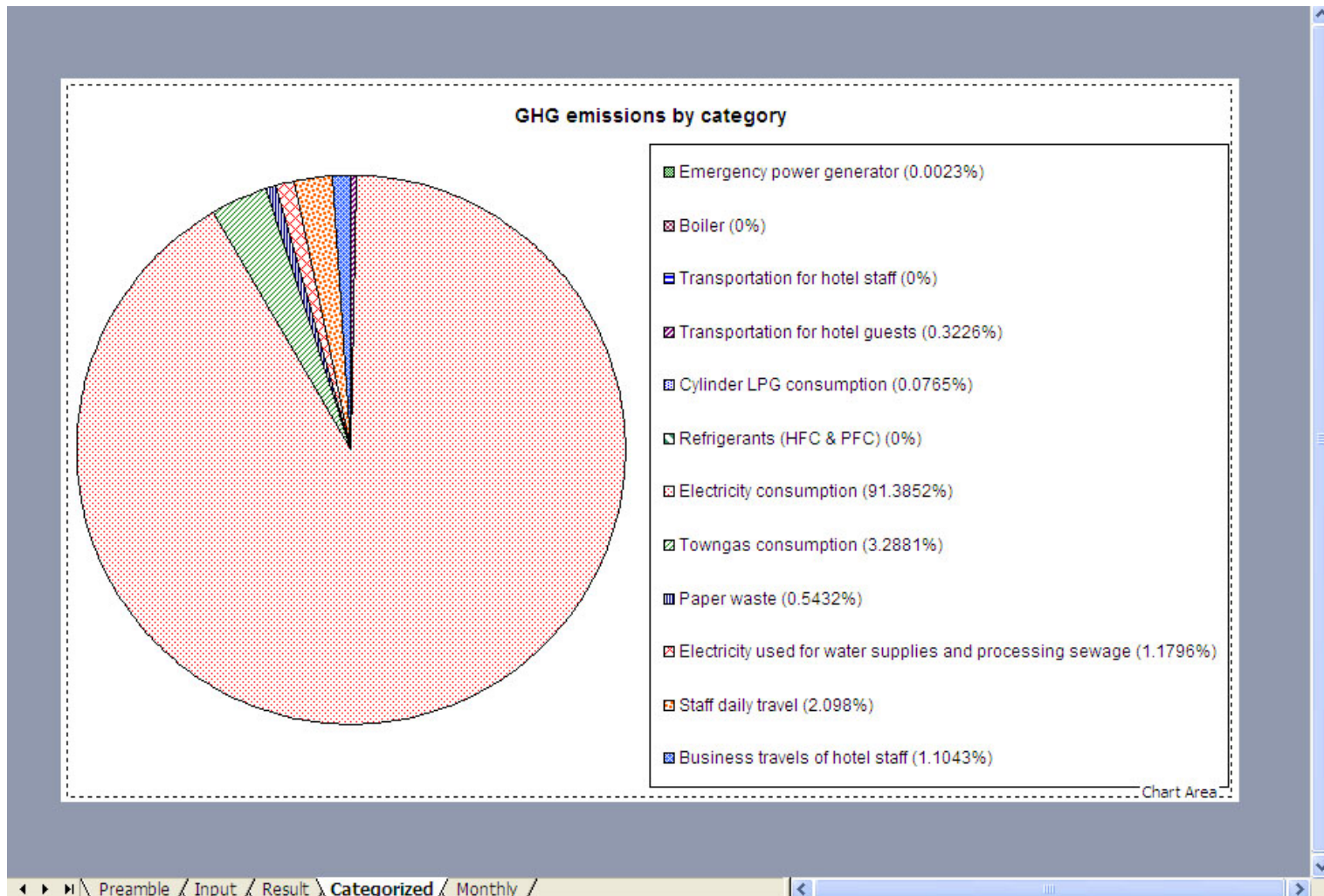
# Data Input

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Please input data in the green boxes below:												
2													
3	Name of Hotel:												
4	No. of guestrooms:												
5	Reporting period		From:										
6			To:										
7													
8	<b>Scope 1 - Direct emissions and removals</b>												
9													
10	1.1 - Liquid fuel for emergency power generator												
11													
12	Fuel Type:												
13	Month												
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28	1.2 - Liquid fuel for boiler												
29													
30	Fuel Type:												
31	Month												
32													
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45													
46	1.3 - Transportation provided for hotel staff												
47													
48			Vehicle 1	Vehicle 2	Vehicle 3								
49	Vehicle Type:												
50	Month												
51													
52													
53													
54													
55													
56													
<b>Scope 2 - Energy indirect emissions</b>													
2.1 - Electricity purchased													
Company:													
Month	Consumption (kWh)												
2.2 - Towngas purchased													
Month	Consumption (unit)												
<b>Scope 3 - Other indirect emissions</b>													
3.1 - Paper consumed & collected for recycling													
Month	A4 paper (kg)	A3 paper (kg)	Newspaper (kg)	Magazine									
3.2 - Water consumption													
Month	Consumption (m <sup>3</sup> )												
	General purposes	Catering services											
3.3 - Staff transportation													
Daily total expenditure of all staff for travelling between h													
	MTR	Bus	Van	Tram									
HKS													
3.4 - Business travels of hotel staff (by flight)													
Month	Distance (km)	Class (Business / Economy)	Trip (Round / Single)										

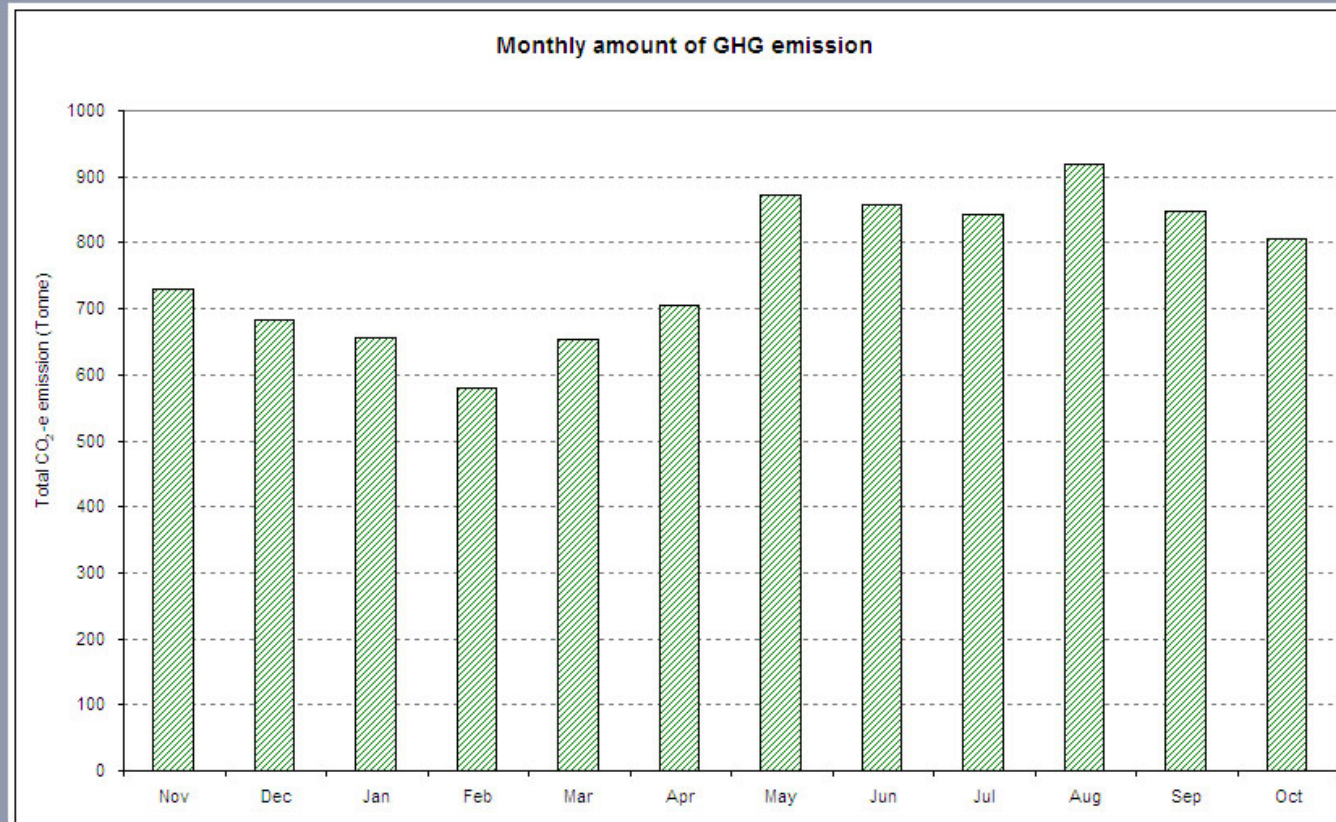
# Result (GHG emission summary)

	A	B	C	D	E	F	G	H	
1	<b>Name of Hotel:</b>	Hotel ABC							
2	<b>No. of guestrooms:</b>	200							
3	<b>Reporting period</b>	1/11/2010 to 20/10/2011							
4									
5		<b>Emission by gas type (kg CO<sub>2</sub>-e emission</b>							
6		CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total	%			
7	<b>Scope 1 - Direct emissions and removals</b>								
8	1.1 - Liquid fuel for emergency power generator	219.58	0.04	0.19	219.81	0.0023%			
9	1.2 - Liquid fuel for boiler	0.00	0.00	0.00	0.00	0.0000%			
10	1.3 - Transportation provided for hotel staff	0.00	0.00	0.00	0.00	0.0000%			
11	1.4 - Transportation provided for hotel guests	27198.53	61.23	3947.82	31207.58	0.3226%			
12	1.5 - Cylinder LPG consumption	7403.72	0.10	0.00	7403.82	0.0765%			
13	1.6 - Refrigerants consumption	-	-	-	0.00	0.0000%			
14	1.7 - Planting of additional trees	-	-	-	0.00	-			
15		<b>Total (Scope 1):</b>			38831.21	0.40%			
16	<b>Scope 2 - Energy indirect emissions</b>								
17	2.1 - Electricity purchased	-	-	-	8839130.12	91.3852%			
18	2.2 - Towngas purchased	-	-	-	318041.47	3.2881%			
19		<b>Total (Scope 2):</b>			9157171.59	94.67%			
20	<b>Scope 3 - Other Indirect Emissions</b>								
21	3.1 - Paper consumption & recycling	-	52540.42	-	52540.42	0.5432%			
22	3.2 - Water consumption	-	-	-	114100.16	1.1796%			
23	3.3 - Staff transportation	-	-	-	202929.31	2.0980%			
24	3.4 - Business travels of hotel staff	-	-	-	106811.60	1.1043%			
25		<b>Total (Scope 3):</b>			476381.48	4.93%			
26									
27		<b>Total emission (kg CO<sub>2</sub>-e):</b>			9672384.28				
28		<b>Total emission (Tonne CO<sub>2</sub>-e):</b>			9672.38				
29									
30		<b>Monthly emission (Tonne CO<sub>2</sub>-e):</b>			806.03				
31		<b>Monthly emission per room (Tonne CO<sub>2</sub>-e/room):</b>			2.02				
32									
33									
34									
35									

# Result (GHG emissions by category)



# Result (Monthly GHG emission)





**Calculator available in the following link:**

[www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html](http://www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html)

## Carbon Footprint Calculator for Hotels in Hong Kong

Funded by: Environment and Conservation Fund, HKSAR  
Study team: Joseph Lai, Francis Yik, Michael Liu  
Department of Building Services Engineering, PolyU

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Calculator

## Introduction

A project entitled "Carbon Footprint Analysis of Hotels in Hong Kong" was funded by the Environment and Conservation Fund (ECF) and The Hong Kong Polytechnic University (PolyU). Intended to probe into the sources and levels of greenhouse gas (GHG) emissions and removals from selected hotels, analyse their carbon footprints, and investigate into the factors and practices that can help mitigate GHG emissions or enhance their removals, the project was carried out by a study team at the Department of Building Services Engineering of PolyU.



**Calculator available in the following link:**  
[www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html](http://www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html)

## Carbon Footprint Calculator for Hotels in Hong Kong

Funded by: Environment and Conservation Fund, HKSAR  
Study team: Joseph Lai, Francis Yik, Michael Liu  
Department of Building Services Engineering, PolyU

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## Results

Based on the data of the hotels, analyses were carried out on the following areas of GHG emissions/removals.

Direct emissions/removals due to:

- Stationary sources combustion
- Mobile sources combustion
- Fugitive emissions
- Assimilation of carbon dioxide into biomass through planting of trees

Energy indirect emissions due to:

- Consumption of purchased electricity
- Consumption of town gas

Other indirect emissions due to:

- Methane gas generation at landfill due to disposal of paper waste
- Consumption of fresh water
- Treatment of waste water



[Click here to download the presentation file showing the project results](#)

# Calculator available in the following link:

[www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html](http://www.bse.polyu.edu.hk/link/carbon-footprint-calculator.html)

## Carbon Footprint Calculator for Hotels in Hong Kong

Funded by: Environment and Conservation Fund, HKSAR  
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Department of Building Services Engineering, PolyU

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## Calculator

For identifying greenhouse gas (GHG) emissions/removals of hotels in Hong Kong, this calculator was devised under the project "Carbon Footprint Analysis of Hotels in Hong Kong". The project, undertaken by a study team in the Department of Building Services Engineering of The Hong Kong Polytechnic University, was funded by the Environment and Conservation Fund of the Hong Kong Government.

The core basis upon which this calculator was developed refers to the methodology and procedures contained in the Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes), which was jointly published by the Environmental Protection Department and the Electrical and Mechanical Services Department in 2010. The emission factors adopted in the algorithm of this calculator essentially refer to those pertaining to year 2010 or the latest figures which were publicly available at the time when this calculator was developed.

Disclaimer: This calculator is intended to serve as a reference protocol for calculating carbon footprints of hotels in Hong Kong. The designer of this calculator will accept no liability for any consequence that may arise from the use of this calculator.



[Click here to download the "Carbon Footprint Calculator for Hotels in Hong Kong" \(zipped Excel file\)](#)

**End of presentation**

**Thank you**