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Title:	Carbon Audit and Carbon Reduction in Hotels in Hong Kong
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Carbon Audit and Carbon Reduction in Hotels in Hong Kong

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Abstract:

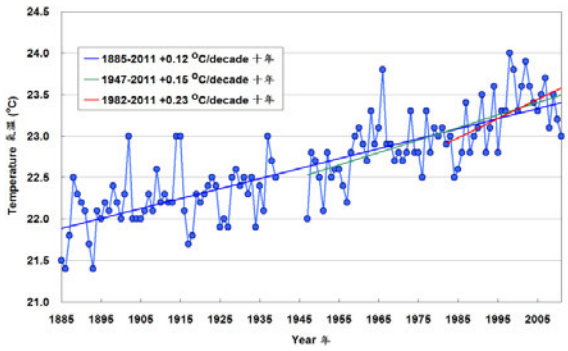
Carbon audit is a powerful tool for business to minimize the impact on the climate change and regarded as a potential guard against rising energy costs. It provides an opportunity to innovate and implement practical measures to reduce emissions. In May 2012, we have engaged by one of our clients, who are coming from hotel sector. The hotel management delivered a clear message that they have commitment to make contribution to the global environment. Through professional and effective carbon audit and reduction measures can help mitigate climate change and initiate more low-carbon services within the hotel portfolio. In addition, green hotel can attract public awareness and increase business. Hence, carbon audit will be the very first step for hotels to realize the significant area for energy cost reduction. In this paper, the guidelines for applying in carbon audit, emission source identification, emission factor & global warming potential (GWP) applications and carbon reduction initiatives for hotel sector will be discussed.

Keywords: Carbon Audit, Emission Source, Emission Factors, GWP

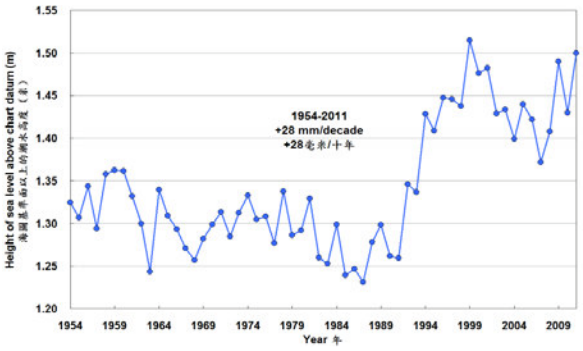
1. Introduction:

In recent years, the topic of climate change has become a hot topic and received international attention. According to the Inter-governmental Panel on Climate Change (IPCC), due to human activities there have been increases in Greenhouse Gases (GHGs) in terms of carbon dioxide equivalent (CO_2e) emitted into the atmosphere which affect the absorption, scattering and emission of radiation within the atmosphere. The effect is global, even in Hong Kong, people are aware of extreme weather happened frequently in recent years. According to the Hong Kong Observatory the temperature records showing a rising trend in the annual mean temperature of 0.12°C per decade from 1885 to 2011 (figure 1(a)). Sea level records also show that mean sea level in the Victoria Harbour has risen at a rate of 2.8mm per year from 1954 to 2011 (figure 1(b)). In addition, the frequency and peak speed of typhoon or even super typhoon occurred in Hong Kong are obvious, e.g. Severe typhoon Vicente has been recorded in this year July. All these records illustrate that climate change in Hong Kong can be attributed to

Figure 1(a): Temp. Vs Year



1(b): Sea level Vs. Year



global warming caused by greenhouse gas (GHG) emissions.

In fact, around 60% of Hong Kong's GHG emissions are coming from buildings. According to *Key World Energy Statistics 2012*, 41.47 million tonne CO_2 was emitted in Hong Kong in 2010, in other words buildings generated about 24.88 million tonne CO_2 emissions. Definitely, this value is huge. Among all the buildings in Hong Kong, hotels buildings are often found to be one of the most energy intensive sectors in the building stock. As a result, their GHG emissions are also great. In order to help hotel sector going green and cost saving, carbon audit will be a vital step in the beginning with speaking to the fact of measuring to manage. Through carbon audit exercise, hotel owners will realize the area of major emissions and take effective programmes for carbon reduction. From the professional view of 3rd party in conducting carbon audit, there are several important points should be well addressed:

I. Selection of Standard / Guideline / Programme;

II. Define organizational or physical boundary;

III. Define operational boundary (subject to standard's requirement);

IV. Define baseline and reporting period;

V. Type of GHGs and identify GHG emission sources;

VI. Use of appropriate emission factors (EFs) and global warming potential (GWP);

VII. Identify calculation methodology;

VIII. Verification

The hotel owner can base on the audit results to formulate appropriate reduction programmes and hopefully maintains an upper position in carbon leadership.

2. Carbon Audit Process:

Carbon management starts with the identification, quantification and reporting of the company's carbon inventory. Carbon, to a certain extend, means energy. Energy cost is rising and energy saving means cost cutting. A need to cut energy use would certainly require energy management, and carbon management would mean a wider scope and a more defined intention.

2.1 Selection of Standard / Guideline / Programme

In Hong Kong, there are several carbon standards and guidelines available. ISO 14064-1:2006 is basic, it provides an umbrella standard that is of special importance for the voluntary approaches to GHG declarations by companies or governments, for example, "Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong" (hereafter referred as HK Guideline) or pilot carbon management programmes by HKSAR Government such as Carbon"Less" certificate scheme Type I, II & III or the recent launched CarbonSmart programme. In fact, ISO14064-1 is GHG programme

neutral, thus it is acceptable for using these GHG programmes together with ISO14064-1. When there is a specific intended use, any specific requirements of this respective GHG guideline will take precedence over ISO14064-1. For example, HK Guideline requires users to report some specific emission sources which are an optional for ISO14064-1. That is to say, under ISO14064-1, user can choose not to report. Hence, the user should clearly define intended use in the very beginning, which directly affects the selection of GHG programmes.

2.2 Define organizational or physical boundary

ISO14064-1 and other local GHG programmes are using different approach to define the boundary of organization. For ISO14064-1, organizational boundary is used, while physical boundary is used in Carbon”Less” or CarbonSmart programme. Organizational boundary defines which facilities are required to be included within the inventory for reporting. Two approaches are necessary to define organizational boundary by “control” or “equity share”. Under the control approach, hotel looks at its facilities where it has influence to implement either operational or financial policies, and then 100% GHG emissions from facilities should be reported. While under the equity share approach, hotel accounts for emissions from all facilities where it has some equity interest, usually it accounts for a percentage of the total emissions equal to the equity share it has in the particular facilities.

On the other hands, physical boundary is much straightforward; it is usually match the site boundaries of the hotel concerned. All the emission sources within the physical boundary which are managed, controlled or dedicated by the hotel should be included in the GHG inventory.

2.3 Define operational boundary

New Zealand Business Council for Sustainable Development (NZBCSD) has categorized GHG emissions into scope 1 (direct) emissions, scope 2 (energy indirect) emissions and scope 3 (other indirect) emissions. This classification was adopted by WBCSD (World Business Council for Sustainable Development) and WRI (World Resource Institute) in their development of the "GHG Protocol, A Corporate Accounting and Reporting Standard". ISO 14064-1 categorized GHG in a similar way and acts as an international harmonized standard on GHG quantification and reporting. These three categories are now commonly adopted by almost all GHG programmes or standards. GHG within each scope can be:

Scope 1 direct: GHG emissions directly from fossil fuel used by the hotel's equipment, including generators, boilers, vehicles, fugitive emissions from cooling equipment, process emissions of CO_2 and so on.

Scope 2 energy indirect: Indirect GHG emissions from power, steam, gas and hot water purchased. In Hong Kong, electricity and Towngas are the two common energy

sources.

Scope 3 other indirect: Indirect GHG emissions from product use, production of purchased materials, outsourced activities, employee business travel, employee commuting to work, waste disposal and so on. HK Guideline, Carbon"Less" or CarbonSmart programme requires user to report selected emission sources; the detail is listed in table 1:

Table 1: Scope 3 reporting requirements in different programmes.

Scope 3 Sources	HK Guideline	Carbon"Less"			CarbonSmart	
		Type I	Type II	Type III	Office	Others*
Paper Waste Disposal	✓	✓	✓	✓	✓	✓
Use of fresh water	✓	✓	✓	✓	✓	✓
Sewage discharge	✓	✓	✓	✓	✓	✓
Transportation of purchased materials or goods, products to & from the organization	×	×	×	✓	×	✓

*Others are referring to retail, catering, hotel, logistics, information and communication technology, industrial or engineering.

Besides emissions, carbon removal should be addressed if hotel has GHG sinks happened. Assimilation of CO_2 into biomass is one of the common GHG sinks. Planting of trees was a typical example of CO_2 assimilation. As defined in HK Guideline, all newly planted trees which are able to reach at least 5 meters in height can be considered to the contribution of carbon removal.

2.4 Define baseline and reporting period

It is important for hotel to define baseline and reporting period of carbon audit. Without the baseline, hotel is not able to identify the actual carbon reduction if the retrofit programmes are implemented. Usually the general practice for selecting the baseline and reporting period is using a year or 12 months, e.g. clause 2.20 note in ISO14064-1 has mentioned that base-year emissions may be quantified based on a year, while Carbon"Less" also clear defines 24 months as the carbon audit period with 12 months as baseline period and another 12 months as reduction period, however it is not necessary to be consecutive. The requirement of baseline and reporting period with different programmes is in table 2:

Table 2: Baseline and reporting period requirements in different programmes

	ISO14064-1*	HK Guideline	Carbon"Less"	CarbonSmart
Baseline period	✓	×	✓	×
Reporting period	✓	✓	✓	✓

*Usually the first reporting period of using ISO14064-1 will be treated as baseline period for next year.

2.5 Type of GHGs and identify GHG emission sources

Hotels shall identify what type of GHGs to be covered and its sources resulting in its scope 1, 2 and 3 emissions. Following the current international practice, six types of

GHGs will be reported including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs). In fact, the idea of six types of GHGs rooted from Kyoto protocol. In practice, many standards / programmes will report these six types only despite the fact that other GHGs, e.g. R-12, R-22, and so on, are in use.

For scope 1 direct emissions, it can be further categorized into four areas: stationary, mobile, fugitive and process emissions: It is noticed that despite mobile cars are controlled by hotel, if it is not dedicated to and from the hotel for assigned service, those emissions may not be necessary counted. In addition, if biomass combustion is happened in scope 1, e.g. biodiesel, the CO_2 emissions will be required to report separately and will not go to the total scope 1 emissions according to the clause 4.2.2 in ISO14064-1. However, there is no mention how to treat biomass combustion for those HK GHG programmes. It should pay attention that the CH_4 and N_2O emissions due to biomass should not be ignored and required to include in the inventory. The following summary table (table 3) identifies most of the emission sources which can be found in hotel sector:

Table 3: Emission sources in hotels

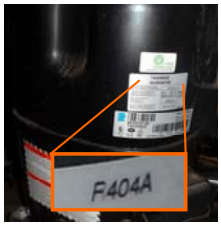
Scope 1	Stationary	Boiler	Gen-set	Stove (Towngas)	Outdoor Heater
					
	Mobile	Shuttle Bus		Private Car	
					
	Fugitive	Chiller	Refrigerator	Fire Extinguisher	WD-40
					
	Process & Other	Cassette Gas	Gel Chafing Fuel	Charcoal	Acetylene
					
Scope 2		Purchased Electricity		Purchased Towngas	
Scope 3		Paper Waste	Fresh Water	Sewage	
					

Table 4: Type of GHGs emitted in Scope 1:

Category	Emission Source	GHG(s)
Boiler	Diesel / Towngas	CO_2, CH_4, N_2O
Gen-set	Diesel	
Stove	Towngas / LPG	
Outdoor Heater	LPG	
Shuttle Bus	Petro / Diesel	
Private Car	Petro	
Chiller	R134a / R22	HFCs / HCFCs*
Refrigerator	R134a / R404A / R502	
Fire Extinguisher	CO_2 / FM200#	CO_2 / HFCs / HCFCs
WD-40	CO_2	CO_2
Cassette Gas	Butane	
Gel Chafing Fuel	Diethylene Glycol / Methanol	
Charcoal	Hydrocarbon	
MAPP Gas++	Mixture of LPG (56%) and Methlacetylene-propadiene (44%)	
Safety Gas	Butane	
Acetylene	C_2H_2	

*HCFCs – Hydrochlorofluorocarbons

#FM200 – HFC227ea

++MAPP Gas -- use for maintenance purpose

It is noticed that perchloroethylene (C_2CL_4) is generally found to be used as solvent in dry cleaning process. Although it is not classified as GHG, it will contribute a certain extend of ozone depletion potential (ODP) effect. Special handling is also required with repeated contact may cause drying or flaking of skin.

2.6 Use of appropriate emission factors (EFs) and global warming potential (GWP)

EFs for scope 1direct emissions are generally available from local sources. For example,

EFs for various fossil fuels in both stationary and mobile combustion can be found in HK Guideline. EFs for scope 2 energy indirect emissions clearly depend on the fuel mix and efficiency of the power and towngas plants. This gives the EF changing time to time. But these values are available and can be obtained from the respective energy suppliers. For example, CLP Power and Towngas will release the EF figures annually. However the EF from Power Assets Holding Limited will be derived from kWh sold and total CO_2 emissions which are assessed from annual and sustainability reports.

Table 5: EFs of different energy suppliers in scope 2

	2009	2010	2011
CLP ($kgCO_2e/kWh$)	0.56	0.54	0.59
Power Assets ($kgCO_2e/kWh$)	0.84	0.79	0.79
Towngas ($kgCO_2e/unit$)*	0.6284	0.6196	0.6179

*One unit of Towngas is equivalent to 48MJ.

EF for scope 3 is a little more complicated. Some of these factors can be found from the service providers. For example, per passenger per ground km (pkm) air travel can be obtained from various airliners, say, Cathy Pacific, British Airline or Finnair. Emission per pkm for air flight information can also be obtained from various flight emission calculators and are available from IPCC guidelines and national authorities such as DEFRA (Department for Environment, Food and Rural Affairs) UK. On the other hands, others may be more difficult especially when it comes to local traveling, for example,

employee commuting to work. In order to account for this particular emission, the distance between bus stations must be known. Together with the per passenger per km emission factors, the respective emission can also be calculated. These values may not available for most countries and cities however, but proxy data can be used in such cases.

For GWP values, the requirement of ISO14064-1 is different from other GHG programmes, summary is in table 6:

Table 6: GWP values for different programmes

	GWP
ISO14064-1	Not specific but latest GWP is usually recommended unless other specifications , i.e. Fourth Assessment Report (AR4)
HK Guideline	Second Assessment Report (SAR)
Carbon"Less"	
CarbonSmart	

2.7 Identify calculation methodology

GHG quantification should be based on the emission quantification methods that are most appropriate or application for the industry and should be consistent and accurate. Quantification of GHG emissions can be divided as the following methodologies:

a). In general case, GHG activity data (AD) multiplied by EF and GWP to have CO_2e.

$$i.e.\ Carbon\ Footpr\,\mathrm{int} = \sum_i^n (AD_i\ x\ EF_i\ x\ GWP_i)$$

b). For some specific emission sources, like butane, charcoal, methanol gel and acetylene combustions which commonly was found in hotel, mass balance

approach will be the appropriate method in quantification.

$$e.g.\ Gel\ Chafing\ Fuel\ (\text{diethylene glycol}):$$
$$(HOCH_2CH_2)_2O + 5O_2 \rightarrow 4CO_2 + 5H_2O$$
$$\therefore EF = \frac{176}{106} \approx 1.66$$

c). It is possible to use of models for calculation; however it is not very common to be applied in hotel sector. On the other hands, the GHG quantification for semi-conductor industry will use quite a lot of modeling technique in calculation.

d). Sometime, measurement, either for continuous (e.g. continuous emissions monitoring system) or intermittent (e.g. coal carbon content) will be considered. However, it is also not common to be used in hotel sector but for petroleum industry.

2.8 Verification

As the carbon inventory eventually produced by Hotel is generally regarded as assertion, recognition of such assertion is necessary and the need for 3rd party verification and certification is obvious. The verification process can take reference to ISO14064-3. This part of the standard established a process for GHG verification, regardless the inventory was developed under ISO14064-1 or not. It is also applicable the verification is being conducted by 3rd part or by a hotel's internal auditor. Nevertheless, there are several benefits associated with verification of GHG emissions: Credibility, Integrity, Transparency and Financial.

Credibility: Especially conducted by 3rd party, this has implications for decision of

intended users such as customers, shareholders and insurance companies.

Integrity: Ensure the GHG data is faithfully represented, contains no materiality.

Transparency: If the GHG emission data is reporting to public, this shows a commitment to environmental transparency and accountability.

Financial: 3rd party verification enables the opportunity to participate in emissions trading schemes such as CDM (Clean Development Mechanism) projects under the Kyoto protocol.

Sometimes, verification exercise can provide significant added values for hotel to identify opportunities for energy consumption saving and process improvement. It also provides a better understanding of how different departments interact and improve the internal communication mechanism, etc.

3. Benchmarking, Recommendation and Carbon Reduction Measurements:

Hotels, have identified their carbon footprint, should consider “directed actions” to reduce their carbon emissions. Most hotels may have energy saving as a regular practice, therefore an understanding on their GHG emissions can be a good start. The pie charts below demonstrate the carbon emissions in different areas with results in 2011:

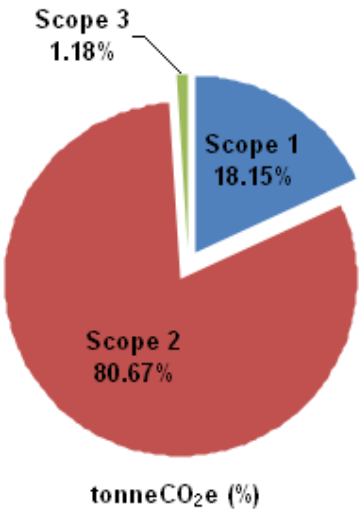
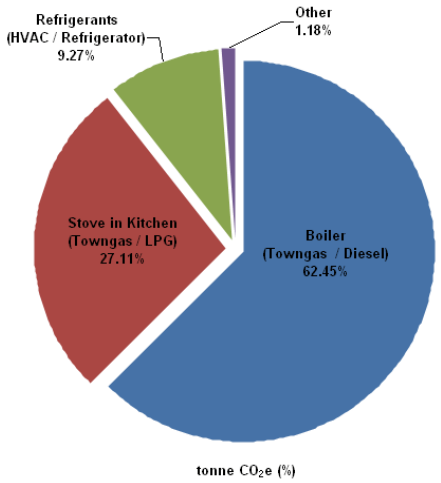
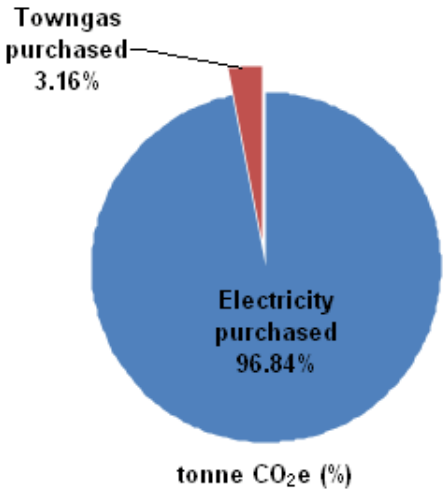


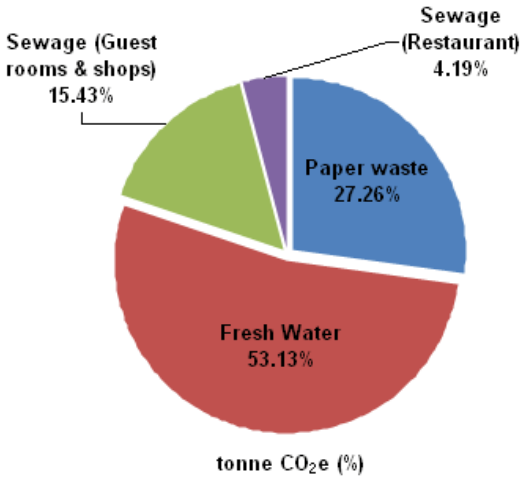
Figure 2(a): Overall GHG emission



2(b): Scope 1 distribution



2(c): Scope 1 distribution



2(d): Scope 3 distribution

It was expected that major emissions were found in scope 2 in figure 2(a). Focusing on scope 1 emissions, boiler consuming towngas or diesel would be the significant source, while fuel used in kitchen and refrigerant would also be other main sources. In scope 3 distribution, emission by fresh water processing contributed more than 53% followed by paper waste emission.

Regarding to the benchmarking, hotels in Hong Kong can make reference to the

EarthCheck as one of the benchmarking tools for their GHG reporting. The EarthCheck Indicators are benchmarked by directly evaluating the organization's performance against a relevant activity measure. In all accommodation sectors defined in the EarthCheck, the GHG emissions are benchmarked against the Guest Nights (primary activity measure). In this project, the carbon indicators evaluated were ranged between 12.19 to 27.35 kgCO_2e per guest night.

Nevertheless, with the above data analysis, certainly, hotels may start with energy efficiency programmes first as perhaps a cost cutting consideration. Based on the experiences in implementing energy saving programme in the hotels in Hong Kong, management can focus in some key areas as follows:

1. Energy management system (EnMS), e.g. ISO50001:2011, together with water management, should be developed and fully implemented in the hotels. It is recommended to integrate the EnMS and water management into hotel's overall management system (if available) and treated them as important as other management functions.
2. Clearly define the energy policy, significant energy use (SEU), energy performance indicators (e.g. Energy Use Intensity, EUI, with MJ/m^2 or kWh/m^2), energy objectives, energy targets and energy management action plan. All these parameters are actually helping hotel in monitoring, measuring and improving energy performance. It

is noted that the objectives and targets should be consistent with the energy policy. Targets should be consistent with the objectives, e.g. in table 7:

Table 7: Example of setting SEU, energy objective and target

SEU	Objective	Target	Energy Management Action Plan	
			Operation Control	Monitoring & Measurement
HVAC	Reduce the HVAC electricity consumption	3% reduction compare to baseline	✓ Optimize AHU control ✓ Set temperature control ✓ Regular filter cleaning ✓ Establish the standard operation procedure (SOP)	Monitoring the meters & monthly cooling degree day (CDD)

3. All staff should be trained and encouraged to get involved in energy and water management and regularly conduct communication to staff to raise their awareness of energy saving issues. Good housekeeping practices should also be exercised in all departments.
4. Compulsory sub-metering is highly recommended to monitor consumption in energy intensive facilities and reserve budget to adopt advanced energy efficient equipment including lights (e.g. T5 or LED), chillers (e.g. water cooled type), energy efficiency motors (e.g. variable frequency drive motors), renewable energy (e.g. solar heater), etc.
5. Apart from the above managerial and technical procedures for energy reduction, inclusion the accounting of ozone depleting substance (ODS) is also recommended for hotels, which includes chlorofluorocarbons (CFCs), bromofluorocarbons (halons),

and hydrochlorofluorocarbons (HCFCs). Although Hong Kong Government has provided a statutory framework for the control of ODS, it can still be seen installed somewhere in the hotel. Hence accounting those emissions can provide a better control of its consumption and develop the phase out schedule to minimize the effect on stratospheric ozone.

4. Conclusions:

In this paper, we outlined and discussed the systematic approach to conducting carbon audit for hotel sector, using a case study of carbon audit for one of Hong Kong's major hotel groups as an illustration. Key technical issues in carbon audit management, such as the use of technical guidelines for carbon audit, emission source identification, emission factor and GWP applications as well as carbon reduction initiatives have been discussed and examined. Through practical experiences and sharing with hotel sector practitioners, it is understood that carbon audit practices, in addition as a technical best practice in green hotel management, can also potentially achieve the following longer-term benefits to hotel owners and operators in Hong Kong.

Firstly, as an emerging new practice, carbon audit serves as an intangible and assurance exercise with respect to the subscribed standard or programme. Although climate change regulation is still on its infancy stage in Hong Kong (as compared to some countries such as the UK, Japan, etc.), international GHG standards such as

ISO14064-1 and pilot carbon management programmes by the HKSAR Government provide shining new and meaningful platforms for businesses in Hong Kong, hotel industry included, to start implementing low-carbon business practices such as carbon audits. Some hotels may have already been reporting their GHG emissions to their headquarters in the past years (Cheung and Fan 2013), it would be until the wider and more systematic adoption of ISO14064-1 and/or the HK guideline among business community in Hong Kong that will lead the climate-friendly business processes to take root at further depth and boost further performance for enhancing overall green productivity of hotel industry in Hong Kong.

Furthermore, as climate change and rising electricity costs become real competitiveness issues for businesses in Hong Kong in 2012 onward, the need for proactive energy management becomes increasingly more pressing for hotel managers. While hotel owners and managers will seek ways for achieving energy efficiency, and hence cost savings and improved productivity for their hotels, a comprehensive approach such as the establishment of an EnMS would be a good starting point for hotels to identify areas of potential savings and improvement opportunities. With new energy saving techniques in space-conditioning, lighting, vertical transportation system etc. for building sector (and hence hotels) coming into the market, hotels can use EnMS as an important measure to ensure the continual improvements in energy performance.

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