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Mandatory Reporting of Greenhouse Gas Emissions from Buildings: Stakeholders' Opinions in Hong Kong

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Abstract

Mandatory reporting of greenhouse gas (GHG) emissions, which is intended to help combat global warming, has been increasingly implemented across the world. For buildings in Hong Kong, however, GHG reporting remains entirely voluntary even though the government has issued a set of guidelines to facilitate building owners and managers to quantify GHG emissions from buildings. Aimed at understanding stakeholders' opinions on whether, and to what extent, the GHG reporting should be made mandatory, a study involving a questionnaire survey was carried out. Analysis of the opinions revealed that the majority supported making the reporting mandatory for office, hotel/hostel, and industrial buildings. Generally more support was received from those who were highly experienced, employees of non-government public organisations, academics/researchers, or qualified carbon/energy auditors. Their agreement on requiring reporting of activities under scopes 1 and 2 of the GHG Protocol was stronger than that for the scope 3 activities. Reporting of paper waste disposal attracted the weakest support. The reasons for not supporting the mandatory policy, including resource constraint and financial and knowledge barriers that confront the stakeholders, were identified. The findings of this study serve as reference for energy policy makers.

Keywords: building stakeholders; greenhouse gas; mandatory reporting.

1. Introduction

Climate change, an escalating environmental problem, is attributed to the increasing greenhouse gas (GHG) emissions across the globe. Man-made activities that give rise to the emissions include combustion of fossil fuel for energy generation, release of refrigerants from mechanical equipment, landfill waste decomposition, and so on. While most of the emissions are inevitable by-products of various economic activities nowadays, more and more stakeholders have started to find ways for reducing their generation. This is not only a social responsibility but also a key to sustainable development.

Quantification of the GHG emissions associated with resource-consuming activities, such as building operations, is essential to understanding the impacts they impose on the environment. Proper documentation of the quantified amounts of GHG emissions, also known as GHG reporting, has been increasingly implemented by local governments as well as large organisations since the late 1990s (Kauffmann et al., 2012). For instance, over 80 company GHG reporting methods and initiatives were identified as being in use around the world, among them some are prescribed by the law and some are taken on a voluntary basis (EuroC, 2010).

In many developed places, more and more studies on environmental reporting have been carried out. In the United States, for example, Brewer (2004) analysed the results of various public opinion surveys, showing that a majority of the public prefers mandatory, instead of voluntary, reduction of GHGs. In Australia, a study was conducted by Bubna-Litic (2008) to examine, in the context of corporate accountability, the effect of mandatory corporate environmental reporting. It was found that the less-than-optimal quality of the reporting was a

result of the lack of regulatory enforcement. In the United Kingdom where there was a public consultation to the Climate Change Act 2008, Scheer and Höppner (2010) completed a critical analysis and recommended that it is necessary to have a closer match between the government's normative rationale, citizen's substantive intent and the consultation design.

Among the metropolises around the world, Hong Kong has a remarkably high density of buildings. A review study (Leung and Lee, 2000) showed that carbon dioxide accounts for 90% of the GHG emissions in Hong Kong. The past effort on curbing the emissions, however, appeared to be lax; even the publication of Hong Kong's emission data was found lagging behind the other modern cities (Kennedy et al., 2012). Until recently, people in Hong Kong have become progressively aware of the mounting demand for GHG reductions. In 2008, the Hong Kong Government first issued a set of guidelines to facilitate building owners and managers to quantify and report the GHGs emitted/removed from their buildings. To date, the guidelines remain as a voluntary initiative and it is entirely up to the individuals to decide whether to adopt the guidelines.

Hong Kong is a community governed by the rule of law (Wesley-Smith, 1998). Whenever it is necessary to introduce a new policy or some amendments to the existing legislation, the government would seek the opinions of society, typically by means of consultation (DOJ, 2012). The introduction of amendments to the Lifts and Escalators (Safety) Ordinance, which was intended to enhance the safe use and operation of the lifts and escalators in numerous high-rise buildings in Hong Kong, serves as an example. In an attempt to collect the views of the stakeholders on the proposed amendments to that Ordinance (Lai, 2013a), a survey was conducted and the result matched well with that of the public consultation organised by the government.

Drawn upon the experience of the above survey, a study was initiated to investigate whether the stakeholders of GHG reporting for buildings in Hong Kong agree to make it mandatory and, if so, the extent to which it should cover. At the initial stage of the study, an extensive search and review of literature and website information was carried out in order to understand the development of the GHG reporting schemes of various developed countries; identify the characteristics and scopes of applications of such schemes; and find out any precedents of regulating GHG reporting that can be taken as reference for the current study.

Shown in the ensuing section is a review of the major overseas GHG reporting schemes, followed by an overview of the situation of GHG emissions, carbon reduction initiatives and reporting guidelines in Hong Kong. Then the design of the questionnaire used for a stakeholder survey under the study and the demography of the respondents are reported. The responses collected, including the various stakeholder groups of supports to making the reporting mandatory for buildings and their opinions on the coverage of the reporting scheme, are analysed and discussed. At the end, the conclusions drawn from the study are given.

1.1 Overseas reporting schemes

Earlier the Royal Institution of Chartered Surveyors has commissioned the Global Zero Carbon Index to gauge the performance of various countries in making progress towards zero carbon built environments (RICS, 2011). The Index, determined by using robust data from the International Energy Agency and World Bank, comprises three sets of indicators, including one that takes into account the policy frameworks that individual countries have established to promote carbon reductions. Meanwhile, the Organisation for Economic Co-operation and Development has conducted a stocktaking of government schemes on

corporate GHG reporting. The result, as reported in Kauffmann et al. (2012), revealed that a number of governments had established voluntary or mandatory GHG measurement and reporting schemes over the past decade. Such mandatory schemes include: GHG Emission Reporting Scheme (Canada), Mandatory GHG Accounting and Reporting System (Japan), National Greenhouse and Energy Reporting System (Australia), the UK GHG Reporting System (United Kingdom), and Greenhouse Gas Reporting Program (United States). The key features of these schemes were reviewed, as reported in the following.

1.1.1 Canada

In March 2004, the Government of Canada adopted a phased approach to launch the GHG Emissions Reporting Program (GHGRP). Under the authority of the Canadian Environmental Protection Act 1999 (CEPA 1999), a Gazette notice is published every year, outlining the GHG reporting requirements for the year specified in the notice. The Program, enforced by the Government (specifically Environment Canada), is to: provide Canadians with information on GHG emissions; validate estimates presented in the National Greenhouse Gas Inventory; support provincial and territorial requirements for GHG emissions information; and support the development of regulations (EC, 2014).

The GHGRP provides that a facility is subject to the reporting requirements if its total direct emissions of GHGs meet or exceed the reporting threshold. In order to determine whether a facility is subject to the requirements, it is necessary to calculate its total emissions for the relevant year for the GHGs and emission sources covered. At the time of this writing, the reporting threshold was 50 kilotonnes of CO_2 equivalent, which was reduced from the

threshold of 100 kilotonnes in 2009. For facilities not meeting the reporting threshold, they are encouraged to report their emissions on a voluntary basis.

1.1.2 Japan

According to the Industrial Efficiency Policy Database (2013), Japan introduced in 2005 the Mandatory Greenhouse Gas Accounting and Reporting System based on the revised Act on Promotion of Global Warming Countermeasures (Act No. 117 of 1998). Aimed at promoting voluntary emissions-reduction efforts of emitters through assessment of the current GHG emission levels, the system became effective on 1 April 2006 (KMIP, 2013). It requires specified entities (which emit GHG emissions above a defined threshold) to calculate their GHG emissions and report the results to the Government.

Under the system, "specified establishment emitters" are those that consume more than 1,500 kl energy per year by crude oil equivalent; conduct business activities with each establishment emitting 3,000 tons or more CO_2 by type of greenhouse emission gas; and employ 21 or more staff in total. Another category, referred to as "specified transportation emitters", are those that fall in the transportation sector. Such emitters include specified freight carriers, specified consigners, specified passenger carriers, and specified air carriers under the Act on the Rational Use of Energy. At the end of fiscal year 2010, there were 11,034 operators (12,846 establishments) the specified establishment emitter category and 1,399 operators in the specified transportation emitter category (IEPD, 2013).

1.1.3 Australia

The legislative framework for the National Greenhouse and Energy Reporting (NGER) system in Australia was established under the National Greenhouse and Energy Reporting Act 2007, the Regulations under that Act and the National Greenhouse and Energy Reporting (Measurement) Determination 2008. There are two sets of objectives of the NGER system, with the first set comprising: a) informing government policy formulation and the Australian public; b) meeting Australia's international reporting obligations; c) assisting Commonwealth, State and Territory government programs and activities; and d) avoiding the duplication of similar reporting requirements in the States and Territories. The second objective is to underpin the Clean Energy Act 2011 by imposing various registration, reporting and record keeping requirements (AG, 2013).

The NGER system requires that for corporations whose energy production, energy consumption, or greenhouse gas emissions meet certain specified thresholds, they have to report their GHG emissions on a mandatory basis. The thresholds are detailed in section 13 of the NGER Act and in supporting material available on the Clean Energy Regulator website. To assist corporations to evaluate whether or not they should apply for registration under the NGER Act, an online tool called National Greenhouse and Energy Reporting System Calculator (NGER calculator) has been devised. Corporations, once registered, need to submit reports through the Online System for Comprehensive Activity Reporting (OSCAR), which is a web-based tool enabling a corporation to calculate its GHG emissions.

1.1.4 United Kingdom

The UK government, following a public consultation in 2011 where the majority supported making the reporting mandatory, announced in June 2012 the introduction of a statute

requiring reporting of GHG emissions by the quoted companies. A consultation, which was set to end in October 2012, was launched to seek views on the regulations drafted (DEFRA, 2012). Since 1 October 2013, the Companies Act 2006 (Strategic and Directors' Reports) Regulations 2013 has required quoted companies to report their annual GHG emissions in their directors' report. Quoted companies are those that are UK incorporated and whose equity share capital is officially listed on the main market of the London Stock Exchange; or is officially listed in a European Economic Area; or is admitted to dealing on either the New York Stock Exchange or NASDAQ (CT, 2014)

Although there is no prescribed measurement methodology under the regulations, robust and accepted methods should be used for effective emissions management and transparency in reporting. According to the recommendations of CT (2014), companies need to ensure that a suitable, widely recognised independent standard is used, such as the GHG Protocol Corporate Standard. Moreover, the accounting approach should cover emissions from all activities for which the companies are responsible globally and all relevant greenhouse gases should be included.

1.1.5 United States

For the purpose of gathering accurate and timely GHG data to inform future policy decisions, the Environmental Protection Agency of the United States issued the Mandatory Reporting of Greenhouse Gases Rule (74 FR 56260), i.e. 40 CFR Part 98 (Part 98). Implementation of Part 98 is referred to as the Greenhouse Gas Reporting Program (GHGRP), with its scope covering suppliers of certain products that would result in GHG emissions if released, combusted or oxidized; direct emitting source categories; and facilities that inject CO_2

underground for geologic sequestration or any purpose other than geologic sequestration. Facilities that emit 25,000 metric tonnes or more per year of GHGs are required to submit annual reports to EPA (EPA, 2013).

In 2010, categories subject to Part 98 began reporting their yearly emissions. Reporting of the emissions to EPA via the electronic greenhouse gas reporting tool (e-GGRT) was commenced in September 2011. In January 2012, the first year of GHGRP reporting data were made public through the Facility Level Information on GreenHouse gases Tool (FLIGHT), which is an interactive Data Publication Tool of EPA. Additional sources began reporting their yearly emissions in September 2012, bringing the total source categories to 41.

1.2 The Hong Kong situation

Referring to the latest available statistics of the Environmental Protection Department (EPD, 2013), the total volume of GHG emissions of Hong Kong in 2009 was 42,900 kilotonnes of CO_2-e, which represents a 28.8% increase from the volume emitted in 1999. The majority of the GHG emissions were due to electricity generation, followed by transport, other end use of fuel, waste, and others. Figure 1 depicts the trend of the emissions. In fact, even with the GHG emissions due to consumption of imported goods and those arising from aviation and shipping excluded (Harris et al., 2012), the emission level remains high, at 6.26 tonnes per capita (IEA, 2009).

Being a member economy of the Asia-Pacific Economic Co-operation (APEC), Hong Kong has committed to achieving a reduction in energy intensity of at least 25% by 2030 (with 2005 as the base year), as set out in the APEC Leaders' Declaration on Climate Change,

Energy Security and Clean Development (APEC, 2007). Without energy-intensive industries, Hong Kong is a service economy where electricity generation is the major source of GHG emissions. It is well recognized that a huge potential of carbon dioxide mitigation lies in the building sector (Ürge-Vorsatz and Novikova, 2008). Given that the building sector accounts for 89% of the end uses of electricity, reducing electricity consumption for building operations is crucial to mitigating GHG emissions.

Over the years, the Hong Kong Government has taken a series of initiatives to promote building energy efficiency and hence carbon reduction (HKGBC, 2011), including:

i. introduction of the Hong Kong Energy Efficiency Registration Scheme for Buildings in 1998 to promote voluntary compliance with the Building Energy Code;
ii. promotion on the use of water-cooled air-conditioning systems by publishing a code of practice in 2006;
iii. operation of the "Green Hong Kong • Carbon Audit" campaign in 2008, to enroll various organisations from different sectors of the community to be the "Carbon Audit • Green Partners" to undertake carbon audits and initiating carbon reduction programmes for their buildings;
iv. implementation of the Buildings Energy Efficiency Funding Schemes in 2009 to provide subsidies of HK$450 million on a matching basis to private building owners to conduct energy-cum-carbon audits and energy efficiency improvement projects in buildings; and
v. Government to lead by examples by launching a comprehensive target-based Green Performance Framework in April 2009 for new and existing government buildings.

The Environment Bureau of the government further rolled out a public consultation on "Hong Kong's Climate Change Strategy and Action Agenda" (HKSAR, 2010). In that consultation, it was proposed to adopt a voluntary carbon intensity reduction target of 50% - 60% by 2020 as compared with 2005 level. In order to more holistically address the demand-side management of energy use in buildings, the Council for Sustainable Development launched a public engagement on "Combating Climate Change: Energy Saving & Carbon Emission Reduction in Buildings" between August and December 2011 (HKSAR, 2011).

Particularly, the Environmental Protection Department and the Electrical and Mechanical Services Department jointly issued in 2008 the "Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes)", which aims to help building owners and managers to measure GHG emissions from buildings. This guidance document was revised in 2010 to become the current Guidelines (EPD-EMSD, 2010). Defined in accordance with the reporting framework of the GHG Protocol (WRI-WBCSD, 2004) and the International Standard on Greenhouse Gases (ISO, 2006), the Guidelines cover six types of GHGs included in the Kyoto Protocol under the United Nations Framework Convention on Climate Change, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). The emissions and removals covered by the Guidelines, classified into three scopes under the GHG Protocol, are summarised in Table 1.

The Guidelines, which is primarily intended for use on commercial (including offices, retails, restaurants, hostels and hotels) and/or residential buildings, can also be applied to institutional buildings such as schools, universities, community centres, and sports complexes. The Guidelines are basically designed for self-assessment and self-reporting by

the reporting entities of buildings, yet third parties may also be employed to assess the GHG emissions/removals. Since in practice it may be difficult to obtain the necessary data for quantifying the indirect emissions under scope 3, therefore the Guidelines provide that reporting of such emissions is optional.

While a broad range of legislations has been enacted to govern the design, construction and maintenance of buildings in Hong Kong (Lai et al., 2011), adoption of the Guidelines for GHG reporting is entirely voluntary. A pilot empirical study on a hotel building found that there was insufficient motivation to implement carbon audit (Lai et al., 2012). A further study showed that in order to enable optimization of carbon footprints of buildings, it is necessary to have wider implementation of GHG reporting and analysis of the reported footprints (Lai, 2013b).

2. Methods

2.1 Questionnaire design and data collection

It is evident from the above review that there have been increasing regulatory controls over GHG reporting in various developed places and that the GHG emissions of Hong Kong are largely associated with the consumption of resources for buildings in use. In order to seek the opinions of building stakeholders on whether, and to what extent, the GHG reporting for buildings in Hong Kong should be made mandatory, a survey was carried out. For this purpose, a questionnaire comprising four sections was designed; an abridged sample of the questionnaire is shown in Appendix A. Under section 1, the respondents were asked to provide information about their personal particulars, including length of work experience,

employer type, work nature, types of building/premises they worked on, and professional and academic qualifications. Section 2 asked about the scope of physical boundary, including building types and areas (communal or tenant), to be covered in mandatory GHG reporting. Answers to the questions refer to a bipolar scale, which ranges from -5 (totally disagree) through 0 (neutral) to +5 (totally agree). Opinions on the extent of mandatory reporting of GHG emissions/removals (under scopes 1, 2 and 3 of the GHG Protocol) were collected by the questions in Section 3. The questions in this section used the same bipolar scale as described above; the respondents were also asked to indicate their reasons if they disagree to any of the questions. Finally, an open-ended question was included in Section 4 to allow the respondents to express any other views not covered by the preceding sections.

The questionnaire was pilot-tested and the comments received were taken to refine the questions. It was noted that the types of building stakeholders spread over a wide spectrum. They include: representatives of building developers and owners; practitioners in the fields of building design, construction and facility management; academics and researchers of the building-related disciplines; and building end-users. Because the questionnaire comprises questions designed based on contents of the GHG reporting guidelines (EPD-EMSD, 2010), ordinary building end-users, most of whom being laymen without technical knowledge of measurement and reporting of GHG emissions, would find it hard to understand the questions. Therefore, the others of the above stakeholder groups including building designers and facility managers, who possess relevant technical backgrounds and realise user requirements and operations of buildings, were selected as target respondents.

A self-administered survey, which is useful for obtaining responses from large groups of respondents (Sekaran, 2003), was conducted on two occasions: a seminar and a forum. The

topics of these events were about building energy and sustainability and the participants were stakeholders in the building sector. Upon entering the event venues, each participant was given a copy of the refined questionnaire. To enable collection of quality opinions from the respondents, the survey administrator briefed them about the contents of the questionnaire and illustrated how to complete the questionnaire. Then a sufficient period of time was allowed for the participants to answer the questions. At the end of the events the participants were requested to hand in the questionnaires they completed. In total, 200 questionnaires completed with useful data were collected.

2.2 Demography of the respondents

The respondents on average had over 14.4 years of work experience. The majority (42.5%) of them were highly experienced, having worked for 15 years or more. The least experienced (≤ 5 years) group of respondents amounted to one-fourth of the sample; 3.5% were veterans with over 30 years of work experience. Table 2 further shows a summary of the distribution (number and proportion) of their demographic information: company types, and professional and academic qualifications.

The vast majority of the respondents were employed by the private sector. 14.5% were from non-government public organizations (NGO) and 6.5% were government employees. As regards their professional qualifications, 23.5% were registered professional engineers, 6.0% were registered energy assessors, and 5.5% were carbon auditors meeting the requirements for registration as a qualified service provider to certify energy-cum-carbon audit projects under the Environment and Conservation Fund of Hong Kong. On the whole, the respondents

were well educated: 96.0% possessed a bachelor degree or above; and 30.0% had their highest qualification up to the master degree level.

The proportions of the respondents working in the building/facility management, construction/contracting and design/consulting fields were comparable, ranging between 21.5% and 23.5% (Table 3). They collectively represented the majority (67.5%) of the respondents. Among the respondents, those working for property developers or playing a project management role were relatively fewer. A small group (3%) of respondents came from the academic/research sector.

Office was the dominant (67.5%) type of building/premises the respondents worked on (Table 3). The proportions of the remaining building/premises, in descending order, were: residential, retail, hotel/hostel, industrial, school/university, leisure/cultural, and restaurant. Additionally, 12.5% of the respondents indicated that they worked on other types of building/premises that are beyond those listed in the answer options.

3. Results and Discussion

3.1 Overall and subgroups of agreements

Of all the respondents, 72.0% agreed to imposing mandatory requirements on GHG reporting for buildings, with the major group (35.5%) indicating a medium level (rating = +3) of agreement (Figure 2). Those with a neutral stance amounted to 17.5%. Only a small proportion (5.5%) expressed their disagreement. Projecting on this basis, it is likely to obtain

strong support from the stakeholders in Hong Kong if a consultation is launched to seek their views on making the reporting mandatory.

The responses were further scrutinized to reveal the proportions of agreements and disagreements given by different subgroups of the respondents. As Table 4 shows, the majority across the board were generally supportive of regulating GHG reporting for buildings. In particular, the supports among those working for the NGOs were more common than the counterpart among the government subgroup.

When grouped by work nature, less than half of those in the property development/project management sector supported requiring buildings to have mandatory reporting of their GHG emissions. In fact, this subgroup of respondents mainly worked on new building projects but the reporting framework of the Guidelines takes aim at quantifying emissions due to operations of existing buildings. This is a factor for the relatively low support rate among them. On the other hand, all those from the academic/research sector considered it necessary to report the GHGs in a mandatory manner.

The professional qualifications that the respondents were allowed to select were not mutually exclusive to each other. In general, carbon auditors include registered professional engineers (RPEs) having attended relevant training for carrying out carbon audits, where RPEs refer to qualified engineers who have registered under the Engineers Registration Ordinance (Cap. 409). Registered energy assessors (REAs) include RPEs possessing the required experience and qualifications as defined under the Buildings Energy Efficiency Ordinance (Cap. 610). Those who were carbon auditors commonly supported mandatory GHG reporting for buildings. This kind of support was even more commonly found among the REA subgroup.

Most of the respondents with their highest academic qualifications up to the bachelor or master degree level agreed to making the reporting mandatory. But only half of those with a lower academic qualification (sub-degree) indicated their support to this arrangement, and an identical proportion of response was found with the doctorate degree subgroup. Note, however, should be taken that the samples of these two subgroups were relatively small, which limit the representativeness of their views.

To further examine whether the ratings of support differed between the subgroups of respondents, a series of analysis was carried out using the Statistical Package of the Social Sciences software. To this end, non-parametric tests that can analyse subgroups of responses given on an ordinal scale are applicable. Based on the responses to the question on the extent to which the respondent agrees to require mandatory reporting of GHG emissions/removals for buildings, the Mann-Whitney test was used to analyse if there existed significant differences between the following pairs of subgroups: i) "less experienced" and "more experienced"; ii) "government/NGO" and "private" employees; iii) stakeholders working mainly on buildings in the "pre-occupied" stage (property development, design, construction, etc.) and those managing buildings in the "post-occupied" stage (building/facility management); iv) those who were carbon auditor, REA or RPE ("qualified") and those were not ("not qualified"); and v) those with post-graduate qualifications ("postgraduate") and those without ("non-postgraduate"). For many professional disciplines, such as engineering in Hong Kong, it is common for a degree graduate to have at least five years of practice before application for registration as a professional engineer (ERB, 2014). Therefore, the "less experienced" subgroup refers to those who had worked for five years or less and those with over five years of experience belong to the "more experienced" subgroup.

The null hypothesis of the test was that the distribution of ratings in each pair of subgroups was identical. The test results, including the values of mean rank, sum of ranks, Mann-Whitney *U*, *z*, and probability (2-tailed), are summarised in Table 5. For each pair of subgroups, the difference between the mean rank values was not substantial. Further checking on the test statistics found that across the sub-groups, the *p*-values, ranging from 0.489 to 0.871, were all greater than 0.05. Therefore, the null hypothesis cannot be rejected. It can be concluded that there were no significant differences between the distributions of ratings in each pair of the subgroups.

3.2 Types of building/premises

As shown in Figure 3, six in every 10 respondents agreed to implementing mandatory GHG reporting for office building/premises but obviously less (42.5%) of the respondents indicated their agreement on requiring retail building/premises to be bound by the mandatory arrangement. These kinds of building/premises are both occupied by commercial users whose energy consumption significantly outweighs other kinds of energy end-uses. While it may be worthwhile to study in future the causes for the significant difference between the agreements, a factor contributing to this finding is that there are more owner-occupiers in office buildings than in retail buildings. In owner-occupied buildings, the owners have complete control over the recording of data for GHG reporting purposes. Practitioners working on such buildings, as compared to those of the retail buildings with multiple ownerships, would have less difficulty in retrieving the necessary data. This is supported by the observation that the proportions of supports for including tenant area in the scope of mandatory reporting were small for both office and retail buildings.

Unlike commercial buildings which are mainly used by business organizations and customers, residential building/premises are occupied by the general public in society and their operation period extends to cover the night time during which most commercial activities are stopped. However, only about one-forth of the respondents indicated their agreement on implementing mandatory GHG reporting for the residential building/premises. This level of response is ascribable to the following considerations: i) residential activities are basic necessities for daily life so reporting of the GHG emissions associated with such activities should not be regulated; and ii) residential activities are less GHG-intensive than other kinds (e.g. commercial) of activities so the mitigation effect obtainable through regulating the reporting of emissions from residential premises is less significant.

Hotels and hostels are similar to residential buildings in that they have round-the-clock operations. Over half of the respondents, representing the second largest proportion of the responses, expressed their agreement on including these two types of premises in the list of buildings for which GHG reporting should be made mandatory. Because hotels and hostels are typically run by operators to provide non-permanent accommodations for overnight visitors, there is no distinction between communal area and tenant area. No options, therefore, were allowed for the respondents to select between these two areas to which mandatory reporting should be applied.

A proportion of responses comparable to that for the hotel/hostel group supported that mandatory GHG reporting should also be imposed on industrial buildings. Even though the volume of industrial buildings in Hong Kong has substantially gone down as a result of the progressive move of industrial organizations to the mainland China since a few decades ago

(Kristof, 1987), the high intensity of GHG emissions generated from industrial activities should be a key consideration for those who supported the mandatory policy.

Premises used for operating restaurants, as compared with those for office and retail purposes, are more energy-intensive. The intensity of their GHG emissions is thus higher. But only a weak support (31.5%) was given to having mandatory GHG reporting for this type of premises. This is attributable to the phenomenon that restaurants in Hong Kong, upon expiry of their short-term tenancy (usually 1-3 years), are frequently relocated from one venue to another. It is not uncommon that new restaurants even shut down a few months after opening. Besides fierce market competitions, the sky-high property price of Hong Kong (RVD, 2014) is a key factor. Requiring such restaurants to keep sufficient data record for GHG reporting can be problematic.

The proportion of response to the same question for restaurants was almost equal to the counterpart for school/university buildings. The natures and hence operations of these two groups of premises are essentially different. As most of the education institutions have already had some proper reporting mechanisms in place (e.g. HKU, 2011; PolyU, 2013), demanding them to report their GHG emissions simply means imposing a regulatory control on an existing environmental initiative that they have been undertaking. The need of such regulation is trivial, which explains why the rate of support to requiring reporting of GHG emissions from the school/university buildings on a mandatory basis was low.

Same as the preceding groups of buildings (hotel/hostel, restaurant and school/university), leisure/cultural buildings are without distinction between communal area and tenant area. They received the lowest rate of support for mandatory GHG reporting. In fact, most of these

buildings such as public library, sports centre, etc. are managed by the Leisure and Cultural Services Department (LCSD) of the Hong Kong Government. Given that they are government venues and that the LCSD has already practised regular GHG reporting (LCSD, 2014), only a small proportion of the respondents considered it necessary to regulate this kind of reporting for leisure/cultural buildings.

A more detailed analysis was made to find out the proportions of different groups of stakeholders (categorized by the kind of building/premises they worked on) casting their votes to support mandatory GHG reporting for different kinds of building/premises. The results, as summarised in Table 6, shows that the maximum proportion was comparable to the above-reported overall agreement (72%) given by all the respondents, with none of the subgroup proportions exceeding that level of agreement.

Practitioners working on a particular building are familiar with the nature and operational characteristics of the same kind of buildings. Imposing mandatory GHG reporting on their own buildings would mean that they have more work to do in order to comply with the associated statutory requirements. This is a kind of vested interest that may affect their responses to supporting or not the mandatory arrangement. Along this philosophy, the proportions of support given by individual subgroups of stakeholders for the respective kinds of building/premises they worked on were inspected, i.e. the values (asterisked figures) along the diagonal of Table 6. It was noted that over half who considered mandatory GHG reporting should be implemented on their respective kinds of building/premises belonged to those who worked on: office (60.7%), retail (65.3%), industrial (58.3%), hotel/hostel (60.0%), and school/university (56.7%).

In contrast, a relatively low proportion of the residential (30.2%), restaurant (33.3%) and leisure/cultural (40.9%) subgroups agreed to have mandatory GHG reporting imposed on the kinds of building/premises they worked on. These results are in line with the foregoing part of findings (see Figure 3).

3.3 Extent of GHG emissions/removals

The responses to the questions in section 3 of the questionnaire were analysed. Figure 4 shows a summary of proportions of respondents who agreed to, disagreed to, or had a neutral stance on including the various types of GHG emissions/removals in the mandatory reporting scheme. Scope 1 emissions cover those due to stationery combustion sources, mobile combustion sources, and fugitive GHGs release from equipment and systems. Within this scope, stationary combustion (74.0%) and fugitive emissions (65.0%) were supported by most of the stakeholders for inclusion in the mandatory scheme.

Mandatory reporting of emissions due to mobile combustion sources received a comparatively lower level of support (61.5%). Among those who opposed to this arrangement, 48.0% considered it hard to gather the required data for reporting, echoing with the difficulty encountered in an earlier carbon audit study (Lai et al., 2012). Coincidentally, 61.5% of the respondents indicated that they agreed to mandatory reporting of CO_2 removals. The reason given by 48.1% of those who were against this arrangement was it is time-consuming to do so. This is a resource barrier that needs to be overcome before requiring mandatory reporting for such emissions.

Emissions due to consumptions of electricity and town gas, which were both under scope 2, were supported by over 70% of the respondents to be included in the mandatory reporting coverage. Essentially quantification of these emissions, in annual term, entails identification of the corresponding monthly electricity and town gas consumptions as well as the emission factors pertaining to productions of electricity and town gas. The fact that such emission factors for a particular year are given in the annual reports of the respective electricity and gas supply companies in the subsequent year typically leads to delay in the quantification and reporting process. This is a concern for those who expressed their disagreement to making the reporting a statutory requirement.

Disposal of paper waste, classified as part of scope 3, attracted the lowest proportion (59.0%) of respondents who agreed to making its reporting mandatory. A detailed scrutiny of the reasons given by the opposition group revealed that among them, 48.6% considered it difficult to gather the required data for reporting GHG emissions due to disposal of paper. The same difficulty was indeed experienced in the carbon audit study of Lai et al. (2012) where the record of the amounts of paper consumed and paper collected for recycling was incomplete. While a small proportion (14.3%) of the opposition group considered that the amount of emissions due to paper waste disposal is insignificant, the reason that it is time-consuming to report such emissions was indicated by 45.7% of them. With this resource constraint, some 34.3% opined that it is costly to do so. 28.6% even did not know how to calculate the amount of this category of emissions. These financial and knowledge barriers, if not removed, would hinder the implementation of the mandatory reporting policy.

The remaining items in Figure 4, also belonging to scope 3 emissions, are: consumption of fresh water, treatment of waste water discharged, transportation of purchased materials or

goods, business travel by employees, and outsourced activities. Their inclusion in the mandatory reporting scheme was supported by the majority (69.5-70.5%) although, according to the Guidelines (EPD-EMSD, 2010), it is optional to report such indirect emissions. Note, in particular, should also be taken that the types and extents of outsourced activities (e.g. cleaning service, building maintenance etc.) vary from building to building (Yik and Lai, 2006). It is thus difficult to properly trace and record the data of such activities.

4. Conclusions and Policy Implications

The global trend of enforcing mandatory requirement on GHG reporting is on the rise. Hong Kong is among the metropolises where buildings are major energy consumers, leading to significant GHG emissions. Whereas the Hong Kong Government has started to make more effort on promoting energy and carbon reduction for buildings, a set of guidelines on GHG reporting for buildings was not made available until 2008. Its adoption, however, remains entirely voluntary.

Aimed at soliciting the stakeholders' opinions on whether, and to what extent, GHG reporting for buildings should be made mandatory, a self-administered questionnaire survey was conducted. Overall, most of the stakeholders were supportive of making the reporting a mandatory policy but the rate of agreement among those in the property development/project management fields was less than half. The survey result shows that if a consultation on the mandatory policy is to be carried out, it is more likely to get support from stakeholders who are highly experienced, employed by the NGOs, academics/researchers, or qualified for conducting carbon/energy audit.

Only office, hotel/hostel, and industrial buildings were considered by over half of the respondents to be the types of buildings on which the mandatory policy should be imposed. While mandatory reporting for institutional and leisure/cultural buildings received a low rate of support, these buildings are managed by some NGOs or government departments who have already implemented regular reporting of the GHG emissions. In buildings with retail, restaurant or residential premises, there are communal and tenant areas. Given that the communal areas are typically managed by some building/facility management companies, obtaining data for reporting the GHG emissions from such areas is rather straightforward. The frequent change in the occupancy of the premises, however, is a hurdle to keeping sufficient record data for quantification of GHG emissions. This is a practical problem that needs to be overcome before the tenant areas can be included in the scope of the reporting scheme.

Among the activities to be covered by the mandatory reporting, disposal of paper waste received the least proportion of support among the stakeholders. If reporting of this kind of emissions is to be included as part of the mandatory reporting scheme, it is essential to find ways to tackle the time constraint and financial barrier of the stakeholders in recording the purchase and use of paper as well as the collection of paper for recycling. Further studies should also investigate how the knowledge barrier to reporting GHG emissions could be surmounted.

While the scopes of GHG emissions cover a range of activities, the emissions from buildings in Hong Kong are dominated by scope 2 indirect emissions (Lai, 2013b), namely those due to consumptions of purchased electricity and town gas. Reporting such emissions on a mandatory basis, according to the survey result, was supported by most of the stakeholders.

These are some important findings that should be considered in formulating an appropriate mandatory GHG reporting policy, especially if it is necessary to assign priorities to the scopes of emissions to be governed or when the reporting of GHG emissions is to be regulated in phases.

The results of the study identified the agreements of the various groups of stakeholders on enforcing the GHG reporting scheme and their levels of support to covering different types of building/premises and different kinds of activities under the scheme. Such information, which is useful to the policy maker in Hong Kong, can also serve as reference for other cities with intensive energy use and GHG emissions from buildings. When it is necessary to conduct public consultations before enacting legislation on GHG reporting for buildings, a similar approach of the study can be taken to collect and analyse the opinions of the stakeholders.

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Appendix A – Abridged specimen of the survey questionnaire

Section 1

1.1 Work experience: _____ years

1.2 Employer:
- ☐ Government
- ☐ Non-government public organization
- ☐ Private company

1.3 *Main* nature of work:
- ☐ Property development / project management
- ☐ Design / consulting
- ☐ Construction / contracting
- ☐ Building / facility management
- ☐ Academic / research
- ☐ Others (please specify): _____

1.4 Buildings/premises that you currently work on *(tick as many as applicable)*:
- ☐ Office
- ☐ Retail
- ☐ Residential
- ☐ Industrial
- ☐ Hotel / hostel
- ☐ Restaurant
- ☐ School / university
- ☐ Leisure / cultural
- ☐ Others (please specify): _____

1.5 Professional qualification *(tick as many as applicable)*:
- ☐ Certified carbon auditor
- ☐ Registered energy assessor
- ☐ Registered professional engineer
- ☐ Others (please specify): _____

1.6 Highest academic qualification:
- ☐ Associate degree / diploma / certificate
- ☐ Bachelor degree
- ☐ Master degree
- ☐ Doctorate degree
- ☐ Others (please specify): _____

Section 2

2.1 Do you agree to require mandatory reporting of GHG emissions/removals for buildings?

"Disagree" level					Neutral	"Agree" level				
total	high	medium	low	marginal		marginal	low	medium	high	total
-5 ☐	-4 ☐	-3 ☐	-2 ☐	-1 ☐	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

If you **agree**, what buildings/areas should be covered (*tick as many as applicable*)?

☐ Office (☐ Communal area ☐ Tenant area)
☐ Retail (☐ Communal area ☐ Tenant area)
☐ Residential (☐ Communal area ☐ Tenant area)
☐ Industrial (☐ Communal area ☐ Tenant area)
☐ Hotel / hostel ☐ Restaurant ☐ School / university ☐ Leisure / cultural

Section 3

3.1 Do you agree to require mandatory reporting of emissions from stationary combustion sources (e.g. boiler, generator**)**?

← "Disagree" level					Neutral	"Agree" level →				
total	high	medium	low	marginal		marginal	low	medium	high	total
-5 ☐	-4 ☐	-3 ☐	-2 ☐	-1 ☐	0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

If you **disagree**, please indicate your reason/s (*as many as applicable*):

- ☐ Such emissions* are insignificant. {*removals for Q3.4}
- ☐ It is hard to gather the required data for reporting.
- ☐ It is not known how to do so.
- ☐ It is time-consuming to do so.
- ☐ It is costly to do so.
- ☐ Others (please state):

The same response options (above) are provided for the subsequent questions (Q3.2 to 3.12):

3.2 Do you agree to require mandatory reporting of emissions from mobile combustion sources (e.g. shuttle transport provided for staff/guests)?
3.3 Do you agree to require mandatory reporting of fugitive emissions (e.g. release of refrigerants)?
3.4 Do you agree to require mandatory reporting of CO_2 removals (e.g. by planting of trees taller than 5 metres)?
3.5 Do you agree to require mandatory reporting of emissions due to consumption of electricity?
3.6 Do you agree to require mandatory reporting of emissions due to consumption of town gas?
3.7 Do you agree to require mandatory reporting of emissions due to disposal of paper waste?
3.8 Do you agree to require mandatory reporting of emissions due to consumption of fresh water?
3.9 Do you agree to require mandatory reporting of emissions due to treatment of waste water discharged?
3.10 Do you agree to require mandatory reporting of emissions due to transportation of purchased materials or goods, fuels, products and waste, to and from the concerned buildings?
3.11 Do you agree to require mandatory reporting of emissions due to business travel by employees (e.g. for attending local or overseas meetings)?
3.12 Do you agree to require mandatory reporting of emissions from outsourced activities (e.g. cleaning, maintenance)?

Section 4

4.1 Other views / opinions (please state below)

Lai, J.H.K. (2014), Mandatory Reporting of Greenhouse Gas Emissions from Buildings: Stakeholders' Opinions in Hong Kong, Energy Policy, Vol. 75, pp. 278-288.

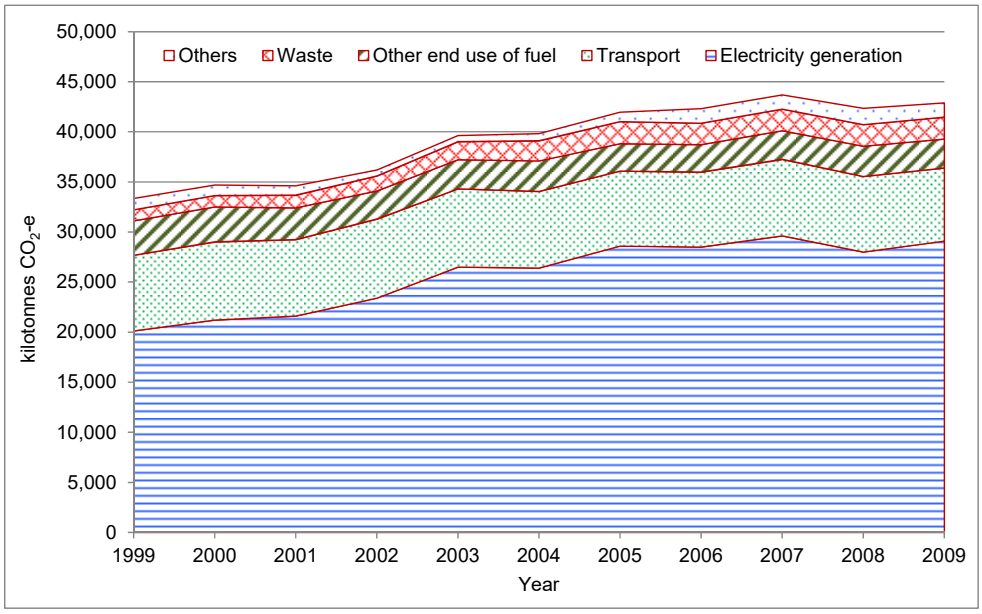

Figure 1: Greenhouse gas emissions of Hong Kong

Lai, J.H.K. (2014), Mandatory Reporting of Greenhouse Gas Emissions from Buildings: Stakeholders' Opinions in Hong Kong, Energy Policy, Vol. 75, pp. 278-288.

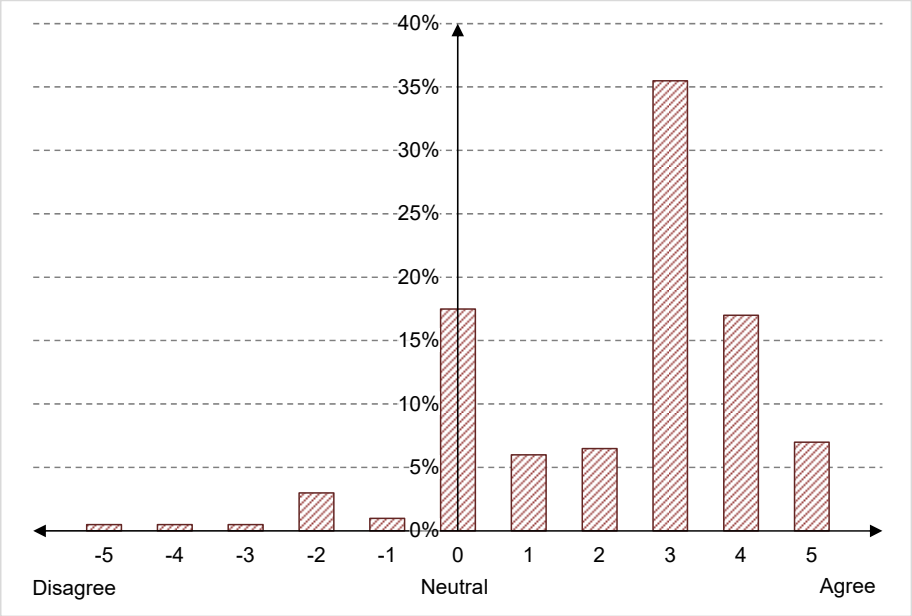

Figure 2: Distribution of responses on mandatory reporting of GHG emissions

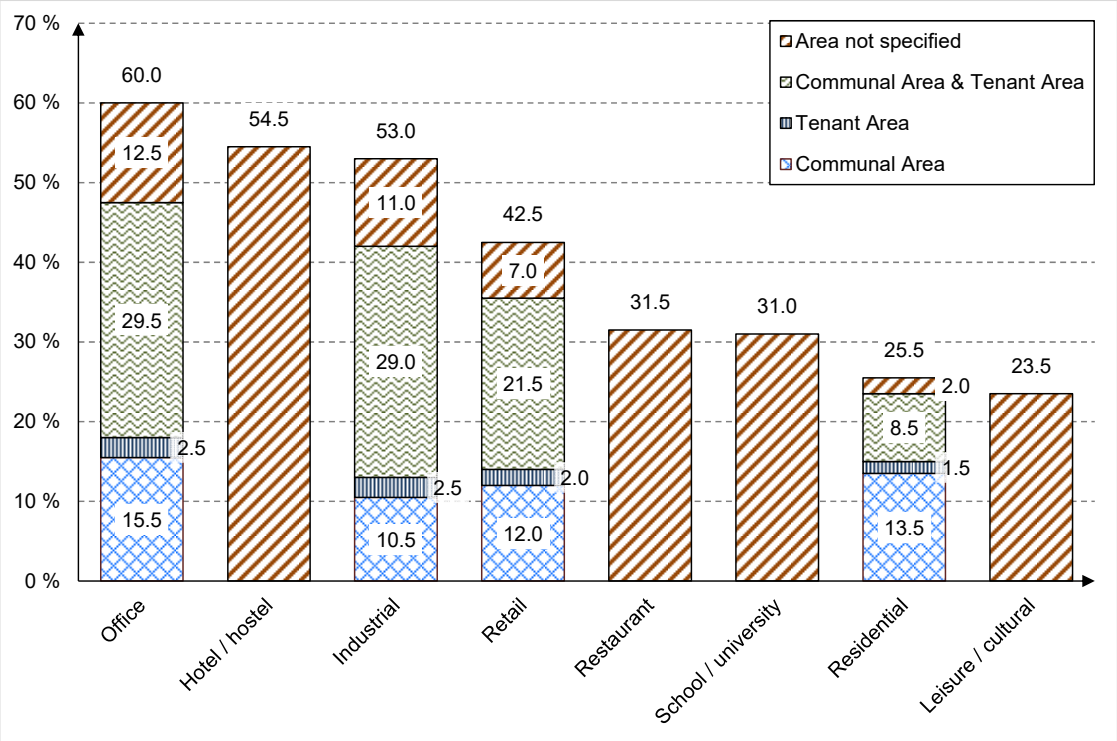

Figure 3: Supports for building/premises types to be covered

Lai, J.H.K. (2014), Mandatory Reporting of Greenhouse Gas Emissions from Buildings: Stakeholders' Opinions in Hong Kong, Energy Policy, Vol. 75, pp. 278-288.

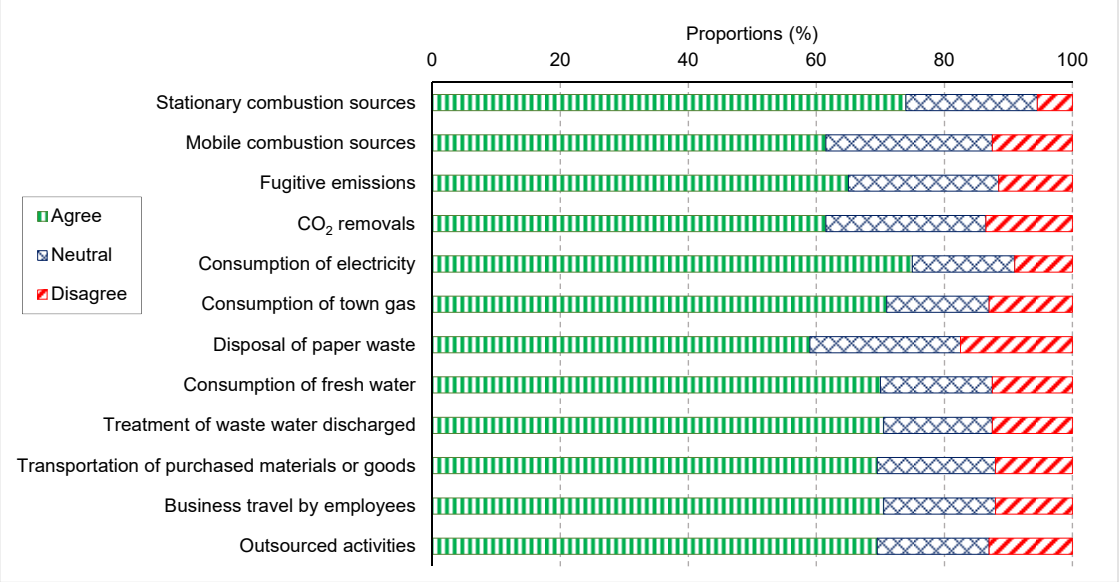

Figure 4: Proportions of opinions on the extent to be covered

Table 1: Scopes of GHG emissions

Category	Activities	Interpretation
Scope 1	Combustion of fuels in stationary sources excluding electrical equipment to generate electricity, heat or steam	This covers emissions from all combustion units (e.g. oil-fired electricity generators, gas-fired boilers) located within the physical boundary which are managed or controlled by the reporting entity.
	Combustion of fuels in mobile sources	This covers emissions from all mobile sources which serve within the physical building boundary, and mobile sources dedicated to provide transportation services for the concerned building (e.g. shuttle bus services provided by the building) should be included in the GHG inventory.
	Fugitive emissions	GHGs (HFC, PFC) released from equipment and systems (e.g. air-conditioning plants, refrigerators) within the physical boundary belong to this group.
	Assimilation of CO_2 into biomass	This caters for CO_2 removed by planting of trees within the physical boundary (e.g. roof, podium garden).
	Any other physical and chemical processing	This varies with the existence of any processes (e.g. chemical product manufacture) leading to GHG emissions within the physical boundary.
Scope 2	Consumption of purchased electricity	While GHG emissions from purchased electricity are physically emitted at off-site facilities where the electricity are converted from fuels and raw materials, the emissions are still a consequence of the activities of the consumer that purchases the energy. Therefore, GHG emissions from the consumption of purchased energy are considered to be "indirect" emissions as they are the indirect consequence of purchase and consumption of electricity.
	Consumption of purchased town gas	Similar interpretation as for electricity (above).
Scope 3	Methane gas generation at landfill in Hong Kong due to disposal of paper waste	CH_4 is generated from decomposition of organic carbon content of paper waste at landfills. The suggested calculation method assumes that the total raw amount of CH_4 emitted (i.e. the amount generated without taking into consideration of collection, recovery and utilization of landfill gas due to the management practices at landfills) throughout the whole decomposition process of the paper waste disposed at landfills will be emitted into the atmosphere within the same reporting period as paper waste collected.
	Electricity used for fresh water processing	This covers indirect GHG emissions due to electricity used for processing fresh water by the Water Supplies Department in its fresh water plants.
	Electricity used for sewage processing	This covers indirect GHG emissions due to electricity used for processing sewage by the Drainage Services Department in its sewage treatment plants.
	Others	Examples of this group of emissions are those due to commuting and business travel by employees; transportation of products, materials, people or waste by third parties; and other outsourced activities.

Table 2: Demography of the respondents

Group	Subgroup	No.	%
Company	Government	13	6.5
	NGO	29	14.5
	Private	157	78.5
	No response	1	0.5
Professional qualification	Carbon auditor	11	5.5
	Registered energy assessor	12	6.0
	Registered professional engineer	47	23.5
	None of the above	130	65.0
Academic qualification	Sub-degree / others	8	4.0
	Bachelor degree	60	30.0
	Master degree	126	63.0
	Doctorate degree	6	3.0

Table 3: Proportions (%) of work natures and building/premises types

Group	Subgroup	No.	%
Work nature	Property development / project management	25	12.5
	Design / consulting	43	21.5
	Construction / contracting	45	22.5
	Building / facility management	47	23.5
	Academic / research	6	3.0
	Others	17	8.5
	More than one of the above	17	8.5
Building/premises [a]	Office	135	67.5
	Retail	49	24.5
	Residential	63	31.5
	Industrial	36	18.0
	Hotel / hostel	45	22.5
	Restaurant	18	9.0
	School / university	30	15.0
	Leisure / cultural	22	11.0
	Others	25	12.5

[a] With some respondents working on multiple buildings/premises, the aggregate proportion exceeds 100%.

Table 4: Proportions (%) of subgroups of responses

Group	Subgroup	Disagree	Neutral	Agree
Work experience	≤ 5 years	8.0	22.0	70.0
	>5 , ≤ 15 years	5.2	24.1	70.7
	>15 years	4.7	21.2	74.1
Company	Government	7.7	23.1	69.2
	NGO	10.3	6.9	82.8
	Private	3.8	25.5	70.7
Main work nature	Property development / project management	12.0	40.0	48.0
	Design / consulting	4.7	20.9	74.4
	Construction / contracting	4.4	22.2	73.3
	Building / facility management	6.4	19.1	74.5
	Academic / research	0.0	0.0	100.0
Professional qualification	Carbon auditor	9.1	18.2	72.7
	Registered energy assessor	0.0	16.7	83.3
	Registered professional engineer	4.3	31.9	63.8
Academic qualification	Sub-degree	16.7	33.3	50.0
	Bachelor degree	8.3	20.0	71.7
	Master degree	3.2	21.4	75.4
	Doctorate degree	0.0	50.0	50.0

Table 5: Summary of Mann-Whitney Test Results

Subgroup	Mean rank	Sum of ranks	*U*	*z*	Sig. (2-tailed)
Less experienced	92.5	4256.5	3175.500	-0.435	0.664
More experienced	96.5	13888.5			
Government/NGO	97.8	4011.0	2918.0	-0.387	0.699
Private	94.2	13944.0			
Pre-occupied	76.4	8094.5	2346.5	-0.162	0.871
Post-occupied	75.1	3381.5			
Qualified	52.9	2804.0	1373.0	-0.691	0.489
Not qualified	57.0	3191.0			
Postgraduate	95.7	12249.0	3687.0	-0.455	0.649
Non-postgraduate	92.0	5517.0			

Table 6: Proportions (%) of support for different kinds of building/premises

Work on	Agree to cover							
	Office	Retail	Residential	Industrial	Hotel/ hostel	Restaurant	School/ university	Leisure/ cultural
Office	60.7*	45.2	28.9	56.3	52.6	32.6	31.9	23.7
Retail	65.3	65.3*	26.5	67.3	61.2	38.8	32.7	22.4
Residential	65.1	50.8	30.2*	57.1	54.0	28.6	31.7	23.8
Industrial	55.6	41.7	27.8	58.3*	52.8	30.6	33.3	25.0
Hotel/hostel	55.6	46.7	31.1	64.4	60.0*	33.3	31.1	26.7
Restaurant	66.7	66.7	22.2	72.2	66.7	33.3*	38.9	27.8
School/university	70.0	60.0	33.3	66.7	66.7	43.3	56.7*	40.0
Leisure/cultural	63.6	50.0	36.4	59.1	50.0	31.8	50.0	40.9*