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Determining Materiality in Carbon Footprinting:

What Counts and What Does Not

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by Eric Ricaurte

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EXECUTIVE SUMMARY

As hotel companies seek in good faith to determine and report their carbon footprints, often in response to stakeholder requests, the issue of materiality arises, in which the hotel firm must determine what factors are important to greenhouse emissions and which are negligible in terms of emissions. The guidance from existing sources on this question is complex and can be contradictory. In addition to examining the boundaries of materiality, this report presents a materiality analysis of two sources of hotel greenhouse gases, fugitive coolant emissions and mobile fuels. Based on data from 154 hotels in 25 countries, neither source appears to be material for most hotels, since neither exceeds the commonly used cut-off point of 5 percent of total emissions. While the circumstances of a particular hotel might render one of these sources material, they do not seem to merit the industry's attention for constant measurement.

ABOUT THE AUTHOR

Eric Ricaurte has helped several global hospitality companies measure and report on sustainability, in addition to his 10 years of experience in operations and consulting in diverse nature and cultural tourism projects throughout Latin America. Eric is a frequent speaker, organizer, and writer in the topic of sustainability measurement within the hotel industry. Eric is currently a research associate at the Cornell University Center for Hospitality Research, where he focuses on sustainability measurement within hospitality and tourism. He began his research as a finalist in the Hotel School's student research competition in 2001 for his paper titled, "Carbon sequestration, offsetting, and trading, and their relation to travel and tourism." His recent industry work includes writing the *Cornell Hospitality Report* "Developing a Sustainability Measurement Framework for Hotels: Toward an Industry-wide Reporting Structure" and serving as technical consultant for Phase 1 of the Hotel Carbon Measurement Initiative, a joint program of the International Tourism Partnership and the World Travel & Tourism Council to standardize carbon metrics across the industry. His chapter, "A Guide to Measuring Sustainability" is included in the American Hotel & Lodging Association Educational Institute textbook *Hotel Sustainable Development: Best Practices and Principles*. Eric has consulted globally for hotel properties; hotel companies; hospitality vendors; tourism operators, attractions and complexes; and tourism boards. Eric earned a Bachelor of Science degree from the Cornell University School of Hotel Administration and a Master of Science degree in Tourism & Travel Management from New York University.

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Climate change, resource scarcity, and evolving consumer demands are putting increased pressure on strategic and operational decisions for hoteliers. Stakeholders are beginning to ask more questions of the hotel stay, brand, and company. At the property level, hotel guests are considering broader environmental impacts of a hotel stay, often by requesting information regarding the hotel's carbon footprint. Certifications and standards have proliferated to facilitate such evaluations, as an evolution in global frameworks allows shareholders and other stakeholders to evaluate a hotel company's environmental approach and performance. These trends are effectively reshaping how a hotel's performance is measured and analyzed. Despite the presence of increasingly valuable frameworks, hotels still face the challenge of standardizing the way environmental, social, and governance (ESG) issues are measured. Central within the discussion is the concept of *materiality*, or the significance of certain topics, data, and measurements that may be either included or omitted from the disclosures of organizations and goods or services. In this article, I examine several aspects of materiality, which become increasingly important, given the stakeholder requests for carbon footprint information, and the fact that the questioners may not fully understand the components and calculations involved in their questions.

Carbon footprint is a shorthand phrase referring to instances of Greenhouse Gas (GHG) emissions accounting.[1] Hotels have found their stakeholders requesting the carbon footprint of the hotel itself, as well as that of a room-night or of a meeting space. The industry's efforts to standardize the calculation of a carbon footprint raise the issue of materiality related to carbon footprinting. Thus, in this article I explore how the concept of materiality relates to the measurement of a hotel's carbon footprint. The article first reviews the literature and guidance on materiality. Then, I present an analysis of the materiality of two common sources of carbon emissions in a hotel, mobile fuels and fugitive coolant emissions. In analyzing a carbon footprint, the Greenhouse Gas Protocol applies the following three categories of emissions: Scope 1, all direct GHG emissions; Scope 2, indirect GHG emissions from purchased electricity, heat, or steam; and Scope 3, other indirect emissions, such as production of purchased materials, transportation in vehicles not owned by the hotel, outsourced activities, and waste disposal.[2]

Evolving Carbon Measurement Guidance

Since early 2011, several organizations have put forth resources intended to guide and standardize the measurement of carbon in organizations, products, services, and buildings. The Greenhouse Gas Protocol released accounting and reporting standards for the Product Life Cycle and Corporate Value Chain (Scope 3). The UNEP Sustainable Buildings and Climate Initiative released its Common Carbon Metric and Protocol for buildings. Cornell University and its hotel industry affiliates have explored the topic in publications[3] and through industry roundtables.[4] The Hotel Carbon Measurement Initiative (HCMI), a joint initiative of the World Travel & Tourism Council and the International Tourism Partnership, produced its first phase guidelines for commonly measuring the carbon footprint of a hotel stay and a meeting; the APEX/ASTM Sustainable Event Standards criteria include measuring GHG emissions; and the Global Business Travel Association (GBTA) developed its 2013 Hotel RFP that requests guestroom-specific data on energy, water, waste, and carbon.

Introducing Materiality in Non-Financial Performance Indicators

Underlying all these metrics is the concept of materiality. The essence of materiality is the determination of which aspects of measurement require the development and communication of performance indicators. Adapted from the legal and accounting worlds, materiality is currently defined (in reverse) by the Financial Accounting Standards Board as "the magnitude of an omission or misstatement of accounting information that, in the light of surrounding circumstances, makes it probable that the judgment of a reasonable person relying on the information would have been changed or influenced by the omission or misstatement."[5]

What we see in this definition of materiality is that stakeholders must be considered in the determination of what information to include. That is, the user of information has as much of a say in what is important as the preparer and the auditor. Making matters more complicated, the literature on materiality reveals that the determination of "what to include" is largely complex, subjective, and lacking in consensus.[6] Moreover, environmental, social, and governance (ESG) information does not currently have a direct impact on financial valuation, and covers an immense scope of topics from which to choose for inclusion. Even in the several cases where omission and inaccuracy of figures have been observed in sustainability reports,[7] none of this seemed to have any direct financial impact or to sway investor or customer decisions. Nonetheless, guidance on determining materiality in sustainability exists, industries have convened to identify material ESG issues, and organizations are now paying hefty consulting fees to have methodical materiality assessments performed on their business. In sum, materiality relates to determining what information is important for a stakeholder to know, even though the outsider can't observe the item because it occurs behind the scenes amid a complex (eco)system. A more cynical view of this question is, "Well, if we leave that out, will anybody notice?"

As esoteric or debatable as it seems, the fact remains that stakeholders are asking more questions relating to these specific behind-the-scenes issues, and the questions themselves are stirring change. Again, our industry is still working to develop a common structure and technical guidance. Moving specifically to developing common performance indicators, materiality as a non-financial performance term has meaning in two instances. The first is the matter of determining which topics of sustainability are

[1] For a background on hotel carbon footprinting, see www.hotelexecutive.com/business_review/3101/hotel-carbon-footprinting

[2] http://www.ghgprotocol.org/calculation-tools/faq.

[3] Eric Ricaurte, "Developing a Sustainability Measurement Framework for Hotels: Toward an Industry-wide Reporting Structure," *Cornell Hospitality Report,* Vol. 11, No. 13 (July 2011); Cornell Center for Hospitality Research.).

[4] Eric Ricaurte, "The Hospitality Industry Confronts the Global Challenge of Sustainability," *Cornell Hospitality Proceedings*, Vol. 4, No. 1 (February 2012), pp. 9-10.

[5] Statement of Financial Accounting Concepts No. 2, "Qualitative Characteristics of Accounting Information," Financial Accounting Standards Board (FASB).

[6] See: Takiah Mohd Iskandar and Errol R. Iselin. "A Review of Materiality Research," *Accounting Forum,* Vol. 23, No. 3 (September 1999), pp. 209-239.

[7] Study forthcoming from LEEDS University Sustainability Research Institute and Euromed Management School. See preliminary results release at: www.leeds.ac.uk/news/article/2696/doing_good__or_just_talking_about_it

material to merit the development of related performance indicators. The second instance relates to determining the boundary of a performance indicator, and the significance of components and processes within that boundary as to whether they meet a certain threshold of materiality to be counted. Let's look at these topics in turn.

Determining Topics

Global Reporting Initiative (GRI) G3.1 guidelines indicate that companies should disclose the process for determining materiality, as a part of how topics were identified, prioritized, and subsequently reported.[8] The GRI currently bases its discussion of materiality on making the case for thresholds that go beyond financial valuation and affect stakeholders other than investors or shareholders.[9]

Industry-wide, GRI sector supplements have attempted to identify common ESG aspects which are material to peers within specific sectors. More advanced discussions on materiality are found in AccountAbility's *The Materiality Report: Aligning Strategy, Performance, and Reporting*, which examines limitations of GRI and other approaches to materiality, and presents the case for integrating materiality at a strategic level of the organization.[10] Materiality literature also recognizes the subjectivity and constant evolution of topics. Moreover, materiality frameworks are somewhat beyond the current reality of many organizations, where certain information is being reported and performance indicators developed for topics specifically because stakeholders are requesting the information. On one level, these organizations are in an intermediate step of reacting to requests while trying to figure out how to attend to these increasing demands collectively and strategically. At a more methodical level, research is now emerging on the key topics most requested by stakeholders.[11] It appears that the determination of materiality may derive from external stakeholder requests more than from an introspective process undertaken directly by the organization.

Regardless of the key sustainability performance indicators for hotels there is little doubt that the topics of carbon, energy, water, and waste will be included, as they are consistently found in certifications and corporate sustainability platforms and reports.[12] Let's use carbon emissions to demonstrate the numerical aspects of materiality, that is, determining thresholds.

Determining Boundaries or Significance

The determination of significance, or how to develop thresholds and devise boundaries and quantification methods for specific sustainability performance indicators is much more closely aligned with that of financial accounting, where materiality is discussed in terms of revenue or profit. Using this approach we can translate the discussion into how different sources of GHG emissions contribute to the carbon footprint of a hotel.

In making those calculations, stakeholder theory must still be considered. A stakeholder such as an investor, owner, or regulatory body requests the carbon footprint of the hotel or the aggregate footprints of each hotel in the organization's overall portfolio. On the other hand, the footprint is relevant to a guest or organizational buyer who is also determining *their* footprint generated from the hotel stay. These two may differ in calculation method and guidance used, though the base question of materiality or significance remains the same.

Materiality in Guidance Documents for Carbon Calculation

Extensive guidance exists on materiality as a question of significance within GHG emissions, though the guidance may vary along with its corresponding terminology. One of

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8 See: Global Reporting Initiative, "Sustainability Reporting Guidelines," Version 3.1 (2010-2011).

9 Ibid., "Technical Protocol: Applying the Report Content Principles," p. 3: "The materiality focus of sustainability reports is broader than the traditional measures of financial materiality. In financial reporting, materiality is commonly thought of as a threshold for influencing the economic decisions of those using an organization's financial statements, investors in particular. The concept of a threshold is also important in sustainability reporting, but it is concerned with a wider range of impacts and stakeholders. Materiality for sustainability reporting is not limited only to those sustainability topics that have a significant financial impact on the organization. Determining materiality for a sustainability report also includes considering economic, environmental, and social impacts that cross a threshold in affecting the ability to meet the needs of the present without compromising the needs of future generations. These material topics will often have a significant financial impact in the near term or long-term on an organization. They will therefore also be relevant for stakeholders who focus strictly on the financial condition of an organization.

"Many topics that attract significant stakeholder interest in an organization, or represent major economic, environmental, or social impacts, result in financial consequences within a time frame that will be relevant for at least some participants in capital markets.

"The threshold for defining material topics to report should be set to identify those opportunities and risks which are most important to stakeholders, the economy, environment, and society, or the reporting organization, and therefore merit particular focus in a sustainability report."

10 Maya Forstater *et al.*, *The Materiality Report: Aligning Strategy, Performance and Reporting* (London, United Kingdom: AccountAbility, 2006).

11 For further research, see: Robert G. Eccles, George Serafeim, and Michael P. Krzus. "Market Interest in Nonfinancial Information," *Journal of Applied Corporate Finance* (Morgan Stanley) Vol. 23, No. 4 (2011), pp. 113-127; C. Deegan and M. Rankin, "The Materiality of Environmental Information to Users of Annual Reports," *Accounting, Auditing and Accountability Journal*, Vol. 10, No. 4 (1999), pp. 562-583; and Charl de Villiers and Chris J. van Staten, "Shareholders' requirements for corporate environmental disclosures: A cross country comparison," *The British Accounting Review*, Vol. 42 (2010), pp. 227-240.

12 Ricaurte, 2011, op. cit.

Exhibit 1

Definition of materiality in greenhouse gas emission calculation and reporting resources

GHG Measurement and Reporting Resource	Suggested Threshold of Significance	Terms Used	Commentary
Climate Registry	5% of Scope 1 and 2 Emissions	Materiality Threshold, Material Misstatement	Refers to "avoidable errors"
UNEP Common Carbon Metric	Not indicated	None	Indicates to include fugitive emissions if available, while transport emissions are excluded
GHG Protocol Corporate Accounting	Determined individually, 5% of total inventory for the part of the organization being verified	Materiality Threshold, Material Discrepancy	Company may determine its own threshold in collaboration with a third party verifier, and specific emissions may be material even if they are under 5%.
GHG Protocol Life Cycle Accounting and Reporting Standard	Determined individually	Quantitative Materiality, Materiality Threshold, Materially Misleading	"The assurer and reporting company should determine an appropriate threshold or benchmark of materiality during the assurance process." Can be pre-determined by the assurer.
GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting standard	Determined individually	Quantitative Materiality, Materiality Threshold, Materially Misleading	"The assurer and reporting company should determine an appropriate threshold or benchmark of materiality during the assurance process." Can be pre-determined by the assurer.
EU Emissions Trading Scheme	5% of aggregate emissions for installations less than 500kt, 2% for installations greater than 500kt	Materiality Threshold	Threshold depends on the project's size
Carbon Disclosure Project (Investor Response)	Not Indicated	Not referenced	Requests that emissions not included are mentioned in the questionnaire
ISO 14046-1:2006	Determined individually	Material Discrepancy	"Acceptable materiality is determined by the validator, verifier or GHG programme, based on the agreed level of assurance."
PAS 2050:2008	1%	Material Contribution	
UK Carbon Reductions Commitment Energy Efficiency Scheme	Emissions above 90% or above the % total of core emissions + ETS Emissions + CCA Emissions*	Residual Percentage	Determined by a calculation and must include a Residual Measurement List if regulated emissions do not meet the residual percentage

**Note*: ETS = EU Emissions Trading Scheme, CCA = Climate Change Agreements.

the most commonly used carbon footprinting methods, ISO 14064, states:

> The concept of materiality is used to identify information that, if omitted or misstated, would significantly misrepresent a GHG assertion to intended users, thereby influencing their conclusions. Acceptable materiality is determined by the validator, verifier, or GHG programme, based on the agreed level of assurance….The organization may exclude from quantification direct or indirect GHG sources or sinks whose contribution to GHG emissions or removals is not material or whose quantification would not be technically feasible or cost effective.[13]

In ISO 14064 we also find the term *material discrepancy*, defined as "an individual or an aggregate of actual errors, omissions, and misrepresentations in the greenhouse gas assertion that could affect the decisions of the intended users."[14] Missing in ISO 14064's guidance is a prescriptive value or threshold for significance. Looking at several thresholds or technical specifications (Exhibit 1), we see that they are varied, but a common boundary is 5 percent.

In addition to the 5-percent materiality threshold, we also see a distinction between a materiality threshold for the organization calculating the footprint versus the findings of the third-party organization verifying the calculations. The GHG Protocol is an example of this. It suggests that organizations should determine their own materiality thresholds but recommends that the verifier (in the case of the corpo-

[13] ISO 14064-1-2006, pp.4, 8.

[14] *Ibid*., p. 4.

rate reporting standard) should use 5 percent as a threshold. Other issues of quantification arise, however, as among the guidance documents the calculation method varies. Some guidance allows for estimation from default data or extrapolation from or partially compiled data, which also varies by threshold as some allow for estimation for sources lower than 5 percent, while others acknowledge this possibility even for those sources that exceed 5 percent. Other contradictions found across the guidance documents include whether to exclude partial data entirely, estimate based on default data, or extrapolate from partial data, and whether to sum or ignore smaller sources of GHG emissions which individually represent less than 5 percent of emissions each, but collectively add up to more than 5 percent. Finally, in carbon calculation some Scope 3 emissions may well be over 5 percent when added to a hotel's Scope 1 and 2 emissions.[15]

As long as a hotel adheres to the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard, where Scope 1 and 2 are the declared boundaries, the boundaries themselves are clear, but too many variables interfere with establishing a carbon footprint of a room-night. If a hotel outsources its laundry, landscaping services, or shuttle transportation, it does not include those in its boundary of Scope 1 and 2, but a neighboring hotel that operates all those functions in-house and would have to include those per the GHG Protocol.

Here is an example of the complexities regarding what to include in a carbon footprint and how to do it. The Climate Registry's General Reporting Protocol Version 1.1 contains an example of a hotel chain that owns 50 lawnmowers, and uses one lawnmower's fuel consumption (and consequently emissions) to arrive at an estimate of GHG emissions from all year-round lawn mowing to be 0.0439 percent of total emissions of the portfolio. The Climate Registry deems this type of extrapolation to be in line with their overall methods of simplified estimation since the source is well under the 5 percent threshold. However, going by the ISO 14064 allowance for an organization to exclude from quantification those sources "whose quantification would not be technically feasible or cost effective,"[16] one could argue that this calculation and inclusion of lawn mowing emissions would not be necessary. These emissions are less than one-tenth of the 5-percent standard, and an omission of lawnmowing emissions would be unlikely to represent significant risk for data interpretation and use. Then again, according to ISO 14064 guidance, this statement is contingent on a reputable, knowledgeable third-party verifier to validate it.

A hotel would also find complications in applying another attempt to tie hotel operations to complex carbon footprinting calculations, those found in the U.K.'s PAS 2050 standard for assessing the carbon footprint of goods and services.[17] According to an adaptation for LCA mapping, some of the potential sources include:

- Computer use by the receptionist at check-in,
- Paper for the guest receipt,
- Use of cleaning products, vacuum, etc., and
- Proportion of overall hotel facilities used by guests (e.g., elevators, common areas, recreation, and gym).[18]

Interesting in this quick itemization of hotel processes is the seemingly arbitrary inclusion of some processes and omission of others. The property's PMS computer, cleaning supplies, and the vacuum are included, but such other items as the shuttle, bed, carpet, and furniture are left out. For the portion of the footprint attributed to energy used directly within the hotel, it seems dubious to measure the energy usage of each process rather than simply taking the total energy bill of the entire hotel. Beyond that, the question remains as to whether life cycle emissions associated with the FF&E and ongoing consumables used within a hotel's operations are material.

InterContinental Hotels Group and Accor both offer corporate reporting examples of complete hotel footprinting that includes several Scope 3 sources.[19] Note that these are not entirely comparable. Accor did not include GHG emissions from water consumption and discharge, for instance, while IHG found those to be 2 percent of emissions. Emissions from employee commutes were 8.3 percent of the total footprint in the Accor study, while IHG reported employee commutes at 4 percent. Materials and waste were the major source of scope 3 emissions, but again they varied considerably: less than 25 percent of Accor's footprint, yet 43 percent of IHG's footprint. One figure of note from Accor's study was that construction and renovation represented 4.5 percent of the hotel's footprint, a much smaller figure than the 10 to 20 percent cited by the United Nations Environmental Program (UNEP) Common Carbon Metric.[20] However, the

15 For more information on Scope, see: the GHG Protocol, www.ghgprotocol.org.

16 ISO 14064-1-2006, p. 8.

17 Crown and Carbon Trust, *Guide to PAS 2050: How to assess the carbon footprint of goods and services* (London, United Kingdom: BSI, 2008), pp. 43-44.

18 *Ibid.*

19 Data retrieved from InterContinental Hotels Group online Corporate Responsibility Report, Environment>Climate and Carbon>Our Carbon Footprint, http://ihgplc.com/index.asp?pageid=747, as viewed June 1, 2012; and Accor (2011). The Accor Group's Environmental Footprint: First multi-criteria life-cycle analysis for an international hospitality group, December 2011, p. 11.

20 See: United Nations Environmental Program Sustainable Buildings and Climate Initiative, *Common Carbon Metric for Measuring Energy Use & Reporting Greenhouse Gas Emissions from Building Operations*, 2011.

boundaries appear different because the U.N. figure includes demolition, but Accor's does not.

Digging further into scope 3 emissions, a study by the UNWTO estimates that 75 percent of the carbon footprint of travel is attributed to transportation, while 21 percent is attributed to hotel accommodation.[21] In other words, scope 3 emissions could well be a much larger factor than scope 1 and 2 emissions. If a hotel were to tack onto its carbon footprint the GHG emissions associated with the design, construction, and renovation of the building; employee commutes and business travel; corporate office emissions; waste generation and disposal; guest travel; and the life cycle emissions of all FF&E and OS&E consumed, then the resulting Scope 3 emissions of a hotel's operation could well dilute the Scope 1 and Scope 2 emissions themselves almost to a point below the 5-percent threshold. Within current life cycle analysis protocols and standards, the greatest difficulty in calculating the carbon footprint of many products is the use phase. In a hotel the reverse is true, where the use phase is what the hotel has most control over and the most precision for calculating, while calculating the other phases is problematic to the degree that so many other inputs are associated with their existence.

Having made that point, it seems clear that hotels do not need to extend their measurement boundaries beyond Scope 1 and 2 in answering the guest's request for the footprint of a stay. Additionally, several sources exclude travel from the hotel's footprint boundary directly or by inference. Even after the Greenhouse Gas Protocol Corporate Value Chain Accounting and Reporting Standard (Scope 3) indicates that business travel should be included within the boundary, it specifically limits its boundary to transportation, and within that transportation specification to Scope 1 and 2 emissions of the transportation services used. Furthermore it states, "Companies may optionally include emissions from business travelers staying in hotels."[22] Similarly, the UK DEFRA's *Guidance on How to Measure and Report your Greenhouse Gas Emissions* does not even mention hotel stays in its scope 3 business travel section.[23] A final instance of excluding travel from the boundary is found in PAS 2050, which specifically identifies choosing to omit emissions from business travel from the calculation, considering them outside the scope entirely.[24] By analogy, if corporate Scope 3 accounting for business travel only includes Scope 1 and Scope 2 emissions of the travel sources and hotel stays are left out or listed as optional, while at the same time the life cycle carbon calculations of products such as furniture and soap do not even include within their own footprint the corporate travel of its company executives selling their products to hotels, there seems no argument for hotels to include broad scope 3 measures when calculating their footprint. Moreover, perhaps hotel stays themselves are immaterial to the overall need for calculating carbon from travel, given the consideration that the guest is not subtracting the avoided carbon footprint that would have been generated had he or she stayed home and turned on the lights, TV, computer, air conditioning, and vacuum cleaner.

Even if all boundaries and calculations were unified through a global accounting mechanism, it is interesting to note that the uncertainty present in the calculation of GHG emissions themselves is likely to vary above a 5-percent threshold. The GHG Protocol offers a comprehensive discussion of uncertainty, and how that uncertainty may be included in a GHG inventory.[25] According to the guidance, two main types of uncertainty exist: estimation uncertainty and scientific uncertainty. Estimation uncertainty deals with the emission factors that are assigned to emissions sources, which are almost entirely provided by third parties and are taken as fact when used by those performing the calculations. However, the appropriate use of those factors within the organization is uncertain. Furthermore, even if parameters and models of calculations become more precise, there is still plenty of uncertainty surrounding the process of the greenhouse effect and removing emissions. For example, the Global Warming Potential (GWP) factors' use of different GHG emissions sources is based on study that is ever evolving but still not entirely understood.

The GHG Protocol guidance provides detailed equations and calculations. In a summary, the guidance suggests setting a confidence level (the Intergovernmental Panel on Climate Change, or IPCC, suggests a confidence level of 95%) and then providing levels of accuracy for the values that are estimated. Data accuracy is ranked *high* when it's likely to be within 5 percent of the estimated value, but a *fair* data accuracy ranking is much lower, at 30 percent. "In other words, the true value of an estimate with a 'fair' ranking has a 95-percent probability of being within plus or minus 30 percent of the estimated value."[26] Formerly rare in publicly disclosed GHG inventories, these types of calculations are

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21 World Tourism Organization and United Nations Environment Program, *Climate Change and Tourism: Responding to Global Challenges* (Madrid, Spain: World Tourism Organization, 2008), p. 33.

22 World Resources Institute and World Business Council for Sustainable Development, *Corporate Value Chain (Scope 3) Accounting and Reporting Standard. USA*: 2011, p. 46.

23 See: Department for Environment, Food and Rural Affairs, *Guidance on how to measure and report your greenhouse gas emissions* (London, UK: Crown, 2009).

24 Crown and Carbon Trust, p. 45.

25 See: *GHG Protocol* guidance on uncertainty assessment in GHG inventories and calculating statistical parameter uncertainty.

26 Ibid., p. 13.

starting to emerge. Though further study could be performed to understand uncertainty in hotel carbon footprint calculations, the conclusion from the guidance and example is that uncertainty of carbon calculations *starts* at 5 percent, the same commonly accepted threshold of materiality in emissions sources.

Assessing Materiality

Returning to hotel carbon footprint calculations, the previous discussion of guidance documents suggests that Scope 3 emissions in most instances will not be included when providing the carbon footprint of a room-night to a guest. Thus, the question then remains as to whether some Scope 1 and 2 emissions sources within a hotel are material. The principal potential sources of scope 1 and 2 emissions in a hotel are:

- Fuel burned onsite for HVAC or generating electricity,
- Fuel burned for food and beverage operations,
- Purchased electricity,
- Purchased district steam,
- Purchased chilled water,
- Fuel burned in vehicles and service equipment operated by the hotel,
- Leakages of refrigerant in refrigeration and cooling equipment, and
- Onsite treatment of waste and effluent in facilities operated by the hotel.

In evaluating these sources, two specifically emerge as questionable: emissions from mobile fuels (i.e., transport vehicles or service equipment) and fugitive emissions from leaks in hotel refrigeration and cooling equipment. In the remainder of this paper, I examine whether these meet a materiality threshold individually or collectively.

Research Design

As mobile fuels are commonly left out of corporate hotel emissions inventories, a study was designed to test two hypotheses:

Hypothesis 1: *Fugitive GHG emissions from hotel operations are immaterial to a hotel's carbon footprint.*

Hypothesis 2: *GHG emissions from mobile fuels burned in hotel operations are immaterial to a hotel's carbon footprint.*

To test these hypotheses, data were collected from individual hotel properties, facilitated through corporate offices of each hotel company. Respondents could provide data either through an online survey, spreadsheet template, or in their original format as previously collected by the corporate offices and could report for any recent 12-month period. Hotels were asked to report energy usage in all available categories, as well the amount of refrigerant replaced within the period. In addition a series of questions were asked to determine the attributes of each hotel in terms of STR segment, hotel type, and the sources of mobile fuel use and refrigerant replacement.

Data were converted into GHG emissions for each hotel using the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard. Outlets and services not operated by the hotel were not included within the boundary. (For a complete description of the boundary and quantification method, see the Appendix.)

Exhibit 2

Data set by country

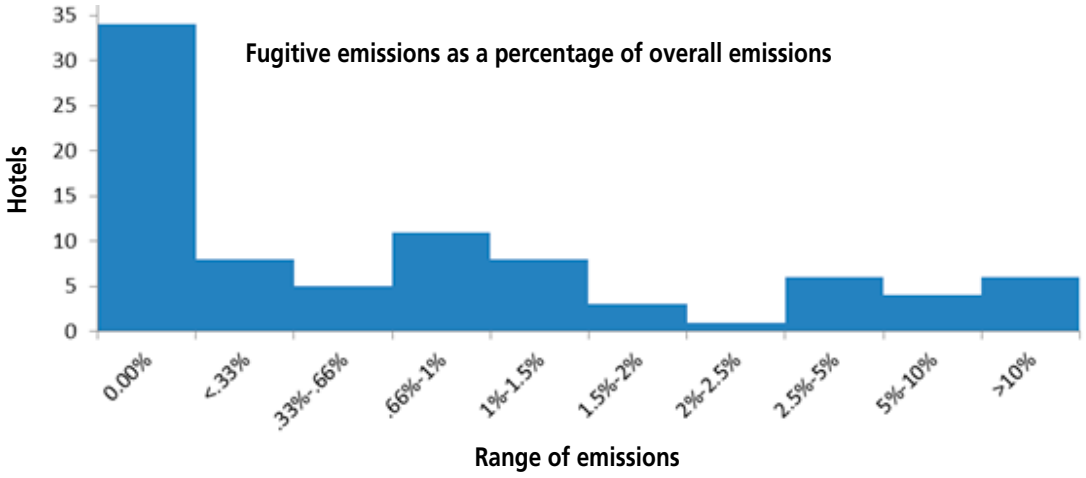
Country	Number of hotels	Percentage
Australia	2	1%
Bahrain	2	1%
Canada	1	1%
China (Mainland)	40	26%
China (Hong Kong)	3	2%
Egypt	3	2%
Fiji	1	1%
India	1	1%
Indonesia	2	1%
Japan	1	1%
Kenya	1	1%
Lebanon	1	1%
Malaysia	8	5%
Maldives	1	1%
Mauritius	1	1%
Myanmar	1	1%
Oman	3	2%
Philippines	6	4%
Qatar	1	1%
Saudi Arabia	2	1%
Singapore	3	2%
Taiwan	3	2%
Thailand	3	2%
United Arab Emirates	6	4%
United Kingdom	5	3%
United States	53	34%

Results

Data were received from 178 hotels from 25 countries, with the largest concentrations of hotels in the U.S. (35.7%) and China (25.6%, Exhibit 2). We initially excluded 27 hotels from the data set based on one of the following factors:

Exhibit 3

Distribution of fugitive emissions



Range	Frequency	% of Data Set
0.00%	34	39.5%
<.33%	8	9.3%
.33%-.66%	5	5.8%
.66%-1%	11	12.8%
1%-1.5%	8	9.3%
1.5%-2%	3	3.5%
2%-2.5%	1	1.2%
2.5%-5%	6	7.0%
5%-10%	4	4.7%
>10%	6	7.0%
Total	**86**	**100%**

- The fugitive emissions question was left blank (only those indicating "No Emissions" were accepted for a value of zero);
- Number of guestrooms or gross floor area was left blank;
- Energy exceeded 1,000 kWh per available room or was less than 15 kWh per available room (likely indicating a data entry error); and
- A transportation vehicle was indicated as used at the hotel but mobile fuel consumption for that vehicle was left blank.

Data from 68 hotels included carbon data but not energy data, and included mobile fuels but not fugitive emissions. Consequently, these respondents were not used for the fugitive emissions analysis, but could be used for mobile fuel emissions. This resulted in a primary data set of 86 hotels from 15 countries for which data on both fugitive emissions and mobile fuel emissions were included in the boundary.

Initial inspection indicated that these two items were less commonly significant as carbon sources. Of these 86 hotels, 17 instances (19.1%) existed where the sum of mobile fuel emissions plus fugitive emissions was greater than 5 percent of the total hotel footprint. Of these 17, only one instance occurred of both fugitive emissions and mobile fuels each being greater than 5 percent of the total footprint, and only one instance occurred where both were less than 5 percent each but collectively their sum surpassed 5 percent. Moving to a lower threshold of 1 percent, 48 hotels had a sum of mobile fuel emissions plus fugitive emissions greater than 1 percent of total emissions.

Fugitive Emissions

Fifty-two hotels reported fugitive emissions, while 34 reported not having fugitive emissions. Of the 52 hotels reporting fugitive emissions, nearly half (46%) reported emissions of less than 1 percent, while 34.6 percent reported emissions between 1 percent and 5 percent, meaning that a total of 80 percent of the hotels reported emissions under 5 percent (Exhibit 3). Ten hotels (19.1%) reported fugitive emissions over 5 percent, and nine of these reported that their chillers used one of four coolants with relatively high global warming protocol (GWP) values (either R-22, R-134A, R404-A, or R410-A). The tenth hotel had conducted maintenance of all units. Nine hotels were located in cities with less than 1,000 annual heating degree-days, and eight of ten were located in climates with over 2,000 annual cooling degree-days.

Of the ten hotels with fugitive emissions greater than 5 percent of the total footprint, nine had leakages over 200kg,

Exhibit 4

Regression model for estimating fugitive emissions

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.661655912
R Square	0.437788546
Adjusted R Square	0.410853866
Standard Error	34.51479982
Observations	60

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	53802.61898	26901.30949	22.5820156	5.99018E-08
Residual	58	69093.74158	1191.271407		
Total	60	122896.3606			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Energy Emissions	0.004057304	0.001827462	2.220185062	0.030328187	0.000399241	0.007715367	0.000399241	0.007715367
CDDs	0.006748859	0.002851163	2.367055055	0.02128845	0.001041637	0.012456081	0.001041637	0.012456081

and the tenth, an economy hotel, reported 54kg of leakage. This suggests that a major chiller leak will be the determining factor in whether a hotel's fugitive emissions are material to its overall footprint. A major chiller leak however did not automatically indicate that emission would be material, though. Four hotels had major chiller leakages of HFC-123, but as the GWP of this gas is relatively low, the contribution to the hotel's overall footprint was insignificant. On the other hand, hotels that had higher-GWP refrigerant but replaced less than 50kg in the chiller did not result in fugitive emissions over 5 percent.

Estimating Fugitive Emissions

A regression analysis was performed to design a model for estimating the percentage of fugitive emissions represented in the overall carbon footprint without having the actual value of fugitive emissions. To provide more precise modeling for a majority but not all of the hotels in question, outlying hotels with the following characteristics were removed:

- Fugitive emissions over 5 percent (which had major chiller leaks or major guestroom maintenance);
- Over 2,500 square foot per key (gross floor area divided by number of rooms); and
- Total GHG emissions over 10,000 $MTCO_2e$.

The following variables were tested in the resulting data set of 59 hotels, against the independent variable of total fugitive emissions:

- Room count,
- Gross floor area,
- Heating degree-days,
- Cooling degree-days, and
- Total GHG emissions from energy use.

With a confidence level of 95 percent and an intercept value of zero, a backward stepwise elimination was performed by a T-stat test of significance. As a result, gross floor area, heating degree-days, and room count were removed, leaving cooling degree-days and emissions.

The resulting regression model is as follows:

Fugitive Emissions = 0.004057304 x ($MTCO_2e$ Energy Emissions) +
0.006748859 x (Number of ^0C Cooling Degree-Days)

Though the model indicates a tendency for fugitive emissions to increase with energy emissions, the percentage represented by fugitive emissions will be more influenced by cooling degree-days, meaning that climate influences the amount of refrigerant used more than any other variable, including number of rooms or the square footage of the hotel (Exhibit 4).

With T-stats over 2.0, P-values less than .05, the degrees of freedom over 10, an F value greater than 4, and its p-value less than .05, the model may be used as a simple estimation method. It does have limitations, however. Given an R-square of 43.7 percent, we must conclude that several other untested hotel attributes are likely relevant to include as variables. Also, though a hotel may not have replaced refrigerant throughout the year, leakages still may have occurred but were not noticed. So the data set may be skewed toward a lower percentage. On the other hand, replacement of refrigerant in the 12-month period may have occurred as a result of prior leakage that exceeds the 12-month period but was not refilled previously, countering this limit of hotels with unidentified leakage. The model is also limited within the data set parameters and only had two economy hotels, and no hotels with more than 6,200 cooling degree-days (^0C) during the year. Furthermore the degree-day and energy data were provided in annual figures instead of weekly or monthly figures which are preferable for this type of model-

Exhibit 5

Country representation in mobile fuels data set

Country	Data Set
Australia	2
Bahrain	2
Canada	1
China	40
Egypt	3
Fiji	1
Hong Kong	3
India	1
Indonesia	2
Japan	1
Lebanon	1
Malaysia	8
Maldives	1
Myanmar	1
Oman	2
Philippines	5
Saudi Arabia	1
Singapore	3
Taiwan	3
Thailand	3
United Arab Emirates	6
United Kingdom	5
United States	49

ing. As such the model will predict fugitive emissions to be material in economy hotels (which tend to have less GHG emissions) in extremely hot climates. Finally, the model was generated using Microsoft Excel, which has limited capacity for analysis as opposed to specialized regression software. Further testing of hotel attributes as variables and increased, representative data sets may help improve this model.

Mobile Fuels

For the 65 hotels from a corporate data set which did not have fugitive emissions data and the three hotels that left the refrigerant leakages field blank in the first instance, the regression model was applied using the cooling degree-days for the calendar year (at a base temperature of 15.5°C), which resulted in a mean increase in emissions of 0.35 percent, with the minimum percentage 0.033 percent, the max 2.279 percent, and standard deviation of 0.349 percent. These 68 hotels were then added back into the original data set (Exhibit 5). The ten hotels with fugitive emissions over 5 percent because of major chiller leaks or guestroom maintenance were removed from the data set as outliers, to arrive at a mobile fuels data set of 144 hotels from 23 countries.

Of the 144 hotels, 34 reported no mobile fuel emissions sources and thus no mobile fuel emissions. Just under 53 percent of the remaining 110 hotels (52.8%) reported that mobile fuels represented less than 1 percent of emissions, and for 63.1 percent of hotels mobile fuels were less than 2 percent of emissions. Adding back in the hotels with no fugitive emissions, 87 percent of the data set had mobile fuel emissions less than 2 percent. Finally, 94 percent of the data set had mobile fuel emissions less than 5 percent. This suggests that most commonly, mobile fuels will not be material and are likely to be 1 percent or less.

All 34 of the hotels with mobile fuel emissions over 1 percent had some type of vehicle (e.g., shuttle van, service van, executive car, boat), but only eight of them (23.6%) had emissions over 5 percent. Though the existence of a hotel vehicle was the primary driver of mobile fuel emissions being greater than 5 percent, the existence of a vehicle did not automatically qualify a hotel's mobile fuel emissions as material (Exhibit 6, next page).

Regression analysis was not practical, but a particular attribute that appeared to influence mobile fuel emissions was property type. All five airport hotels with shuttle vans had emissions over 1 percent, four of which were over 4.7 percent. Eight of the 18 resort hotels had emissions over 1 percent. This conclusion, however, only supports the original factor of operating vehicles, as airport hotels and resorts are more likely to incorporate vehicles in their operation. Similar to the fugitive emissions data set, only two economy hotels were present, and though in each of these hotels mobile fuel emissions were less than 1 percent, instances may occur where an economy hotel's shuttle van constitutes over 5 percent of the hotel's total emissions.

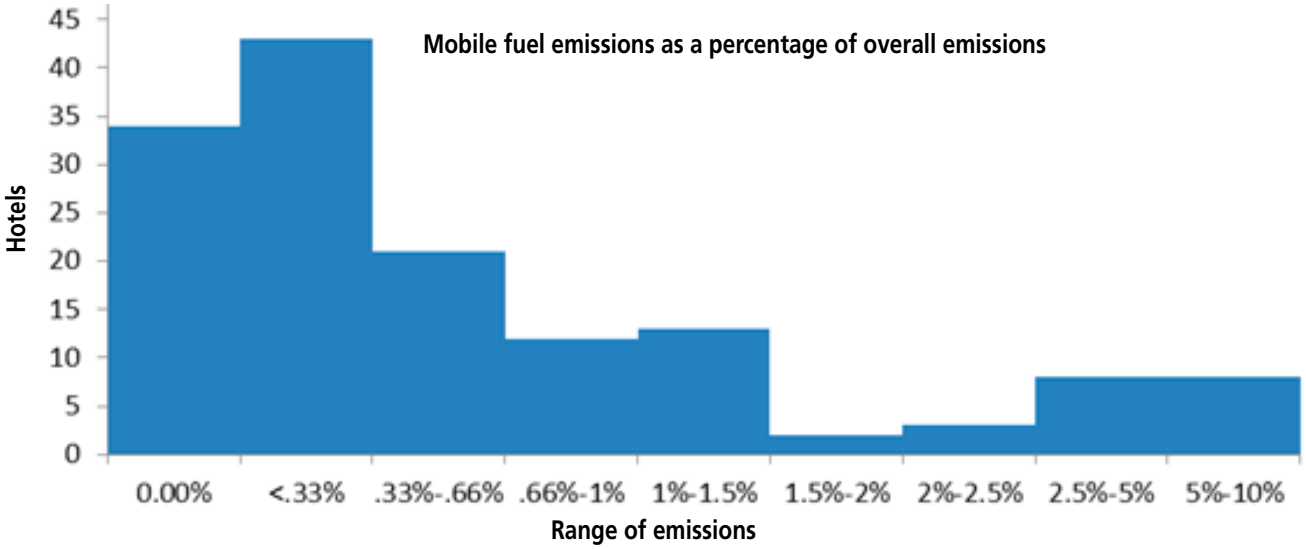
Portfolio Analysis

Though instances occur for both fugitive and mobile fuel emissions exceeding 5 percent of a single hotel's total GHG emissions, their low frequency of occurrence within the entire data set of 154 hotels places the weighted average of each below 1 percent as a percentage of the GHG emissions of the entire data set.[27] Were this data set to represent the portfolio of a hotel company, it would indicate that neither emissions source is material to the organization's GHG emissions inventory, supporting the two hypotheses (Exhibit 7, next page). Therefore arguments for omission, estimation, or extrapolation would be valid depending on the guidance used for aggregate calculation.

[27] Data set includes extrapolated values of fugitive emissions for 68 hotels, of which major chiller leakages may have occurred but were not reported.

Exhibit 6

Frequency distribution of mobile fuels



Range	Frequency	%
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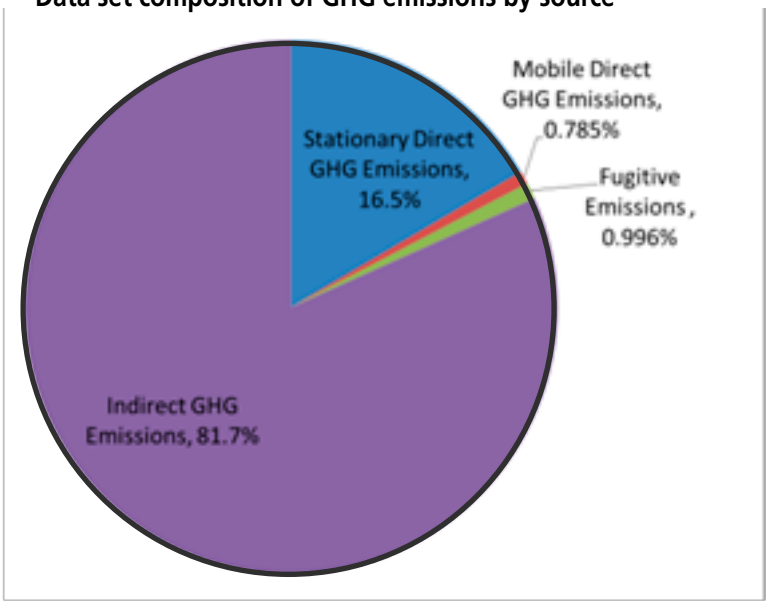
.33%-.66%	21	14.6%
.66%-1%	12	8.3%
1%-1.5%	13	9.0%
1.5%-2%	2	1.4%
2%-2.5%	3	2.1%
2.5%-5%	8	5.6%
5%-10%	8	5.6%
Total	144	

Exhibit 7

Data set composition of GHG emissions by source



Renewable Energy and Carbon Offsets

In performing the study, three possible hotel actions were identified that make carbon calculation more complex and will need future consideration. Hotels may choose to generate renewable energy onsite, purchase Renewable Energy Certificates (RECs) for electricity generation, or purchase carbon offsets to mitigate the carbon footprint of the building.

No hotels in the data set generated renewable energy onsite, though a few did indicate purchasing RECs or carbon offsets. For conformity, no subtraction of GHG emissions was made from the hotel's carbon footprint for these instances. However, such purchases are directly related to the carbon footprint of a hotel room or a hotel company, and companies that purchase them do so to mitigate their impact. So while this study's purpose was to examine the materiality of specific emissions, the calculations are limited in not taking into account mitigation efforts.

Though RECs and carbon offsets may be different approaches to mitigation, they merit the question of how

to include them in a hotel's carbon footprint calculation and communication. In the case of a hotel purchasing only RECs for its purchased electricity consumption, for example, subtracting or giving a value of zero to the corresponding electricity emission may significantly reduce the hotel's carbon footprint. However, that reduction only corresponds to electricity and not other energy or refrigerants. The remaining footprint will comprise fuel burning and refrigerant leakages, and thus could drive up the proportion of the hotel's footprint attributed to mobile fuel burning and fugitive emissions well past a materiality threshold of 5 percent.

The scenario of a hotel purchasing carbon offsets appears to be easier to calculate, as carbon offsets are generally purchased by first performing the carbon footprint calculation and subsequently offsetting the desired portion of the footprint. In this instance the offset itself would not affect the materiality of fugitive emissions or mobile fuels since they are calculated prior to the offset purchase. However, the communication of the carbon footprint and its composition for voluntary responses to stakeholder requests could be misleading if data sets did not separately track the footprint and then subtract the amount offset.

Discussion

The data indicate that although carbon emissions from the burning of mobile fuels and refrigerant leakages are not likely to meet a materiality threshold for a hotel company's portfolio, they may represent a significant percentage of overall emissions for an individual hotel. The results do not suggest that the hypotheses will consistently hold either true or false under given criteria. Rather, certain attributes and circumstances will enable the possibility of emissions from the burning of mobile fuels or refrigerant leakages. One distinction to draw is that mobile fuels may routinely represent more than 5 percent of the hotel's carbon emissions year-over-year and are unlikely to be above 10 percent of emissions. Fugitive emissions, on the other hand, in certain circumstances and for certain performance periods can be well over 10 percent due to leakages, yet will not be consistently significant over time. This suggests that incidences of materiality should be studied by instance in the case of footprinting a single hotel.

Scenarios

To determine whether the contribution of fugitive emissions and mobile fuels is material to an individual hotel's carbon footprint, the following are recommended by scenario.

- **Hotels Without Vehicles**—If a hotel does not have transportation vehicles, mobile fuel emissions from other sources are most likely insignificant.
- **Hotels With Vehicles**—If a hotel operates a vehicle, it can perform a twelve-month performance period test to determine the percentage that mobile fuel emissions represent toward total emissions. If the result is greater than 5 percent, it can be considered material, and the property will need to measure emissions in each year's GHG calculations. If the result is less than 5 percent, the hotel could estimate emissions each year based on the performance period's result.
- **Hotels with Significant Chiller or Guestroom PTAC Replacement**—If refrigerant was replaced in a chiller due to a major leak (over 100kg) or as part of a major guestroom maintenance procedure during the twelve-month period, and the refrigerant used in the chiller has a high GWP, then emissions may be material to the hotel's overall footprint and should be measured.
- **Hotels with Insignificant Chiller or Guestroom PTAC Refrigerant Replacement or without Chiller Refrigerant Replacement**—If the hotel had a significant leak in the chiller but uses a refrigerant with a low GWP, or if a hotel did not replace refrigerant for a significant leak in a chiller or as part of major guestroom maintenance, then the fugitive emissions are unlikely to represent over 5 percent of the total footprint. However, they may represent over 1 percent of the total footprint. For hotels that periodically replace refrigerant due to minor leaks in PTAC units or other refrigeration equipment during the year and does not track these values, an estimated value of fugitive emissions could be applied to the rest of the footprint of the hotel, using means such as extrapolation or estimation through modeling.

Limitations

While this study demonstrates the general immateriality of fugitive emissions and mobile fuels contributing to a hotel's total carbon footprint, the instances of materiality (over 5 percent of total emissions) reveal that physical and operational attributes of a hotel can influence its carbon footprint. This suggests that further study of the different attributes and influencing variables will enable better understanding and modeling to predict materiality. Several scenarios were not tested in the study, any of which could influence a hotel's carbon footprint and resulting percentages of emissions. For example, hotels with outsourced laundry may have a lower footprint than those with in-house laundry, increasing the proportion of emissions from other sources. Likewise, the testing of variables specifically within data sets representative of each chain scale segment will help identify items with high materiality. This study did not test occupancy as a variable to determine percentages of emissions, although it is commonly accepted that occupancy rates affect a hotel's overall energy consumption. The study's purpose is to determine the percentage of certain emissions to the total, and

not to examine all factors that might contribute to a hotel's energy consumption. That said, it may be that occupancy rates caused emissions to raise or lower significantly over the test period.

Though calculating a hotel's carbon footprint is relatively straightforward, the challenge of modeling hotel emissions remains, if only due to a lack of a standard definition and variability of emission factors. For example, gross floor area may translate to conditioned space for one hotel but not another. Of the hotels surveyed, even gross floor area has different meanings in energy tracking. Some hotels calculate the area inside the building walls, while others count the area covered by the hotel building's walls. Adoption of standard guidance on calculating floor area will enable better, more consistent modeling.

The study also had limitations in the translation of energy to carbon. Emission factors for purchased electricity have been shown to vary widely both geographically and over time. As electricity is often the primary source of energy and GHG emissions in a hotel, variations in electricity emission factors do not enable fair comparison of other emission factors. For example, the percentage of emissions represented by identical amounts of mobile fuels or fugitive emissions could vary greatly in two hotels with equal amounts of electricity, natural gas, and mobile gasoline consumption but located in two different countries. The mobile fuels percentage can be adjusted by developing models based solely on energy consumption or normalizing for country emission factors, but that is not possible for fugitive emissions. Finally, the calculations will change as hotels take action to reduce carbon emissions with renewable energy and carbon offsetting.

Conclusion

This study has shown the importance and complexity of materiality in a hotel's carbon-related performance and has demonstrated calculations for the materiality and the footprint of mobile fuels and fugitive emissions in relation to a hotel's overall GHG emissions. Further industry discussion and research are necessary to arrive at standard forms of calculating and communicating hotel carbon footprints that include the purchase of RECs and carbon offsets, as well as defining the materiality of all the variables involved. Consideration should also be given to the practicality of data collection and the inherent uncertainty involved for emissions sources that will produce a final figure only marginally more precise, for which the figure itself is only optionally included in protocols used by stakeholders. ■

Appendix

Boundaries and Quantification Methods Used in Carbon Footprint Calculations

Boundaries

Data Parameters	Included	Not Included
Data-as-boundary	All operations utility consumption	Construction/Renovation
Recent, contiguous 12-month period	Stationary Fuels Burned	Outsourced operations
Facility-level	Mobile Fuels Burned	Treatment of wastewater
Self-reported	Fugitive Emissions	Water purification
No weather normalization	Purchased Electricity	Offsite IT servers
No chain scale normalization	Purchased Steam	Employee commutes and travel
		Corporate or regional offices
		Life cycles of materials and supplies

Quantification Methods

Data Point	Source	Observation
Energy Units Conversions	EPA Energy Star Energy Units Conversion Table	Converting all to kWh
Heating and Cooling Degree Days	www.degreedays.net	Base temperature of 15.5 Degrees Celsius
Methane (CH_4)	IPCC 2nd Report (2006)	GWP of 21
Nitrous Oxide (N_20)	IPCC 2nd Report (2006)	GWP of 310
Refrigerants	WRI HFC and PFC Emissions Version 1.0	100-year GWP cycle
Butane	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
Diesel	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
Fuel Oil #1-6	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
Natural Gas	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
Propane	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
LNG	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
LPG	WRI 4.0 Stationary Combustion, US Energy Information Administration Form EIA-1605 Appendix H	Global Factor including N_2O and CH_4, Site Energy
Purchased Electricity	WRI 4.1 Stationary Combustion (2011) , EPA eGRID 2010 for USA	Country Factor for Non-USA, eGRID regional Factor for USA, Site Energy
Purchased Steam	US Energy Information Administration Form EIA-1605 Appendix N	Country Factor for Non-USA, eGRID regional Factor for USA, Site Energy
Purchased Chilled Water	US Energy Information Administration Form EIA-1605 Appendix N	Country Factor for Non-USA, eGRID regional Factor for USA, Site Energy

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