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HOTEL SUSTAINABILITY BENCHMARKING (HSB) STUDY

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Cornell University
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Working Paper

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Wyndham Worldwide

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I. SUMMARY

This document presents the results of the first Cornell Hotel Sustainability Benchmarking (HSB) study of hotel carbon and energy data from the 2012 calendar year, which may evolve and repeat annually. By developing industry benchmarks, a more thorough understanding of attributes affecting energy usage and carbon emissions can be advanced. Lessons learned can be applied to both internal and external stakeholder audiences with the end goal of reducing the environmental impact of hotel operations.

The study was conducted for the following purposes:

1. Provide credible benchmarks according to industry-specific segmentation and metrics globally;
2. Provide industry data analysis while maintaining a confidential data set, through an academic center, that will not be shared with 3rd parties or used commercially; and
3. Pursue a common definition and transparent, rigorous method for modeling carbon and energy usage based on hotel-specific attributes and data.

Similar studies have been proposed or conducted several times by numerous entities in the past. The differences and specific advantages of this study are:

1. The current climate of collaboration among industry peers around sustainability measurement and reporting with the common desire to reduce duplication of efforts;
2. Increased external stakeholder requests and use of sustainability-related performance data;
3. Global reach;
4. Technological capacity of global hotel companies enabling the facilitation of data collection; and
5. Technical expertise and reputation of the study's investigators regarding sustainability performance measurement, benchmarking, and modeling.

This study was undertaken as a collaborative effort among the Cornell University Center for Hospitality Research (CHR), the Cornell University Center for Real Estate and Finance (CREF), Greenview, and select global hotel companies:

- Hilton Worldwide
- Host Hotels & Resorts
- Hyatt Hotels Corporation
- InterContinental Hotels Group
- Mandarin Oriental Hotel Group
- Marriott International
- Starwood Hotels & Resorts
- The Hongkong and Shanghai Hotels
- Wyndham Worldwide

The results of the seminal study revealed several interesting insights:

- A challenge exists in compiling and validating accurate, complete data among the industry.
- Footprints range widely by location and segment, and even within location and segment itself.
- Further exploration is needed regarding the drivers in energy beyond occupancy and climate in order to develop accurate modeling.
- This type of benchmarking exercise will benefit most from common definitions of measurement for all aspects including occupied room counts, floor area, energy usage, and carbon emission factors.
- Several opportunities exist for improving data quality in subsequent studies.

II. BACKGROUND

The value of benchmarking performance against prior years and current competitors, as well as the use of accepted benchmarks are proven and widely understood within the hotel industry. Benchmarking is in place in several forms within and around hotels. Benchmarking has long been valued, practiced, and even mandated in the case of energy consumption in buildings.

In the past few years, new benchmarking needs emerged for a growingly diverse audience. Specifically in the field of sustainability, utility benchmarking requests have increased. Benchmarking of utility data in municipalities, regions, and countries is emerging, and rating systems have emerged. Some efforts have used limited data sets or cursory calculations, or have not received wide-spread industry buy-in. In the absence of an industry-led initiative, these efforts cloud the dialogue. Moreover, the dialogue is increasingly important as customers purchasing large quantities of hospitality services are requesting the carbon footprint of their stay while demanding consistency and transparency in the calculation methods used. Consequently, carbon footprinting exercises will lead to external uses of benchmarking of carbon among hotels.

Several attempts at industry-wide benchmarking in both energy and carbon have been attempted in the past[1], demonstrating a clear need for globally accepted benchmarks that are 1) backed by sufficient, timely data, 2) tailored to hotel operations specifically and not as a subset of commercial buildings, and 3) supported by critical mass of industry audience.

The need has been voiced for independent data analysis and collaborative industry efforts for operational performance at the Cornell Hospitality Research Summit in 2010 and Sustainability Roundtable in 2011[2]. Several attendee companies expressed willingness to submit data to an independent host within the industry. As a precursor, the industry has recently established the Hotel Carbon Measurement Initiative (HCMI), a common protocol on carbon calculation[3]. However, HCMI in its current version does not outline a standardized set of emission factors which can cause significant variation in the final carbon metrics of a hotel. The need for comparable data on energy consumption and carbon emissions within industry persists. The purpose of the Hotel Sustainability Benchmarking study is to establish a formalized, annual benchmarking program specifically tailored to the global hotel industry.

Application of HSB Data

Specific applications of HSB data include:

1. **Allowing for Internal Benchmarking** – hotel properties and companies wishing to compare performance against a general competitive set may use the benchmarks against their own performance. Managers, owners, and lenders may identify poorly performing properties based on the comparison to the median in that market. Low and High values may be used when internally scrubbing data for quality checks.
2. **Improving Rating Systems** – entities that rank or score hotels based on environmental performance can incorporate benchmarks from the report and quantification methods to tailor their own methodology. For example, the resulting energy benchmarks and properties' positioning can be compared with Energy Star ratings.
3. **Expediting Customer Carbon Footprint Calculation** – lodging customers seeking to calculate the carbon footprint of hotel stays may use the HSB results as default data for their location of stay in question as a credible means of calculation. This will expedite the practice of calculation, saving time in requesting property-specific data across an entire city for event planners, or globally for corporate business travel.
4. **Streamlining Voluntary Carbon Offset Programs** – carbon offset programs can use HSB figures to more credibly and transparently estimate carbon footprint values to offset in an equally expedited format.

[1] For further discussion on historical attempts and use of benchmarking, see Ricaurte (2011) 8-16.
[2] Ricaurte, Eric. "The Hospitality Industry Confronts the Global Challenge of Sustainability." Cornell Hospitality Proceedings 4.1, February 2012.
[3] For further information on HCMI, see http://en.wikipedia.org/wiki/Hotel_Carbon_Measurement_Initiative

5. **Improving Internal Modeling** – hotel companies with proprietary benchmarking systems may take the correlations, regression studies, and lessons learned into consideration for improving their own internal modeling.
6. **Setting Municipal Coding and Regulations** – entities that wish to benchmark performance specifications of energy or carbon performance in municipalities or regions can use the geographic-specific data from which to benchmark their codes or common thresholds.
7. **Improving Country Perspectives –** in countries without any formalized benchmarking process, the research may fill the gap for basic environmental data uses in these countries in feasibility studies, cost analysis, and payback calculations on retrofits and renovations.
8. **Use for Hotel Development –** developers and consultants from smaller outfits and even larger firms may be able to use benchmarks in feasibility studies for estimating energy usage and any resulting fees, risks, or opportunities relating to carbon.

III. DATA PREPARATION

An advisory group was formed consisting of one representative from each participating company. The foremost challenge in arriving at global benchmarks was consolidating and harmonizing the data sets and carbon calculation across companies, segments, and geographic regions. As issues of measurement arose, the group was engaged through conference calling and surveying. Final decisions on study preparation however fell upon the principal investigator.

The advisory group supported the development and testing of a common data request form, allowing for flexibility within each entity to utilize their internally existing data structures. All participating companies were requested to submit floor area, monthly energy consumption by type, monthly occupancy by type, property location, and market segment. A pilot test was performed with select data, presenting the results to the advisory group for review with their corresponding issues. Surveying and group discussion was held to further finalize issues.

Final data were submitted, and a validity check was returned to all participants, flagging data that lacked a full year's data, exceeded minimum 5% or maximum 95% thresholds, or demonstrated a questionable variance over the 12-month data set period. Participants corrected data or overrode the flags where possible. The results are presented in the tables in Appendix A. Further information on data preparation and calculation methods can be found in Appendix B.

IV. RESULTS

Data were received from 4,620 hotels in 112 countries. Of this global data set, 2,922 (63%) hotels were excluded for failing to meet validity tests or missing data. To maintain confidentiality, individual hotel data are not publicly disclosed; only geographies with data available for a minimum of 10 hotels have summary statistics reported. Of the remaining 1,698 hotels, over 500 were removed from the final published results for not meeting the minimum number of properties (10) within a geography.

The sample size itself is telling of the current situation. To-date, this study represents the single largest energy and carbon benchmarking exercise ever undertaken and made publicly available by the hotel industry or a 3rd party. The high exclusion rate demonstrates the longstanding challenge of hotel companies across the industry obtaining correct data from their portfolios of owned, managed, and in particular franchised hotels. Furthermore, though the data sets are global, we still lack a critical mass of quality hotel data within several geographies with comparable drivers of energy and carbon. However, the major milestone should not be overlooked that the data were not collected through property surveying, but from company data sets.

<u>**Interpreting the Tables**</u>

Using a threshold of 10 properties, data were collapsed into what are termed *Geographies* which are typically either metropolitan statistical area or country. A total of 30 geographies are presented in the tables.

Analyzed 2012 calendar year data for each geography are presented in Appendix A according to the following six metrics:

1. **HCMI Rooms Carbon Footprint per Occupied Room** – using the Hotel Carbon Measurement Initiative (HCMI) methodology as a reference, these values represent the HCMI metric corresponding to the apportioned rooms footprint of each hotel[4]. This metric is useful in calculating the carbon footprint of a hotel stay from the guest's perspective.

2. **Hotel Carbon Footprint Per Room** – the total GHG emissions of the hotel divided by the total number of rooms, without factoring in occupancy or floor area.

3. **Hotel Carbon Footprint per Occupied Room** – the total GHG emissions of the hotel divided by the total number of occupied rooms. Occupied rooms are rooms sold plus comp rooms, minus no-shows.

4. **Hotel Carbon Footprint per Square Meter** – the total GHG emissions of the hotel divided by the total area of conditioned space, expressed in square meters.

5. **Hotel Energy Footprint per Occupied Room** – the total energy consumption of the hotel divided by the total number of occupied rooms. Occupied rooms are rooms sold plus comp rooms, minus no-shows.

6. **Hotel Energy Footprint per Square Meter** – the total energy consumption of the hotel divided by the total area of conditioned space, expressed in square meters.

For each metric, values are broken down in the following:

1. **Count** – the number of properties included within this geography and segment grouping
2. **High** – the highest value found within the geography segment grouping (this is the ***worst*** performer of the group)
3. **Median** – the middle value found within the geography and segment grouping
4. **Low** – the lowest value found within the geography segment grouping (this is the ***best*** performer of the group)
5. **SD** – the standard deviation across the hotels within the data set

Discussion

Data analysis reveals several nuances specific to hotels and calculation methods which will need to be further harmonized for accurate modeling. Furthermore, results demonstrate specific characteristics that should be taken into consideration when performing benchmarking or footprinting exercises.

Some key energy drivers were visible with the data, while others remain speculative with further variables needed to be gathered in future studies.

Wide Range in Energy Usage

The most apparent observation from the data is the extreme variation across geographies and even within geographies. There were also a handful of outliers. These may be large properties with several amenities or highly inefficient fuel sources or inefficient use of energy. While these hotels are several standard deviations away from the mean, they demonstrate that some hotels may have very large footprints. These instances of hotels with high footprints exist in many geographies, and are not just statistical anomalies though they fall far from the mean. For example it was

[4] Due to the lack of credible data on the presence of onsite laundry wash within the sample, no allocation was made for outsourced laundry wash.

apparent that the luxury sector on average has a much higher energy per square foot than other full-service hotels, yet because of data constraints these were collapsed into the same grouping as upscale hotels. Likewise, the Upper Midscale segment demonstrates a wide range of footprint values within the segment itself, as the segment demonstrates the widest range in its total floor area, amenities, and location among the data set. We explore a few of the drivers of the general energy variation below: laundry wash, room size, and HVAC usage analysis.

Laundry Wash

Handling of laundry wash may influence a hotel's energy consumption, however the specific effect is difficult to pinpoint based on the data. Table 1 below presents how 421 hotels (about 25% of hotels in the sample) indicated the property status of laundry wash[5]. Of those, about ¾ of hotels handle laundry in house, with upscale hotels doing laundry more often. Because data were insufficient to determine laundry usage in the data set, we did not add in any factors to the HCMI metrics to account for outsourced laundry. This is an opportunity for improvement in the next study, and we used this year's data to analyze the contribution of laundry to a hotel's energy footprint for the data available.

Table 1: Breakdown of Laundry Wash in the Data Sample

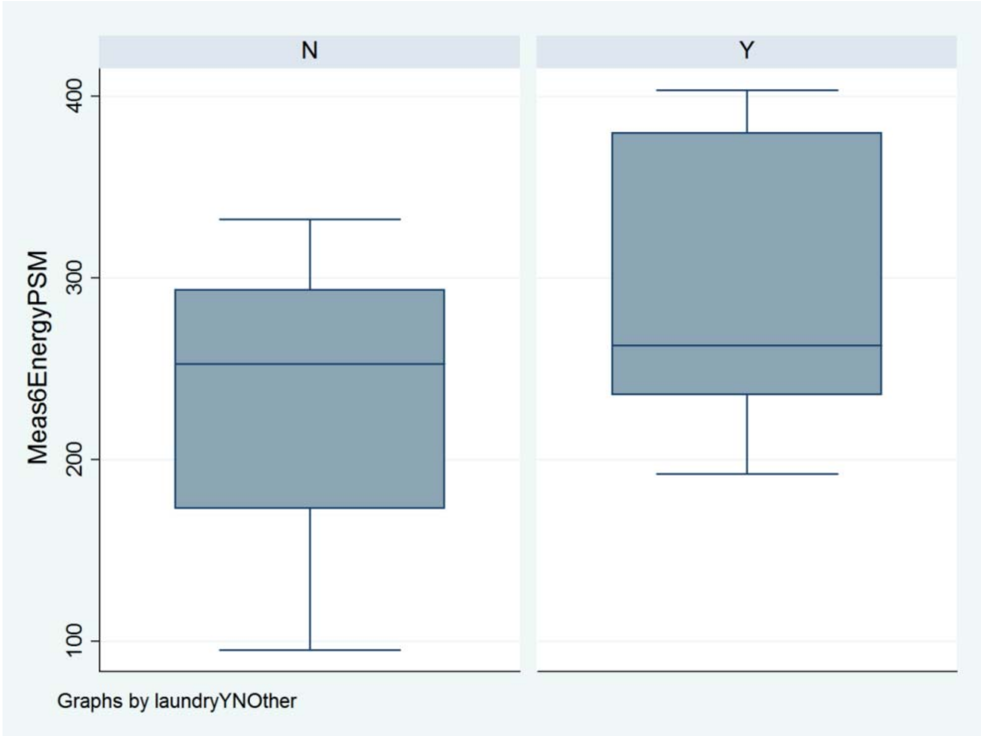
Segment	Laundry Wash Identified	Included In Utility Data (Laundry InHouse)	Not Included In Utility Data (Laundry Outsourced)	% Included
Economy/Midscale/Upper Midscale	83	35	48	42%
Upscale/Upper Upscale/Luxury	338	261	77	77%
Total	**421**	**296**	**125**	**70%**

To attempt to analyze the contribution of laundry wash to a hotel's energy usage the most straightforward solution would be to sub-meter the usage from laundry facilities and analyze the data across a representative sample. This is an opportunity for future study, however in the current data set without sub-metered laundry data, two broad approaches exist: the bottom-up and the top-down approach. The bottom-up approach adds up the amount of laundry used, determines drivers of this laundry use, and looks at the energy per unit of laundry (which may vary based on technology). The top-down approach looks at total energy use and attempts to infer the energy used for laundry based on variation in laundry use across hotels.

A simple, illustrative example of the top-down approach is given in Figure 1 below. These represent the distribution of energy per square meter (in kWh) between those who outsource laundry (N) and those who handle it in-house (Y) for upscale or higher hotels in one major US metropolitan city. There is considerable overlap in the distributions. Secondly, there are fewer than 10 observations in each group. Third, since these are of the same segment and geography, climate and segment are not driving the difference. However, there are other drivers of energy use even within this segmentation that could drive the effect. The difference in the averages is about 30%, but it is not statistically sound to infer 30%.

[5] We recognize that partial laundry wash exists in-house in some instances. For the sake of this exercise, properties that outsourced or at an offsite location washed bed linens and towels were considered to be outsourced.

Figure 1: Distribution of energy intensity among hotels with or without laundry wash



The top-down approach can be applied to the global dataset using statistical analysis. Multivariate regression analysis was run to see at what level those hotels that do laundry in-house have an increase in total energy use normalized to the hotel indoor area (Energy PSM). Using controls for city and segment and allowing laundry's impact to vary across the segments, laundry had a 14% +/- 50% increase for upper midscale and below and an 8% +/- 50% increase. The wide margin of error is due to the wide variation in the overall energy usage of hotels and the small number of hotels.

Peak and HVAC use percentage

Although annual data are used for reporting and benchmarking in many cases, monthly utility data is extremely valuable in understanding what energy savings reductions are likely. In fact, ASHRAE energy audit guidelines state that monthly utility bill analysis is an essential first step.

Using the sample we have effectively run a utility bill analysis for 2000+ hotels across dozens of countries and climate zones. Monthly data is split up into cooling and heating months, and a baseline energy usage is computed. Figure 2 below plots the inferred heating and cooling (usage above baseline) as a percentage of total use; in a year, the average hotel uses about 13% of energy use on heating and cooling, with a wide variation. A large proportion of this variation is climatic differences, but a surprisingly large amount is not.

Figure 2: Inferred Heating and Cooling as a Percentage of Total Energy Consumption

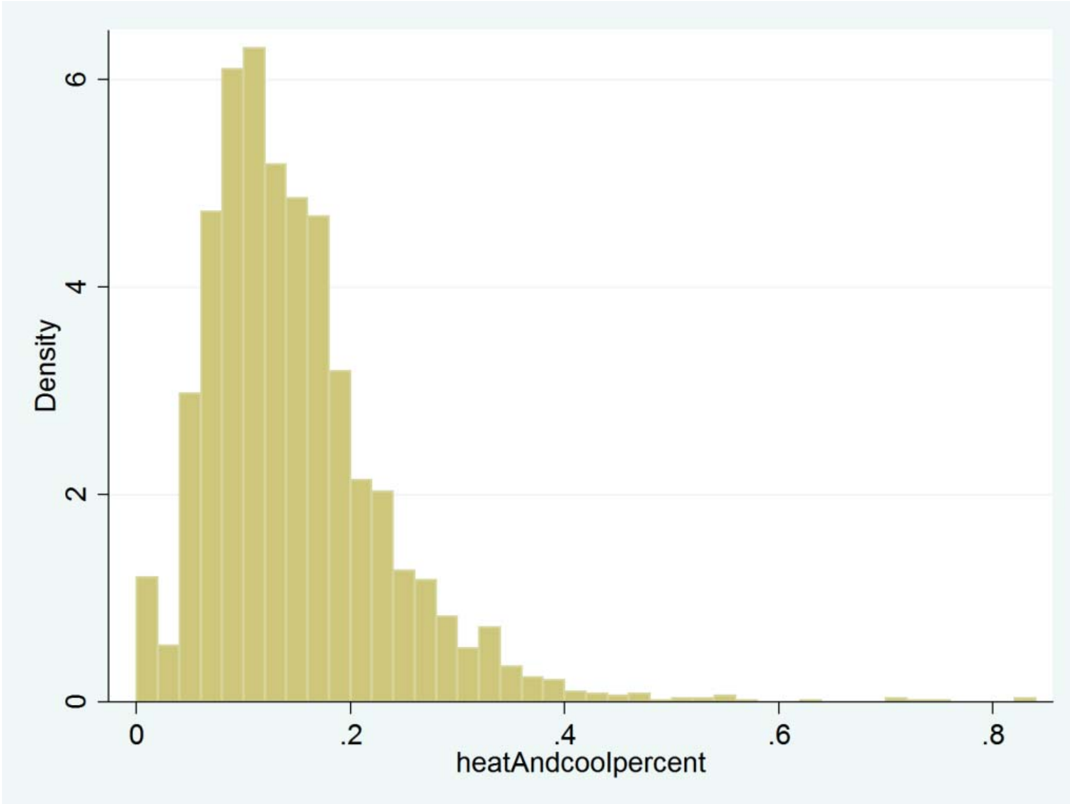


Table 2 below shows the variation within geography and segment of inferred HVAC as a percentage of total use. Variation within a geography and a segment is largely driven by the physical assets and HVAC and building thermal system. High values within a geography indicate buildings that have high potential for cost-effective retrofits. Those with lower values within a geography are buildings with well-performing thermal control systems. There is a cluster of hotels with inferred HVAC at zero; this does not mean that HVAC was not used, but that the bill analysis was not able to clearly distinguish HVAC usage from other normal usage using monthly data. A typical property has a winter and/or a summer peak. Irregular usage patterns would represent data quality issues, a seasonal use pattern, or an atypical climate profile.

Table 2: Inferred HVAC as a Percentage of Total Use by Geography and Segment

	Sample	**Median HVAC energy percentage**	**25-75 interval**
UPPER MIDSCALE OR LOWER	34		
Chicago	11	15%	11%-24%
Dallas	12	15%	12%-17%
Minneapolis	11	15%	14%-23%
UPSCALE AND HIGHER	1049		
Atlanta	48	10%	7%-14%
Austin	18	10%	8%-12%
Baltimore	18	13%	11%-20%
Beijing	11	21%	16%-25%
Boston	43	18%	13%-25%
Charlotte	13	8%	7%-11%

(Table 2 Continued)	**Sample**	**Median HVAC energy percentage**	**25-75 interval**
Chicago	59	20%	16%-24%
Cincinnati	17	14%	12%-20%
Cleveland	10	17%	13%-21%
Dallas	49	12%	9%-17%
Denver	27	16%	13%-19%
Detroit	17	22%	17%-27%
Houston	34	12%	6%-16%
Indianapolis	18	16%	11%-19%
Jacksonville, FL	16	12%	10%-14%
Kansas City	17	15%	13%-20%
London	11	15%	11%-21%
Los Angeles	60	7%	5%-9%
Louisville, KY	10	15%	13%-17%
Miami	38	7%	5%-12%
Minneapolis	11	19%	9%-30%
Nashville	14	12%	8%-20%
New Orleans	14	8%	6%-11%
New York	70	18%	11%-22%
Orlando	21	11%	7%-13%
Philadelphia	33	16%	10%-21%
Phoenix	39	11%	7%-14%
Portland	12	13%	7%-17%
Richmond, VA	14	14%	11%-18%
Riverside-San Bernardino-Ontario, CA	10	9%	9%-9%
Sacramento	12	8%	7%-11%
San Antonio	19	14%	10%-23%
San Diego	27	7%	6%-10%
San Francisco	38	8%	6%-10%
Seattle	22	13%	9%-18%
Shanghai	18	20%	18%-24%
St. Louis	13	13%	8%-19%
Tampa-St. Petersburg-Clearwater, FL	25	11%	6%-13%
Virginia Beach-Norfolk-Newport News, VA-NC	18	14%	10%-20%
Washington, DC	85	12%	9%-16%

Taking NYC Upscale and Luxury Hotels as an example, the median hotel had 18% of their energy use applied to heating, cooling, and ventilation. Most hotels were within the 25%-75% range of 11% to 22% of energy to HVAC. This means that 25% of hotels had HVAC usage of higher than 22%. These hotels are prime candidates for energy retrofits that may ultimately save the hotel money in the long-run.

Across geographies, those in milder climates (e.g. California, with 9% median HVAC usage) have lower HVAC usage than those in harsher climates (e.g. Detroit and Chicago with 20-22% median HVAC usage). Hence, the above table is essential in determining whether the HVAC usage percentage is high or not. 14% would be a high-usage, wasteful building in California, but would be a very low-usage one in Detroit and Chicago.

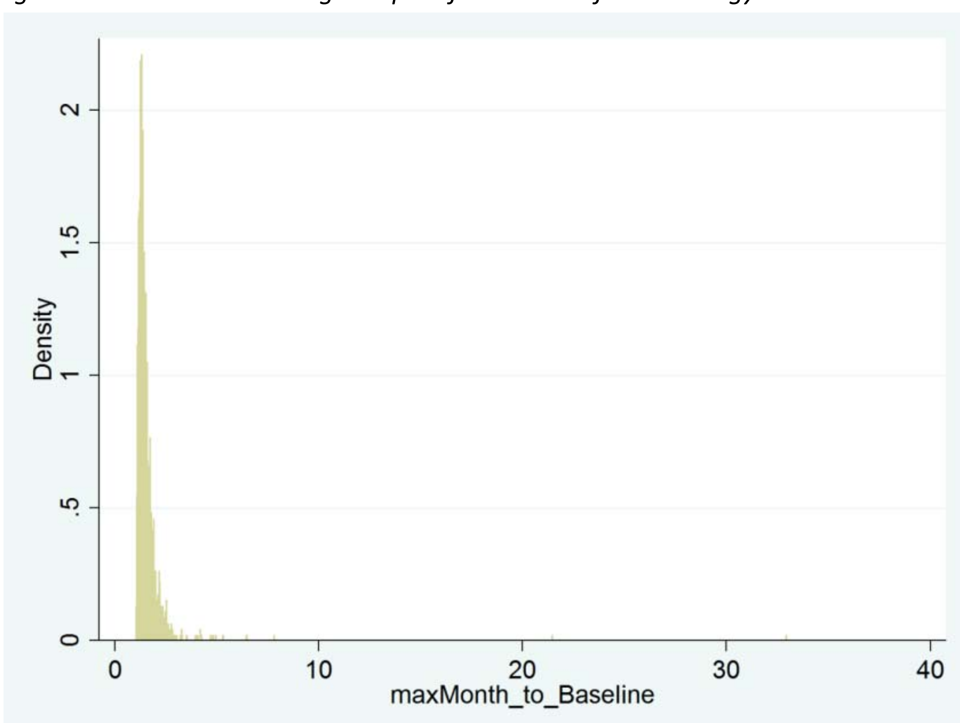
International comparisons can also be helpful. Shanghai and Beijing have higher median usage than US cities with corresponding climate zones (like DC and Boston). Hence, these hotels may have potential for large energy savings. Cheaper energy costs in China may also indicate less financial incentive to pursue efficiency, hence the higher usage numbers.

HVAC percentage is also an easy data check. Extreme outliers (<2% and >50%) are likely to be errors in data reporting or data processing or both. The gathering of monthly data also allows analysis of the largest energy usage month to the baseline. The global distribution is shown in Figure 3 below. The median hotel has a peak of 1.4 times the baseline. 10% of hotels in the data set use 1.9 times or more of their baseline usage in their highest month. Again, one would expect most of this variation to be across climate. However, a surprising amount of this variation is within a geography and segment.

This peak month is the building operating under the highest thermal stress. Since buildings in the same geography face the same weather, this "peak" usage can also reveal which buildings perform better. Using New York Upscale and Luxury hotels as an example, the median hotels have a peak of 1.5 times baseline, but 10% of hotels use 2.0 times baseline.

Utility bill analysis is not a substitute for engineering analysis. Building science tells us that more compact buildings lose less heat in the winter than narrow buildings. Hence, both the HVAC percentage and peak-month values may be higher for a reason that is not easily change-able (e.g., the shape of a building). However, the utility bill analysis is a very simple and fast analysis. Combined with benchmarking, these can help identify buildings that can be more energy efficient.

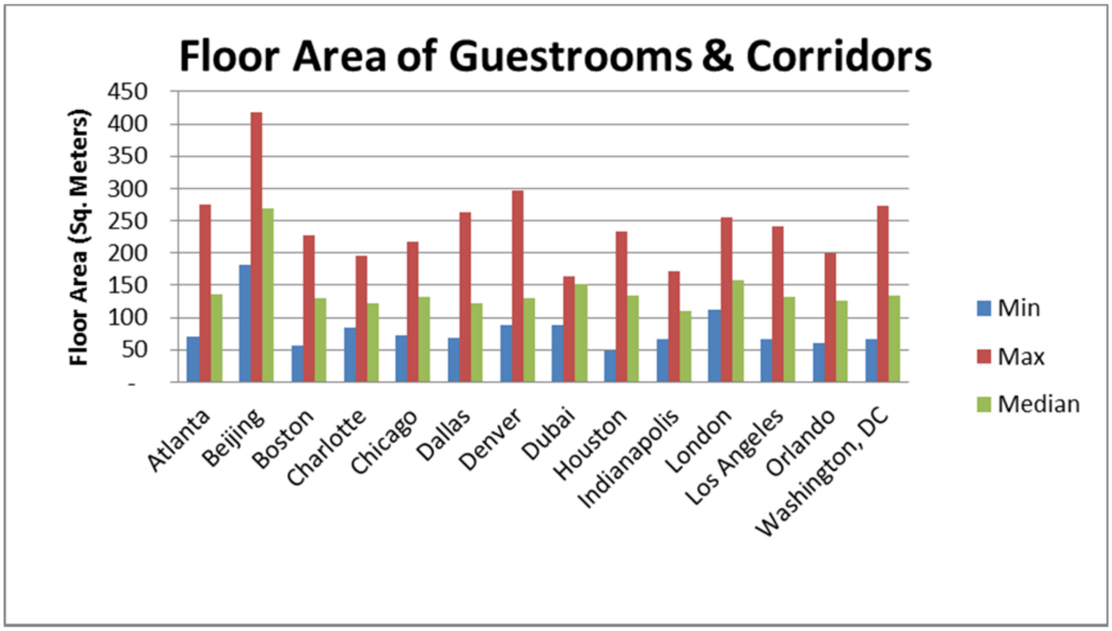
Figure 3: Distribution among Sample of the Ratio of Peak Energy Month to Baseline



Variation in HCMI Room Size

Variation in HCMI figures as well as energy per occupied room can also be explained when considering the varying floor area of guestrooms globally and within specific markets. We divided the HCMI rooms & corridors allocation of the hotel by the number of rooms, presented in Figure 4 below.

Figure 4: Examples of Range in Floor Area among Select Geographies



Analyzing these results, it is important to note that though the median values of energy usage intensity generally fall within similar ranges across geographies, a significant range will exist within each geography and this may be due to room size as well as the amount of public areas and back of house areas lumped into the calculation.

Standardized Emission Factors

This study also seeks to provide clarity on carbon emissions in hotels since it uses standardized emission factors for the entire data set. One current limitation to comparability in the general current state of carbon calculation in facilities is the disparate use of emission factors in the calculation. The choice of emission factors and assumptions will inhibit comparison and uniform footprinting. The science and precision of arriving at carbon factors and global warming potential itself is subject to a high degree of uncertainty and disagreement as has been noted in prior studies[6]. For example, the use of regional vs. national emission factors in the United States could sway the hotel's footprint by a factor of 3 or more. Furthermore, emission factors are constantly changing as data sets are updated, and even if the same reference for emission factors is the same, using different years of a references publication can cause variation. Thus for comparing carbon, it is more important that the entire industry use the same factors than to constantly seek maximum perceived precision for factors themselves derived from inherent uncertainty.

Renewable Energy

An increasing number of hotels are running on some portion of renewable energy. Slightly over 100 hotels indicated renewable energy sources as part of their energy usage, but data reporting quality varied across properties. What was not represented in the data is also the increasing percentage of renewable or low-carbon energy being fed into the electricity grid in certain countries. As renewable energy mandates become more prevalent, the distribution of low-carbon energy will be more interesting to study. This will average out across a country or region with the same specific

[6] See Ricaurte, Eric. "Determining Materiality in Carbon Footprinting: What Counts and What Does Not." Cornell Hospitality Report 12.12, September 2012, 11-12.

sources of energy generation. On the other hand, hotels that are purchasing or generating renewable energy need to be able to be distinguished for this effort.

V. LIMITATIONS AND OPPORTUNITES

The study's overall limitation is at the same time its greatest opportunity. The data sets presented are not necessarily actionable due to the additional set of factors to consider when examining performance in energy usage and carbon emissions. In arriving at a unified, globally-representative data set with significant industry participation, however, the opportunity exists to further refine and improve the benchmarking methods each year. Increased participation from additional companies as well as increased availability of data within current companies will greatly strengthen the data set in the future.

As such, for next year's figures, the data set and geographies themselves may change, as may new agreements to harmonize emission factors. Therefore, analyzing year-over-year comparison may not be practical in the coming year. The following limitations and opportunities for future studies were identified:

Issue	Description	Limitation/Approach
Fugitive Emissions and Mobile Fuels Data	Some participating companies included fugitive emissions and mobile fuels in their data sets, while some did not.	• The contribution of fugitive emissions to carbon footprints was not analyzed in this study. In future years fugitive emissions may be added to the carbon footprint metrics. This may be collected if valuable to the group, also enabling analysis of which types of facilities generate more emissions and how that may influence footprints.
Collapsed Segmentation	Using a threshold of 10 properties per segment, sufficient data were not available in most cases for presentation of results separately within each segment.	• Segments were collapsed into two categories only for this study: Economy/Midscale/Upper Midscale, and Upscale/Upper Upscale/Luxury. • As the sample was limited to data provided by hotel companies, the independent segment was not analyzed. • In future studies, larger data sets will enable further segmentation.
Other Energy Drivers	Several energy drivers such as type of amenities present within the hotel's utility data set were not analyzed. Furthermore, humidity is often a driver of energy and was not factored into the analysis.	• In future studies, the researchers will work with the advisory group to define additional variables to include in the data collection for analysis to support modeling. Key opportunities are restaurants, swimming pools, humidity, and further clarity on laundry wash.
Geographies Across Countries and Regions	Collapsing the data set into geographies that span across entire countries limits the usefulness of the carbon benchmarks, as emissions per kWh of electricity vary widely across countries.	• Hotels in countries with less than 10 properties were excluded from the published results. With more robust data, more markets and countries can be added each year.

Hotel Location Segment	The business types of hotels were not analyzed (suburban, airport, resort, etc.) in the present study but may offer further insight wen analyzed.	• Future studies can include data capture on location segments for analysis.
Data Verification	Data submitted were self-reported from respective sources.	• All self-reported data were accepted for this year's study, with a validity check for completeness and extreme outliers being the only control used. • For future studies, participating companies should indicate whether and how data have been verified. A minimum threshold of data verification processes may be added as a validity test.
Monthly Energy Data Calendar Parameters	Monthly energy consumption figures are either normalized by the participating company (or provider) to match calendar days exactly, or use billing cycles which are a proximate but imperfect match.	• As a first year, the researchers did not seek to standardize exact calendar matches for monthly data received. • Each company submitted their energy data as they currently have it prepared by month, indicating what the months represent (whether normalized to match calendar days, smoothed, or raw from utility billing cycles, or unknown).
Purchased Chilled Water Emission Factors	Default data and research on emission factors for chilled water across a global data set is inconsistent.	• A default method for calculating emissions from purchased chilled water was used per the US Energy Information Administration's (EIA) guidance on Voluntary Reporting of Greenhouse Gas Emissions arriving at an emission factor as a function of the emission factors for electricity generation per country. • For future studies, further granularity will be sought by the researchers in applying factors for chilled water.
Purchased Steam/Heat Emission Factors	Default data and research on emission factors for purchased steam or heat across a global data set is inconsistent.	• For this year's study, a default emission factor of purchased steam or heat was applied to all properties globally when purchased steam or heat was used (per the US EIA's guidance on Voluntary Reporting of Greenhouse Gas Emissions). • For future studies, further granularity will be sought for emission factors for purchased steam, requesting support from all participating companies to provide the respective COP or Emission Factors when provided by the utility.

VI. CONCLUSIONS

Over the past few years, great strides have been made both externally and internally within the industry about how hotels can consistently report the energy consumption and carbon footprint of a room. Paramount collaboration has carried forth the researching, standardizing, and submitting data to enable better carbon measurement. Better data sets will increase the value of this study and its applications as the process continually improves. However as benchmarks become standardized and better available, the more important next step is to disseminate this information. Too often data are reported from hotels to a central location, but the hotel never sees how it is used or helps the company. Furthermore, the move can be made beyond just reporting to using the data for continuous improvement and ultimately achieve the goal of reducing energy consumption and carbon emissions at each hotel property and for the industry as a whole.

Finally, benchmarking in the hotel industry has tended to lean toward reliance on singular magic numbers such as RevPAR. However, when analyzing energy and carbon, it is important to recognize the increased complexity that will affect performance. While rigorous statistical analysis can enable valid regression models to properly compare, singular numbers will not be all-telling for whether a property is managing its energy and carbon footprint well. A series of specifications, processes, and other factors are involved and collectively form the managerial approach to benchmarking.

Looking ahead to Next Year's Study

The 2014 Cornell HSB study will open in May 2014, with results produced in the fall of 2014. Eligible companies will be invited to participate. Based on the number of participating companies, HSB may limit additions to the advisory group based on a minimum threshold of hotel properties' data submitted. Interested parties may contact Eric Ricaurte, eer3@cornell.edu for further information.

APPENDIX A: BENCHMARKS BY GEOGRAPHY

Region	MSA Definition
Atlanta	Atlanta-Sandy Springs-Roswell, GA
Baltimore	Baltimore-Columbia-Towson, MD
Boston	Boston-Cambridge-Newton, MA-NH
Charlotte	Charlotte-Concord-Gastonia, NC-SC
Chicago	Chicago-Naperville-Elgin, IL-IN-WI
Cincinnati	Cincinnati, OH-KY-IN
Dallas	Dallas-Fort Worth-Arlington, TX
Denver	Denver-Aurora-Lakewood, CO
Detroit	Detroit-Warren-Dearborn, MI
Hong Kong-Shenzhen-Macau	Hong Kong-Shenzhen-Macau
Houston	Houston-The Woodlands-Sugar Land, TX
Indianapolis	Indianapolis-Carmel-Anderson, IN
Kansas City	Kansas City, MO-KS
Los Angeles	Los Angeles-Long Beach-Anaheim, CA
Miami	Miami-Fort Lauderdale-West Palm Beach, FL
New Orleans	New Orleans-Metairie, LA
New York City	New York-Newark-Jersey City, NY-NJ-PA
Orlando	Orlando-Kissimmee-Sanford, FL
Philadelphia	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
Phoenix	Phoenix-Mesa-Scottsdale, AZ
San Antonio	San Antonio-New Braunfels, TX
San Diego	San Diego-Carlsbad, CA
San Francisco	San Francisco-Oakland-Hayward, CA
Seattle	Seattle-Tacoma-Bellevue, WA
Tampa	Tampa-St. Petersburg-Clearwater, FL
Virginia Beach	Virginia Beach-Norfolk-Newport News, VA-NC
Washington DC	Washington-Arlington-Alexandria, DC-VA-MD-WV

MEASURE 1: HCMI ROOMS FOOTPRINT PER OCCUPIED ROOM (kg)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	38	81.9	30.0	17.8	13.2
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	33.8	19.0	16.2	5.9
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	81.1	19.9	14.4	13.8
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	27.9	18.2	15.3	4.9
Chicago	USA	N/A	N/A	N/A	N/A	N/A	53	112.8	30.1	20.2	18.0
CHINA		16	100.9	43.8	7.6	24.5	23	235.0	122.7	62.9	50.7
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	56.4	29.8	24.3	7.9
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	62.3	26.6	17.1	9.9
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	52.5	30.3	22.7	10.0
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	49.2	28.1	23.2	6.5
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	298.5	108.1	85.6	86.3
Houston	USA	N/A	N/A	N/A	N/A	N/A	26	57.9	27.3	20.1	10.7
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	51.4	26.1	19.0	10.0
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	68.4	37.7	26.2	11.9
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	47.2	16.2	12.2	7.6
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	84.8	28.3	16.1	14.5
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	11	36.8	29.3	15.7	6.2
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	54.4	17.8	9.3	9.4
Orlando	USA	N/A	N/A	N/A	N/A	N/A	15	44.4	23.8	16.4	8.3
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	44.1	19.0	15.1	8.1
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	54.8	25.8	18.4	11.1
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	53.3	29.8	19.8	10.0
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	65.8	18.1	6.8	13.0
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	14	29.9	14.7	9.2	5.6
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	34.9	20.6	15.2	5.1
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	64.4	23.8	19.3	12.2
USA		107	80.3	22.7	5.5	11.2	1,026	112.8	25.0	6.8	12.3
UNITED KINGDOM*							11	41.6	23.9	2.6	12.8
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	66.7	23.6	17.9	11.4
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	59.7	23.2	14.6	8.2

**All segments collapsed*

MEASURE 2: HOTEL CARBON FOOTPRINT PER ROOM (kg)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	39	20,115.4	9,305.5	5,196.8	4,052.2
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	9,848.0	5,194.1	4,250.7	1,940.8
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	22,401.5	6,037.4	4,261.9	3,675.3
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	8,534.7	5,348.1	4,270.3	1,677.7
Chicago	USA	N/A	N/A	N/A	N/A	N/A	54	29,750.4	8,886.4	5,709.1	5,011.4
CHINA		16	18,812.9	13,229.8	1,990.5	5,684.5	23	71,473.3	26,171.8	15,271.1	14,256.8
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	16,883.9	7,772.8	5,498.8	2,592.7
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	14,341.6	6,582.2	4,335.6	2,997.4
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	17,754.7	8,657.2	6,309.3	3,299.5
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	14,919.0	7,877.8	6,695.0	2,165.3
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	50,010.1	32,291.7	18,365.3	12,087.7
Houston	USA	N/A	N/A	N/A	N/A	N/A	28	26,885.6	9,847.1	4,431.2	4,907.4
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	14,856.9	7,291.1	4,929.2	3,098.9
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	17,172.0	10,116.4	7,455.6	3,298.6
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	14,556.3	4,956.6	3,707.0	2,577.7
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	22,151.1	9,063.6	5,059.7	3,816.1
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	12	11,608.0	8,356.3	4,593.8	1,906.6
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	15,092.7	5,420.6	2,678.0	2,894.9
Orlando	USA	N/A	N/A	N/A	N/A	N/A	17	14,409.1	7,202.8	5,051.0	3,434.0
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	12,045.0	5,154.9	4,219.3	2,532.0
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	16,323.4	5,940.9	4,558.6	3,761.9
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	16,685.3	7,711.6	5,232.2	3,518.7
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	16,764.8	6,175.5	2,012.2	3,135.3
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	15	9,648.4	5,022.1	2,938.5	1,695.8
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	11,310.4	6,251.7	4,399.4	1,844.2
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	18,875.3	6,574.0	4,813.9	4,147.0
USA		109	24,410.1	5,509.2	1,503.2	2,985.3	1,037	30,642.4	6,953.1	2,012.2	3,590.7
UNITED KINGDOM*							12	17,335.4	6,880.8	647.2	4,937.5
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	16,556.6	6,407.0	4,398.0	2,858.9
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	15,850.4	6,587.5	4,143.6	2,494.2

**All segments collapsed*

MEASURE 3: HOTEL CARBON FOOTPRINT PER OCCUPIED ROOM (kg)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	39	90.0	33.9	1.1	17.0
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	37.2	19.4	16.2	7.5
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	83.5	21.9	14.6	14.2
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	31.7	18.5	15.5	6.1
Chicago	USA	N/A	N/A	N/A	N/A	N/A	54	116.2	33.1	1.4	20.4
CHINA		16	115.2	49.3	7.7	27.6	23	285.0	138.2	63.8	62.9
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	64.4	31.4	24.9	10.3
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	77.9	27.2	17.9	12.9
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	61.6	31.1	22.9	12.8
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	59.4	29.3	23.4	9.0
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	314.8	113.8	92.2	91.2
Houston	USA	N/A	N/A	N/A	N/A	N/A	28	69.0	29.1	0.5	16.6
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	56.0	26.8	19.5	12.5
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	86.3	38.3	27.6	16.1
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	49.5	17.3	12.8	8.7
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	90.4	30.5	20.2	16.1
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	12	43.9	30.3	0.6	11.8
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	56.0	19.2	9.6	10.3
Orlando	USA	N/A	N/A	N/A	N/A	N/A	17	60.5	21.9	0.3	16.8
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	46.4	19.4	16.0	9.4
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	82.2	26.4	18.9	16.0
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	68.1	30.7	20.3	15.2
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	76.7	21.9	6.9	15.1
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	14	33.6	16.1	9.3	6.4
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	38.0	22.8	15.8	5.9
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	67.1	24.5	20.1	14.3
USA		108	96.5	22.9	1.4	12.4	1,035	134.1	26.1	0.3	14.9
UNITED KINGDOM*							12	44.6	23.9	0.7	15.2
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	75.7	23.9	20.5	13.8
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	67.2	25.0	16.0	10.5

**All segments collapsed*

MEASURE 4: HOTEL CARBON FOOTPRINT PER SQUARE METER (kg)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	39	196.4	124.0	80.9	29.0
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	143.9	98.2	79.2	19.4
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	194.2	89.0	49.8	31.0
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	145.7	83.9	73.1	25.0
Chicago	USA	N/A	N/A	N/A	N/A	N/A	54	348.9	141.5	97.2	46.6
CHINA		16	699.7	106.8	53.1	200.4	23	369.5	209.2	72.3	77.0
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	181.5	132.2	97.2	26.5
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	196.6	105.3	73.6	28.3
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	208.0	140.6	91.4	35.8
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	202.2	139.9	103.7	27.3
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	328.4	259.9	139.8	76.2
Houston	USA	N/A	N/A	N/A	N/A	N/A	28	264.6	131.1	83.1	49.1
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	199.0	143.8	94.7	28.6
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	227.9	150.3	120.9	29.8
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	188.8	65.6	37.1	32.9
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	201.9	141.6	87.0	32.7
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	12	142.9	119.1	113.2	9.1
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	236.3	94.8	39.3	33.0
Orlando	USA	N/A	N/A	N/A	N/A	N/A	17	223.4	131.3	85.3	35.7
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	155.1	88.6	66.1	24.6
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	189.9	107.7	81.3	27.2
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	167.0	128.6	87.2	25.6
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	129.3	81.8	29.7	26.2
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	14	90.2	62.9	51.4	12.7
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	104.4	83.0	62.4	11.4
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	194.3	116.6	84.7	31.5
USA		111	409.1	118.1	20.4	67.1	1,036	348.9	114.3	22.4	36.9
UNITED KINGDOM*							12	254.3	122.2	6.7	84.5
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	204.6	98.1	78.1	34.5
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	196.1	101.8	69.2	26.2

**All segments collapsed*

MEASURE 5: HOTEL ENERGY FOOTPRINT PER OCCUPIED ROOM (kWh)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	39	207.0	78.7	2.1	42.6
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	114.8	60.2	50.2	21.9
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	270.1	83.3	56.9	44.7
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	90.1	52.0	42.4	17.4
Chicago	USA	N/A	N/A	N/A	N/A	N/A	54	221.2	69.4	2.9	47.6
CHINA		16	344.6	92.6	12.8	77.5	23	835.3	298.4	103.7	164.5
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	139.2	62.0	54.5	24.9
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	167.6	61.6	46.9	32.4
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	151.4	60.2	41.4	33.2
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	122.5	57.8	47.3	19.2
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	474.9	233.8	138.7	127.6
Houston	USA	N/A	N/A	N/A	N/A	N/A	28	207.7	69.0	1.2	46.6
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	145.3	57.2	46.1	30.7
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	113.9	66.0	48.8	20.7
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	201.4	72.5	51.2	35.5
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	232.6	73.7	45.6	41.1
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	12	134.2	89.1	1.4	35.1
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	214.5	66.4	38.7	39.9
Orlando	USA	N/A	N/A	N/A	N/A	N/A	17	148.2	55.2	0.7	40.8
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	169.8	57.8	48.7	32.6
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	192.3	65.5	47.3	39.2
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	168.7	78.4	46.2	44.3
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	322.5	87.7	24.3	64.3
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	14	142.0	66.7	38.9	28.7
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	114.8	78.4	55.7	15.2
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	144.4	61.0	46.8	30.7
USA		108	404.8	51.2	2.6	55.2	1,035	339.6	64.1	0.7	39.0
UNITED KINGDOM*							12	162.0	88.8	2.5	54.9
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	229.8	62.8	54.8	44.0
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	203.3	68.4	45.6	31.6

**All segments collapsed*

MEASURE 6: HOTEL ENERGY FOOTPRINT PER SQUARE METER (kWh)

GEOGRAPHY		Economy/Midscale/Upper Midscale					Upscale/Upper Upscale/Luxury				
Region	Country	Count	High	Median	Low	SD	Count	High	Median	Low	SD
Atlanta	USA	N/A	N/A	N/A	N/A	N/A	39	518.7	287.5	184.7	79.4
Baltimore	USA	N/A	N/A	N/A	N/A	N/A	11	448.7	288.7	229.1	64.9
Boston	USA	N/A	N/A	N/A	N/A	N/A	23	702.5	350.0	174.6	118.0
Charlotte	USA	N/A	N/A	N/A	N/A	N/A	12	404.2	229.4	196.1	72.6
Chicago	USA	N/A	N/A	N/A	N/A	N/A	54	676.1	318.5	210.8	101.6
CHINA		16	1,807.3	199.8	92.7	540.3	23	884.3	355.5	120.9	197.3
Cincinnati	USA	N/A	N/A	N/A	N/A	N/A	17	389.1	284.7	204.0	55.5
Dallas	USA	N/A	N/A	N/A	N/A	N/A	35	466.5	244.2	161.1	76.0
Denver	USA	N/A	N/A	N/A	N/A	N/A	19	516.2	265.5	168.3	98.1
Detroit	USA	N/A	N/A	N/A	N/A	N/A	13	420.3	281.1	209.9	66.0
Hong Kong-Shenzhen-Macau	CHINA	N/A	N/A	N/A	N/A	N/A	5	559.7	461.9	210.3	133.0
Houston	USA	N/A	N/A	N/A	N/A	N/A	28	820.9	315.9	205.4	138.4
Indianapolis	USA	N/A	N/A	N/A	N/A	N/A	12	475.3	303.7	243.0	63.7
Kansas City	USA	N/A	N/A	N/A	N/A	N/A	12	490.8	269.0	206.3	76.2
Los Angeles	USA	N/A	N/A	N/A	N/A	N/A	23	768.2	267.8	143.4	136.2
Miami	USA	N/A	N/A	N/A	N/A	N/A	28	487.0	323.7	192.1	82.0
New Orleans	USA	N/A	N/A	N/A	N/A	N/A	12	385.3	321.6	235.1	49.4
New York City	USA	N/A	N/A	N/A	N/A	N/A	47	901.7	325.5	179.3	136.5
Orlando	USA	N/A	N/A	N/A	N/A	N/A	17	490.9	308.7	220.0	78.7
Philadelphia	USA	N/A	N/A	N/A	N/A	N/A	24	508.8	258.3	197.0	92.6
Phoenix	USA	N/A	N/A	N/A	N/A	N/A	31	460.0	258.6	189.6	69.2
San Antonio	USA	N/A	N/A	N/A	N/A	N/A	15	561.8	329.2	198.2	91.9
San Diego	USA	N/A	N/A	N/A	N/A	N/A	15	543.7	321.5	105.1	116.1
San Francisco	USA	N/A	N/A	N/A	N/A	N/A	14	408.2	265.4	204.9	62.6
Seattle	USA	N/A	N/A	N/A	N/A	N/A	14	347.0	281.7	222.6	37.8
Tampa	USA	N/A	N/A	N/A	N/A	N/A	17	440.4	260.5	201.1	78.2
USA		111	1,571.2	260.3	52.2	214.8	1,036	901.7	277.8	105.1	86.2
UNITED KINGDOM*							12	878.5	366.5	18.6	317.2
Virginia Beach	USA	N/A	N/A	N/A	N/A	N/A	17	620.5	269.3	202.0	109.7
Washington DC	USA	N/A	N/A	N/A	N/A	N/A	68	454.8	278.4	182.5	69.7

**All segments collapsed*

APPENDIX B: DATA PREPARATION AND CALCULATION METHODS

Segmentation

- The researchers assigned a chain scale segment to each hotel per the 2013 US Chain Scale Segment from STR[7]. The US list was used as a proxy to determine global lists.

Square Footage

- Square footage was requested in area of conditioned space.

Energy Harmonization

- All energy values were converted to kWh using commonly accepted conversion factors.
- Purchased energy usage was calculated based on site energy boundary (not source energy) for the energy footprint values.
- No additional conversions were made to energy data received, which were assumed to be representative of the hotel's actual utility usage.

GHG Emissions Calculation

- Included within the calculation:
  - Emissions from stationary combustion of fuels on-site
  - Emissions from purchased electricity, heat, or steam
- Fugitive emissions and emissions from mobile fuel consumption were not included
- Sources of emission factors used:
  - Electricity
    - EPA eGRID version 2012 for all US properties
    - IEA CO2 Emissions from Fuel Combustion (2012 Edition, updated March 2013) for all non-US properties
  - Purchased heat or steam: US Energy Information Administration Form EIA-1605 Appendix N
  - Purchased chilled water: US Energy Information Administration Form EIA-1605 Appendix N (assuming electric-driven chiller), applying country emission factors from IEA CO2 Emissions from Fuel Combustion (2012 Edition, updated March 2013).
  - Hong Kong Towngas – Hong Kong and China Gas Company Ltd., 2012.
  - All other fuels: World Resources Institute Stationary Combustion Tool 4.0

Data Verification

- Data supplied by participating companies did not undergo a process of data verification. Researchers used the data received by companies, performing a validity test. The researchers did not review actual utility bills, occupancy data from PMS systems, or blueprints for square footage calculations. Each participating company may have a different approach to its data validation and verification, which was treated separate from this study and is the responsibility of each participating entity.

[7] 2013 STR Chain Scales: http://www.hotelnewsnow.com/chainscales.pdf