Reporting Metrics and Benchmarking Results in Hotel Energy Consumption: A Systematic Literature Review (SLR)

A. Schick[1]

[1] Research Group Real Estate and Facility Management, Vienna University of Technology, 1040 Vienna, Austria

Abstract

Current regulative policies and sustainable tourism goals require the European hotel industry to create environmental intensity metrics and benchmarking initiatives for non-financial reporting matters. Optimizing and understanding energy use in this field is crucial for enhancing sustainability and operational efficiency. Arising from 40 key-words around the topic, this systematic literature review screened 1,170 peer-reviewed papers from Scopus and Web of Science Databases. Applying distinctive exclusion criteria, 99 key papers were identified and analyzed in detail using the Grounded Theory approach. Findings show that there is growing interest in the re-search field. The dominant intensity metric to measure energy consumption is primary energy use divided by hotels' floor area (Energy Use Intensity, EUI). Furthermore, occupant-related metrics must also be integrated to display the hotel industry's distinctive features adequately. This review analyzes the energy audit results of 1,494 hotels and finds an average EUI of 273.9 kWh/m2. Further findings indicate that consumption generally depends on hotel characteristics such as size, quality level, and number of services. In addition, location and climate normalization play crucial roles when benchmarking on a global scale. Further research is needed to create a regulative-compliant intensity metric matrix and validate it with quantitative data from benchmarking audits in Central European and continental climate regions.

Keywords

Energy Benchmarking, Green Intensity Metrics, Sustainable Hotel Industry, Systematic Literature Review

1. Introduction

According to the UN Enironment Programme (2020), approximately 38% of global carbon dioxide (CO_2) emissions are from the real estate industry. Tourism contributes to greenhouse gas emissions and is responsible for 5% of global CO_2 emissions (UNWTO, 2023), with 21% of those emissions being due to the hotel sector (hotels and other lodging units) (UNWTO, 2019). The hospitality sector has developed and applied green practices for decades to mitigate its environ mental footpath (Han et al., 2018; Jones et al., 2016; Kim et al., 2016). Rosselló-Batle et al. (2010) concluded that energy use in the operation phase is 4 to 6 times greater than in the planning and construction phases. Thus, this is the phase where achieving the highest reduction in resource use is possible (Cunha and Oliveira, 2020; Rosselló-Batle et al., 2010). To report sustainability matters (so-called non-financial reporting) in the hotel industry, a plethora of schemes, including methods, calculators, and measuring tools (e.g., HCMI, Net Zero Methodology for Hotels), reporting standards (e.g., GRI; SASB), certification programs (e.g., EMAS, ECO-Label), energy management frameworks (e.g., ISO 14001, ISO 50001, ISO 50004) have been developed. In addition, the EU legislative framework asks for the "*development of sustainability benchmarks*" in the defined catalog of measures (European Commission, 2018, p. 8 f). Research found that reuse programs in linen, energy-efficient light bulbs, green purchasing, and wastewater treatments are among the most popular green practices in the hospitality industry (Acampora et al., 2022; Manganari et al., 2016). Nevertheless, as postulated Agyeiwaah et al. (2017), scientific and existing standards and certification initiatives seem ineffective. Therefore, this research generally follows the inherent call of several authors, such as Manning (1999) Cheong and Lee (2021) formulating sustainability indicators for the operating system of a hotel and promoting the measurement of emissions. Therefore, this study aims to perform a Systematic Literature Review (SLR) to identify, collect, and categorize the academic field of sustainability intensity indicators in the field of energy consumption to measure and benchmark hotel real estate operations. A further focus is placed on the validity and reliability of the encountered benchmarks by analyzing resource audit results and the factors affecting resource consumption in the hotel real estate.

2. Methodology

When writing a literature review, the basics of teleology process theory must be internalized. The process should be adaptable, with possible movement back and forth between the stages (Juntunen and Lehenkari, 2021). In the study Snyder (2019) a process model was developed out of well-known literature review standards (e.g. Okoli, 2015; Saunders et al., 2012; Tranfield et al., 2003; Wong et al., 2013; Templier and Paré, 2015), four main steps – designing the review, conducting the review, analyzing, and writing the review. This model was also used by most recent literature review articles focusing on environmental accounting for business studies (e.g. Schaltegger et al., 2022) and specifically in the given research field tailored to the tourism industry (Acampora et al., 2022; Antonova et al., 2021; Warren and Becken, 2017). Furthermore, the stages align with the proposed data analysis technique of Grounded Theory, highlighting that the stages are intended to be a guide to help systematize the existing literature (Wolfswinkel et al., 2013).

Pre-specified exclusion and inclusion criteria are set to narrow the list of articles and answer research questions (Snyder, 2019; Wolfswinkel et al., 2013). In terms of geographical location, no exclusion was taken, thus covering relevant publications worldwide within the set boundaries of research. Furthermore and to the contrary of other literature reviews in this field journals were not restricted to only tourism-related literature (Acampora et al., 2022; Kim et al., 2017) or limited database use (e.g., only use of Scopus in Reem et al., 2022) as well as any restrictions of the article's publication date (e.g., Antonova et al., 2021). The review process started by conducting Web of Science and Scopus, the main online databases for academic literature collection (Chadegani et al., 2013). When searching in the literature, a combination of search terms was formed to search strings, and the so-called Boolean logic was used. This concept links the defined keywords together with AND, OR, NOT combinations (Jalali and Wohlin, 2012; Ridley, 2012; Wee and Banister, 2016).

Group 1: in the title or keyword or abstract (linked intra-group with OR connector)
energy OR energ* OR electricity OR heating OR power

Linked with AND connectors to

Group 2: in the title or keyword or abstract (linked intra-group with OR connector)
account* OR management OR approach OR materiality OR process* OR benchmark* OR system* OR management* OR intensity OR indicator* OR model* OR scorecard OR management OR tool* OR framework* OR performance* OR measure* OR development* OR system* OR index OR kpi* OR indicator* OR report* OR life-cycle* OR assessment* OR audit* OR index* OR consumption*

Linked with AND connectors to

Group 3: in the title or keyword or abstract (linked intra-group with OR connector)
hotel* OR motel* OR lodging OR accommodat* OR hospitality OR restaurant* OR resort*

Please note: Each Term in Group 1, 2 and 3 is matched with each other so that combinations in energy consumption benchmarking for the hotel industry are being captured. The symbol (*) has the function to include all possible variations (e.g. benchmark* instead of benchmarking).

Table 1: Keyword Groups

As the research elaborated, the main authors within the subtopics were identified. To further enrich the database for the research, an iterative backward and forward snowballing search was used as a research technique (Jalali and Wohlin, 2012; Wee and Banister, 2016; Xiao and Watson, 2019). As suggested by Denyer and Tranfield (2009), the selection and evaluation of the studies were taken by skimming the title and abstract. Whenever the relevance was perceived as high, the full text was read. The analysis section of the conducted research deals with the abstracting of relevant information and making sense of it (Bearman et al., 2012; Snyder, 2019). The collected data was subsequently analyzed in an Excel formatted codebook using a concept matrix, which changed over time as research evolved (Webster and Watson, 2002; Wolfswinkel et al., 2013). The assessment of study quality (e.g., methodological rigor) was not further investigated due to the quality level of the underlying research databases identified. The validity of the research was secured by following the guidelines building on the concept already used by various other literature reviews within this research field (Hahn and Kühnen, 2013; Hansen and Schaltegger, 2016).

For this study, the Grounded Theory approach created by Glaser and Strauss (2010) is used. This analysis involves specific stages, precisely the open coding stage (data is chunked into high-abstraction level type categories, which are then assigned a code), the axial coding stage (the collected codes are grouped together into categories and sub-categories), and the selective coding stage (categories are integrated, contrasted and refined) (Onwuegbuzie et al., 2015; Wolfswinkel et al., 2013). When sub-categories emerge, comparative analysis continuously relates, compares, and links the identified categories to refine the concept (Wolfswinkel et al., 2013). As a result of the coding steps, this method enables the researcher to identify significant patterns within the collected data and build a robust theoretical framework for the collected data. The last part of the process is associated with the writing process or dissemination of the analysis to express essential aspects of the review. Tables and figures were used to illustrate the findings (Juntunen and Lehenkari, 2021).

3. Results

Applying the above-described procedure (see Table 2), the initial search yielded 1,170 articles. The first data cleaning and removal of duplicates reduced the total number by 349 articles. The application of the defined exclusion criteria to abstracts and full texts narrowed down the publication set further to 91 articles. The literature references of articles in this preliminary set were screened for further publications meeting the above criteria as well as the expert opinion was consulted, resulting in 8 additional publications. A final set of 99 papers from 1979 to 2023 were eligible for data extraction.

Database from origin to November 2023	**Scopus**	**Web of Science**	**Total**
First scan - citations	715	455	1170
Data cleaning, removal of duplicates and incorrect entries	-199	-150	-349
Data cleaning, adjustment to exclude non-english, non-german articles	-5		-5
Articles after data cleaning	511	305	816
Reading of title and abstract according to defined exclusion criteria	-310	-193	-503
Articles subjected to full text review	201	112	313
Exclusion based on full text review	-132	-90	-222
Articles included after full text review	69	22	91
Snowballing technique, expert opinion			8
Total			**99**

Table 2: Exclusion Strategy Process

Figure 1 shows the yearly evolution of publication and reveals a growing pattern; most articles (57%) have been published within the last ten years. This development is in line with the adoption of the initiation of *Sustainable Development Goals* (SDGs) as well as *2030 Agenda for Sustainable Development* (United Nations, 2015) and proves that the interest in the field under investigation is of increasing importance.

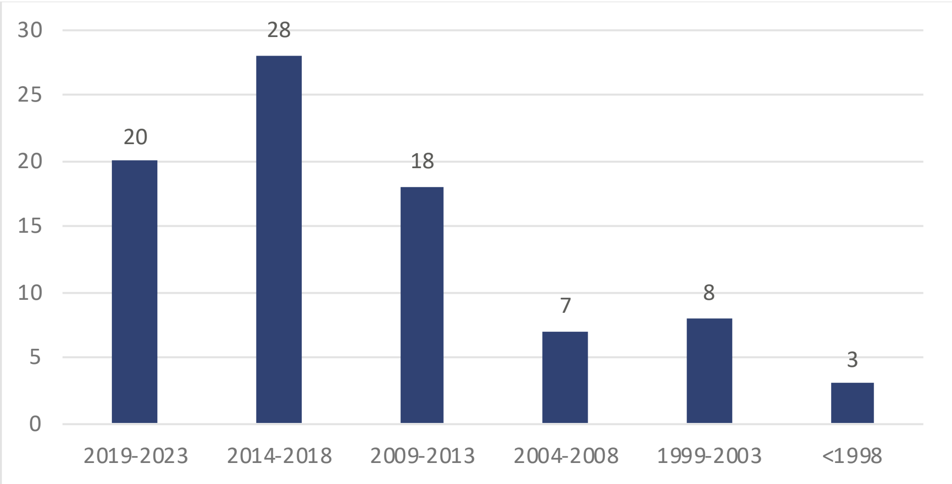

Figure 1: Year of Publication

The identified 99 articles have been issued in a total of 34 different journals. The most significant journal, as shown in Table 3, is *Energy and Buildings*, with a total of 19 articles, followed by the *International Journal of Hospitality Management*, with 7 papers. It is worth noting that the identified journals have a business and management, sustainability, building science as well as hospitality background, indicating the multitude of areas involved in research on corporate sustainability matters in the hotel industry.

Source title	Publisher	Topic	Publications	Country
Energy and Buildings	Elsevier	Building Science	19	United Kingdom
International Journal of Hospitality Management	Elsevier	Hospitality	7	United Kingdom
Journal of Cleaner Production	Elsevier	Environmental Management	5	United Kingdom
Sustainability	MDPI	Environmental Management	4	Switzerland
Renewable Energy	Elsevier	Environmental Management	3	United Kingdom
Tourism Management	Elsevier	Hospitality	2	Elsevier
Ecological Economics	Elsevier	Environmental Management	2	United Kingdom
Tourism Management	Elsevier	Hospitality	2	Elsevier

Table 3: Contributing Journals

Figure 2 illustrates the geographical areas of authors and hotel samples under investigation, showing that Asia and Europe are the most prominent. The top examined regions are Southern Europe (18 articles) and Eastern Asia (24 articles). Interestingly, all other regions under investigation are below six articles, revealing an uneven distribution in the geographical spread of studies. This result may be due to the fact that the author's location and sample location are 90% similar, resulting in a pattern that accessibility to data is easier in the author's country.

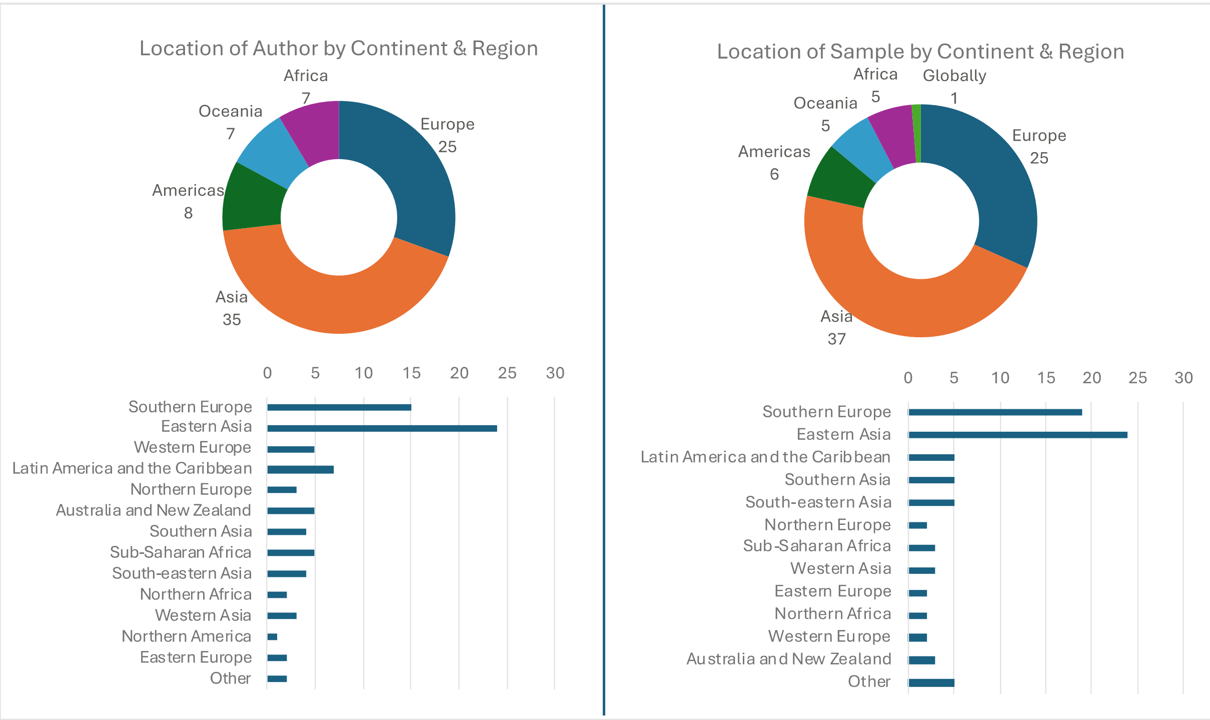

Figure 2: Sample Location by Continent and Area

As illustrated in Figure 5, most studies (77%) analyzed a sample below 50 hotels. Larger samples were generally found in quantitative studies where data was extracted from an external data set (Alkhalaf and Yan, 2018; Becken and McLennan, 2017; Bohdanowicz and Martinac, 2007). With sample sizes below ten hotels, data collection was with qualitative methods, often using semi-structured interviews.

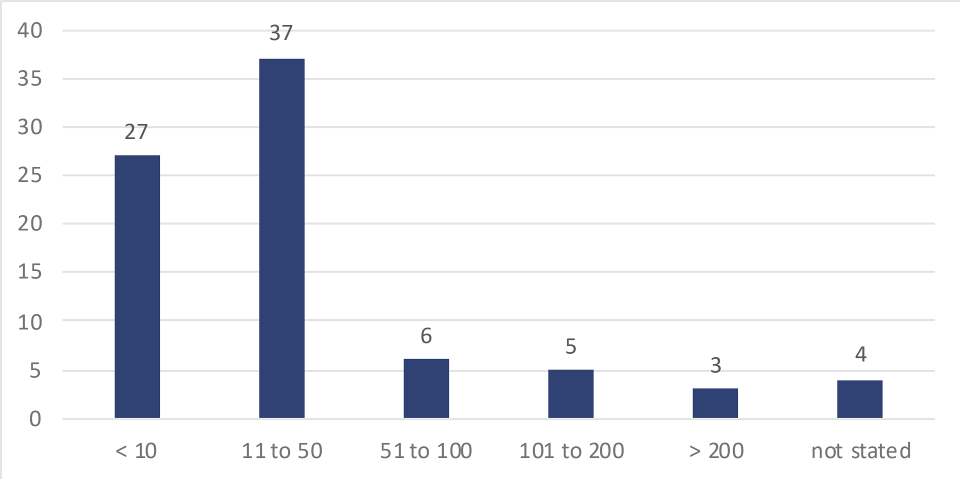

Figure 3: Sample Size

The research type and statistical analysis of the selected articles are displayed in Table 4. Data collection was predominantly done by questionnaire-based quantitative research methods (71% of the total sample). Most of the studies were collecting information about structural building characteristics (e.g., building age, floor area, number of rooms) and operational data (e.g., occupancy level, outlet characteristics) as well as associated resource consumption statistics (e.g., electricity and fuel use). In a publication where a single-case was studied, often semi-structured interviews with lead management and technical staff were being done to complete data collection (Debnath, 2015; Karagiorgas et al., 2007; Scholz et al., 2020).

	Frequency (*n*)	in %
Research Type		
Quantitative	57	71.3
Qualitative	16	20.0
Mixed	7	8.8
Statistical Analysis*		
Descriptive Analysis	36	40.4
Linear Regression Analysis	12	13.5
Multiple Regression Analysis	22	24.7
Correlation Analysis	6	6.7
Variance of (co)variance (e.g. ANOVA)	5	5.6
t-test	1	1.1
Data Envelopment Analysis (DEA)	2	2.2
Chi-square Analysis	1	1.1
Cluster Analysis	1	1.1
Other	3	3.4

*multiple counts possible

Table 4: Research Type and Statistical Analysis used

Regarding the statistical analysis of the data, there is a tendency to use descriptive analysis (40% of the total sample) exploiting results from distribution models, using medians and percentiles. To allocate main drivers for energy consumption, correlation analyses were frequently performed by different authors. Linear and multiple regression analyses are being used to calculate the regression coefficients of significant factors affecting the resource consumption of hotel real estate. Ultimately, predicting total energy consumption was the main goal in the regression analysis of the studies. Hybrid models by mixing descriptive and regression analysis are used as well frequently by different authors.

Regarding the resource use measurement process, there is no consensus as to how to report energy consumption in the hotel industry. During the 1990s first calls were imposed to perform environmental management and audits (Dale and Kluga, 1992; Kirk, 1995). Therefore, simple calculations to benchmark predominantly energy resources using averages, medians, and rankings were executed to determine environmental efficiency (Santamouris et al., 1996; Zmeureanu et al., 1994). However, several authors stressed that metrics are often misunderstood by operations of the hotel (Coles et al., 2016) or non-financial reporting's from large hotel chains do not use the same measurement units for reporting, making comparisons nearly impossible (Legrand et al., 2013). For example, Legrand et al. (2013) found that energy intensity of six hotel chains are reported in six different metrics kWh/m^2, MJ/m^2, kWh/Available Room (AR), MWh/AR, MJ/Guest Night (GN), and in kg (CO_2 equivalent/GN). Due to the aim and objective of this research, all analyzed studies within this literature review developed intensity metrics. More precisely, this kind of indicator measures resource consumption (input) with a specific measurement of the provision of services (output) of the company (Duric and Potočnik Topler, 2021). Both refer to a certain time unit (e.g., day, month, or year).

$$intensity\ indicator = \frac{total\ input\ of\ used\ resources\ per\ unit\ and\ time}{total\ output\ of\ provided\ service\ per\ time\ unit}$$

Input measures are commonly referred to as the respective resource unit (e.g., electricity and heating). Energy consumption (Q) of a hotel is usually calculated using the following formula adding annual consumption of electricity (Q_e), chilled water (Q_c), hot water (Q_h), steam (Q_s), diesel oil (Q_d), gasoline (Q_g) and natural gas (Q_n) respectively (Sheng et al., 2018).

$$Q = Q_e + Q_c + Q_h + Q_s + Q_d + Q_g + Q_n$$

Electricity consumption is generally the dominant source of carbon emissions in hotels (Beccali et al., 2009; Lai, 2015; Santiago, 2021). Other energy sources than electricity generally play a minor role in the hotel industry (Önüt and Soner, 2006). Hotel electricity share varies according to location, classification, infrastructure, and concept but is generally around 80% of total energy use (Önüt and Soner, 2006; Santiago, 2021; Yao et al., 2015). Output may be used using building industry benchmarks (e.g., per floor area), specifically tailored to the hotel industry (e.g., number of guests accommodated, number of rooms or beds) or individualized for specific outlets of the hotel (e.g., laundry consumption expressed in kg per linen, in restaurant number of meals served) (De Burgos-Jiménez et al., 2002). The extracted magnitudes used for inputs and outputs in the hotel industry, as well as resulting indicators, are illustrated in Table 5.

Input Units	Output Units	Unit of measurement	Time unit	Top 5 metrics	Abbreviation	Frequency Count	
						Total*	**Audits****
electricity, chilled water, hot water, steam, diesel oil, gasoline and natural gas, renewable energy	per floor area, per room, per outlet, per guest night, per bed, per employee, per food cover	MWh, kWh, MJ	per day, per month, per year	Energy use intensity	EUI	**68**	**46**
				Energy use per guest night	EUPGN	**19**	**15**
				Energy use per occupied room	EUPOR	**10**	**5**
				Energy use per room per year	EUPAR	**9**	**6**
				Energy use per bed per year	EUPAB	**4**	**1**

*the frequency count is defined as whether an indicator was mentioned in the respective article.
**out of frequence count total, counted when article was applying the indicator(s) to the research sample

Table 5: Intensity Indicators Overview

The Energy Use Intensity metric (EUI) or average energy use index, defined in units of resource use per gross floor area per annum (kWh/m^2/annum), is usually used as the hotel industry's energy consumption indicator.

$$Energy\ use\ intensity\ (EUI) = \frac{primary\ energy\ consumption}{total\ floor\ area\ (in\ square\ meter)}$$

Numerous authors analyzed and audited this indicator (68 counts in the sample under investigation, 46 of audits). Quantification and auditing of different hotel properties started in the early 90ies (Lam and Chan, 1994; Zmeureanu et al., 1994) and has a long track record until today. The authors stress that the EUI is not satisfactory for hotels' highly fragmented asset class (Kim and Oldham, 2017; Qi et al., 2017; Teng et al., 2017) and needs to be normalized for other secondary drivers (Bohdanowicz and Martinac, 2007). Therefore, the second group of identified intensity metrics suggests using the energy consumption per production unit, defined as the ratio between energy consumption and an operational reference value. The most prominent one within the energy segment is energy use per guest night (per day), which has been mentioned 19 times and audited 15 times in the chosen sample.

$$Energy\ use\ per\ guest\ night\ (EUPGN)\ = \frac{primary\ energy\ consumption}{total\ guest\ nights}$$

Less frequently used indicators are energy use per occupied room (mentioned ten times and audited five times), energy use per room per year (mentioned nine times and audited six times), and energy use per bed per year (mentioned four times and audited one time).

$$Energy\ use\ per\ occupied\ room\ (EUPOR)\ = \frac{primary\ energy\ consumption}{occupied\ rooms}$$

$$Energy\ use\ per\ room\ per\ year(EUPAR)\ = \frac{primary\ energy\ consumption}{available\ rooms}$$

$$Energy\ use\ per\ bed\ per\ year\ (EUPAB) = \frac{primary\ energy\ consumption}{available\ beds}$$

The resource audit results of previous scientific studies are analyzed in Table 7. It is found that the vast majority of studies analyzed city hotels (25 studies), followed by studies with a mixed focus (11 studies) and countryside hotels (5 studies). Overall, regardless of climate, quality level, or location, the analyzed sample possesses an EUI of 273.9 kWh/m^2 (1,494 hotels). Regarding the operational concept, it is found that city hotels (EUI 305.9 kWh/m^2, 718 sample hotels) consume considerably more energy than countryside hotels (EUI 182.4 kWh/m^2, 156 sample hotels). However, it must be acknowledged that this number may be distorted due to the low number of sample hotels in the countryside hotels sample.

	Number of Studies	Average Sample Size	Total Sample Hotels	in %	Mean EUI in kWh
Vacation	6	26	156	9.6%	182.4
City	26	28	718	44.0%	305.9
City and Vacation	10	72	722	44.3%	225.3
Not stated	4	9	35	2.1%	348.5
1 star	6	72	430	9.9%	238.2
2 star	9	55	496	11.5%	245.1
3 star	23	48	1096	25.3%	277.0
4 star	30	42	1254	29.0%	288.6
5 star	26	41	1055	24.4%	285.9
Temperate	15	43	651	46.2%	237.1
Tropical	13	25	327	23.2%	352.4
Dry	10	18	182	12.9%	143.9
Continental	3	83	250	17.7%	278.5
Polar	0				
Various	0				

Table 6: EUI Audit Comparison by Hotel Type, Quality Level and Climate

Furthermore, several authors argue that consumption per floor area generally relates to climate (Table 6). There, properties located in hot and humid areas (Chan et al., 2003; Deng and Burnett, 2002; Prasad and Singh, 2015; Xuchao et al., 2010) consume substantially more energy than those in dry (Khemiri and Hassairi, 2005; Tang et al., 2016; Teng et al., 2012; Xin et al., 2012) and temperate (Atmaca and Yýlmaz, 2019; Dat and Quang, 2018; Santamouris et al., 1996) climate. However, it has to be acknowledged that even within the same region, indicators vary significantly. For example, Santamouris et al. (1996) analyzed 158 hotels in the Athens area and concluded an EUI of 273 kWh/m^2 and Pieri et al. (2015) found an EUI of 430 kWh/m^2 when analyzing 32 hotels in Greece. This review finds that, on average, the EUI varies between 143.9 kWh/m^2 in dry regions (182 sample hotels, average sample size 18 hotels) up to 352.4 kWh/m^2 in tropical regions (327 sample hotels, average sample size 25 hotels). Regarding the quality level of hotels, there is a trend towards more luxurious hotels consuming more energy (EUI 5 star 285.9 kWh/m^2, EUI 4 star 288.6 kWh/m^2) than hotels offering more basic accommodation (EUI 1 star 238.2 kWh/m^2, EUI 2 star 245.1 kWh/m^2). This result is generally in line with the authors claiming that resource consumption increases with the quality level of a hotel (Nguyen and Rockwood, 2019; Priyadarsini et al., 2009; Xuchao et al., 2010; Yao et al., 2015; Qi et al., 2017). A detailed analysis of studies conducting energy consumption audits is illustrated in Table 7.

Source	Year of Publication	Research Method	Sample Size (No. of hotels)	Location of Sample	Mean EUI (kWh/m2/ year)	Quality Level	Type of Hotel (City / Vacation)	Climate Region
Zmeureanu, R.G., Hanna, Z.A., Fazia, P.	1994	Quantitative	16	Canada	**612.0**	Not stated	Not stated	Temperate
Shiming, D., Burnett, J.	2002	Quantitative	16	Hong Kong	**563.8**	3, 4, 5	City	Tropical
Deng, S.-M., Burnett, J.	2000	Quantitative	16	Hong Kong	**563.8**	3, 4, 5	City	Tropical
Deng, SM	2003	Quantitative	36	Hong Kong	**541.6**	4 star	City	Tropical
Chan K.T., Lee R.H.K., Burnett J.	2003	Quantitative	26	Hong Kong	**519.4**	3, 4, 5	City	Tropical
Prasad, K; Singh, A	2015	Quantitative	2	Fiji	**482.2**	Not stated	Vacation	Tropical
Gonçalves, P., Gaspar, A.R., Silva, M.G.	2012	Qualitative	1	Portugal	**446.0**	4 star	City	Temperate
Xuchao W., Priyadarsini R., Siew Eang L.	2010	Quantitative	29	Singapore	**427.0**	3, 4, 5	City	Tropical
Priyadarsini, R., Xuchao, W., Eang, L.S.	2009	Quantitative	29	Singapore	**427.0**	3, 4, 5	City	Tropical
Pieri, S.P., Ioannis, T., Santamouris, M.	2015	Quantitative	35	Greece	**420.0**	2, 3, 4, 5	City	Temperate
Onut, S; Soner, S	2006	Quantitative	32	Turkey	**407.2**	5 star	City	Temperate
Hui, S., Wong, M.	2010	Qualitative	1	Hong Kong	**402.0**	Not stated	City	Tropical
Lam, J.C., Chan, A.L.S.	1994	Quantitative	17	Hong Kong	**366.0**	Not stated	Not stated	Tropical
Lai J.H.K.	2016	Mixed	30	Hong Kong	**356.6**	4, 5	City	Tropical
Ricaurte, E.	2011	Quantitative	20	Global	**351.5**	1, 2, 3, 4, 5	City and Vacation	Continental
Chan, W.W., Lam, J.C.,	2002	Quantitative	17	Hong Kong	**342.0**	3, 4, 5	City	Tropical
AlFaris F., Abu-Hijleh B., Abdul-Ameer A.	2016	Quantitative	12	Dubai	**320.5**	4, 5	City	Tropical
Bohdanowicz, P., Martinac, I.	2007	Quantitative	184	Europe	**297.0**	3, 4	City and Vacation	Continental
Huang, K.-T., Wang, J.C., Wang, Y.-C.	2015	Mixed	58	Taiwan	**277.0**	4, 5	City and Vacation	Temperate
Babatunde O.M., Oluseyi P.O., Denwigwe I.H.	2019	Quantitative	28	Nigeria	**273.7**	1, 2, 3, 4, 5	City and Vacation	Tropical
Santamouris, M., Balaras, C.A., Dascalaki, E.	1997	Quantitative	158	Greece	**273.0**	1, 2, 3, 4, 5	City	Temperate
Oluseyi, PO; Babatunde, OM; Babatunde, OA	2016	Quantitative	28	Nigeria	**266.0**	2, 3, 4, 5	City	Tropical
Yao, Z., Zhuang, Z., Gu, W.	2015	Mixed	45	China	**243.4**	3, 4, 5	City	Dry
Cunha, F.O., Oliveira, A.C.	2020	Qualitative	1	Portugal	**214.0**	4 star	Vacation	Temperate
Filimonau, V., Dickinson, J., Robbins, D.	2011	Quantitative	2	United Kingdom	**213.0**	Not stated	Not stated	Temperate
Wang, J.C.	2012	Quantitative	200	Taiwan	**208.0**	1, 2, 3, 4, 5	City and Vacation	Temperate
Chedwal, R., Mathur, J., Agarwal, G.D., Dhaka, S.	2015	Quantitative	79	India	**207.9**	Not stated	City	Tropical
Bianco, V., Righi, D., Scarpa, F., Tagliafico, L.A.	2017	Quantitative	not stated	Italy	**203.0**	1, 2, 3, 4, 5	Not stated	Temperate
Coles, T., Dinan, C., Warren, N.	2016	Quantitative	29	UK	**190.8**	3, 4	City and Vacation	Tropical
Qi, M., Shi, Y., Li, X.,	2017	Quantitative	46	China	**187.0**	5 star	City and Vacation	Continental
Farrou, I., Kolokotroni, M., Santamouris, M.	2012	Quantitative	90	Greece	**182.0**	Not stated	City and Vacation	Temperate
Khemiri, A; Hassairi, M	2005	Qualitative	1	Tunisia	**170.9**	3 star	City	Dry
Becken, S., Frampton, C., Simmons, D.	2001	Quantitative	30	New Zealand	**158.6**	Not stated	City and Vacation	Dry
Atmaca, M., Yýlmaz, Z.	2019	Quantitative	2	Turkey	**155.5**	4 star	City	Temperate
Dat, M.V., Quang, T.N.	2018	Quantitative	32	Vietnam	**151.2**	3, 4, 5	City	Temperate
Xu C.Q., Pan S., Hui Z., Wu J.S., Wang Y.M.	2014	Qualitative	1	China	**145.7**	5 star	City	Dry
Zhao, J., Xin, Y., Tong, D.	2012	Quantitative	19	China	**142.5**	Not stated	City	Dry
Rosselló-Batle, B., Moià, A., Cladera, A., Martínez, V.	2010	Qualitative	2	Spain	**140.0**	3, 4	Vacation	Temperate
Udawatta L., Perera A., Witharana S.	2010	Qualitative	1	Sri Lanka	**139.9**	5 star	Vacation	Temperate
Trung, D.N., Kumar, S.	2005	Quantitative	37	Vietnam	**127.4**	3 star	City and Vacation	Temperate
Lu, S., Wei, S., Zhang, K., Kong, X., Wu, W.	2013	Quantitative	27	China	**125.3**	4, 5	City	Dry
Xin, Y., Lu, S., Zhu, N., Wu, W.	2012	Quantitative	19	China	**123.2**	4, 5	City	Dry
Tang M., Fu X., Cao H., Shen Y., Deng H., Wu G.	2016	Mixed	24	China	**119.9**	1, 2, 3, 4	City	Dry
Lau C., Tang I.L.F., Chan W.	2021	Quantitative	13	China	**118.0**	4, 5	Vacation	Dry
Teng Z.-R., Wu C.-Y., Xu Z.-Z.	2017	Quantitative	3	China	**91.2**	2, 3	City	Dry

Table 7: EUI Audit Results[1]

[1] Please note: to facilitate comparability, all formats were recalculated to a common numerical standard (e.g., MJ to kWh or feet to m2). When several quality levels of hotels were being investigated within the study, a weighted average was formed. Furthermore, when more than one year was analyzed in the study, the mean of all years under investigation is presented. The climate zone was differentiated by the

4. Discussion and Conclusion

This paper investigates energy consumption benchmarking intensity metrics and associated audit results for the hotel industry by conducting a systematic literature review. Implementing reproducible research criteria, an extensive keyword search on relevant research databases, 1,170 articles were screened, revealing 99 articles for detailed analysis. The synopsis of the relevant literature presented shows that energy intensity metrics must consist of input and output variables to gain comparability in benchmarking. Regarding input variables, there is a consensus that the primary energy consumption, i.e., the total energy demand for operating the hotel building and its appliances, must be collected. It has been seen that most studies used the Energy Use Intensity (EUI) as the primary output variable for energy benchmarking in the hotel industry. Nevertheless, different authors claimed that an occupant-related variable should be integrated as well to display the usage degree of the building. This relevance is further increasing due to events such as the Corona crisis, in which EUI figures may be highly distorted. As a result, as already highlighted in the study of Farrou et al. (2012), a range of intensity metrics may be more suitable than a single-value benchmark. Therefore, an effective intensity metric should be easy for hotel staff to collect, understandable for all parties involved, and fulfill regulatory frameworks' reporting needs. Installing smart meters and sensor automation in data transfer would increase data validity and reduce the possibility of human error.

Out of 46 articles analyzing EUI audit results, an average EUI of 273.9 kWh/m^2 is found. Scholars agree that specific parameters of the hotels must be displayed to cluster results and increase comparability effectively. It is advisable to differentiate characteristics into operational (e.g., performance metrics, operations concept, hotel classification, types of services offered) and physical attributes (e.g., building structure, building age, total number of rooms and beds, number of floors, gross floor area), as well as factors related to location and climate. The review results find that variations occur mainly based on climate, quality level and service level of hotels, which is similar

---

widely used Köppen Climate Classification System and was classified according to hotel location like in other studies in the respective research field (Bohdanowicz and Martinac, 2007; Huang et al., 2015). The presented data is not climate-normalized.

to other study findings (Nguyen and Rockwood, 2019; Priyadarsini et al., 2009; Xuchao et al., 2010). However, it has been found that 5-star hotels do not consume more energy than 4-star hotels. However, it has to be acknowledged that studies analyzing solely 5-star properties are rare (Lanka Udawatta et al., 2010; Önüt and Soner, 2006; Xu et al., 2014). Furthermore, this study finds that countryside hotels consume less energy than hotels in urban areas. Concerning climate variations, it is found that previous audits in humid regions consume considerably more energy than other locations. Therefore, climate plays an often underestimated role in energy consumption analysis and data must be normalized to be comparable with other geographical regions. Nevertheless, it has to be acknowledged that numerous other non-researched factors, such as thermal insulation, roofing, type of carpentry, or guest behavior, might influence energy consumption patterns. These considerations necessitate a critical evaluation of the applicability of these indicators for external benchmarking, as their lack of direct comparability can lead to misleading interpretations and hinder rigorous comparisons for benchmarking purposes. Nevertheless, the mentioned indicators are valid for assessing the progress in energy performance improvements of each hotel in internal benchmarking.

Further elaboration on the above-listed influencing factors and their impact on energy consumption is advisable for additional research. In addition, creating and implementing an intensity metrics matrix on a large-scale sample size in locations such as Central or Northern Europe is perceived as researchable. There, a strong focus must be on differentiating characteristics to further elaborate on regression models predicting total energy consumption. Integrating the latest developments of regulative frameworks is necessary to comply with financial reporting and can be seen as a further research field. In addition, existing benchmarks do not consider the influence of guest and staff behavior (Warren and Becken, 2017), which forms a further field of future research. This study contributes to the existing body of knowledge by listing and categorizing intensity metrics for energy benchmarking for the hotel industry. Furthermore, energy audit results are displayed and clustered according to hotel characteristics and location. Scholars and practitioners may use the identified benchmarks to achieve better environmental performance and enhance their sustainability performance. Furthermore, the created metrics and energy benchmarks could benefit green lease negotiations between owners and operators. Additionally, policymakers and regulative authorities may use intensity metrics and audit results to set boundaries within the operational phase of hotel real estate. Nevertheless, as other authors have noted (Guix, 2020; Guix et al., 2018; Kang et al., 2015), research attempting to incorporate environmental issues into hotel operations remains in an explorative stage.

5. References

Acampora, A., Lucchetti, M.C., Merli, R., Ali, F., 2022. The theoretical development and research methodology in green hotels research: A systematic literature review. Journal of Hospitality and Tourism Management 51, 512–528. https://doi.org/10.1016/j.jhtm.2022.05.007

Agyeiwaah, E., McKercher, B., Suntikul, W., 2017. Identifying core indicators of sustainable tourism: A path forward? Tourism Management Perspectives 24, 26–33. https://doi.org/10.1016/j.tmp.2017.07.005

Alkhalaf, H., Yan, W., 2018. Modeling of Building Energy Consumption for Accommodation Buildings (Lodging Sector) in Japan—Case Study. ASI 1, 39. https://doi.org/10.3390/asi1040039

Antonova, N., Ruiz-Rosa, I., Mendoza-Jiménez, J., 2021. Water resources in the hotel industry: a systematic literature review. International Journal of Contemporary Hospitality Management 33, 628–649. https://doi.org/10.1108/IJCHM-07-2020-0711

Atmaca, M., Yýlmaz, Z., 2019. A Study on Energy and Cost Efficiency for Existing Hotel Buildings in Turkey. E3S Web Conf. 111. https://doi.org/10.1051/e3sconf/201911103037

Bearman, M., Smith, C.D., Carbone, A., Slade, S., Baik, C., Hughes-Warrington, M., Neumann, D.L., 2012. Systematic review methodology in higher education. Higher Education Research & Development 31, 625–640. https://doi.org/10.1080/07294360.2012.702735

Beccali, M., La Gennusa, M., Lo Coco, L., Rizzo, G., 2009. An empirical approach for ranking environmental and energy saving measures in the hotel sector. Renewable Energy 34, 82–90. https://doi.org/10.1016/j.renene.2008.04.029

Becken, S., McLennan, C., 2017. Evidence of the water-energy nexus in tourist accommodation. Journal of Cleaner Production 144, 415–425. https://doi.org/10.1016/j.jclepro.2016.12.167

Bohdanowicz, P., Martinac, I., 2007. Determinants and benchmarking of resource consumption in hotels—Case study of Hilton International and Scandic in Europe. Energy and Buildings 39, 82–95. https://doi.org/10.1016/j.enbuild.2006.05.005

Chadegani, A.A., Salehi, H., Yunus, M.M., Farhadi, H., Fooladi, M., Farhadi, M., Ebrahim, N.A., 2013. A Comparison between Two Main Academic Literature Collections: Web of Science and Scopus Databases. Asian Social Science 9, p18. https://doi.org/10.5539/ass.v9n5p18

Chan, K.T., Lee, R.H.K., Burnett, J., 2003. Maintenance Practices and Energy Performance of Hotel Buildings. Strategic Planning for Energy and the Environment 23, 6–28. https://doi.org/10.1080/10485230309509628

Cheong, F., Lee, Y.-H., 2021. Developing an Environmental Management System for Evaluating Green Casino Hotels. Sustainability 13, 7825. https://doi.org/10.3390/su13147825

Coles, T., Dinan, C., Warren, N., 2016. Energy practices among small- and medium-sized tourism enterprises: a case of misdirected effort? Journal of Cleaner Production 111, 399–408. https://doi.org/10.1016/j.jclepro.2014.09.028

Cunha, F.O., Oliveira, A.C., 2020. Benchmarking for realistic nZEB hotel buildings. Journal of Building Engineering 30, 1–12. https://doi.org/10.1016/j.jobe.2020.101298

Dale, J.C., Kluga, T., 1992. Energy Conservation: More than a Good Idea. Cornell Hotel and Restaurant Administration Quarterly 33, 30–35. https://doi.org/10.1177/001088049203300608

Dat, M.V., Quang, T.N., 2018. A study on energy consumption of hotel buildings in Vietnam. Journal of Science and Technology in Civil Engineering 12, 109–116. https://doi.org/10.31814/stce.nuce2018-12(5)-11

De Burgos-Jiménez, J., Cano-Guillén, C.J., Céspedes-Lorente, J.J., 2002. Planning and Control of Environmental Performance in Hotels. Journal of Sustainable Tourism 10, 207–221. https://doi.org/10.1080/09669580208667163

Debnath, S., 2015. Integrated waste management framework: a business case from hospitality industry. International Journal of Business Excellence 8, 566–582. https://doi.org/10.1504/IJBEX.2015.071278

Deng, S.-M., Burnett, J., 2002. Water use in hotels in Hong Kong. International Journal of Hospitality Management 21, 57–66. https://doi.org/10.1016/S0278-4319(01)00015-9

Denyer, D., Tranfield, D., 2009. Producing a systematic review., in: The Sage Handbook of Organizational Research Methods. Sage, Thousand Oaks, pp. 671–689.

Duric, Z., Potočnik Topler, J., 2021. The Role of Performance and Environmental Sustainability Indicators in Hotel Competitiveness. Sustainability 13, 1–26. https://doi.org/10.3390/su13126574

European Commission, 2018. Action Plan: Financing Sustainable Growth [WWW Document]. URL https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:52018DC0097&from=DE (accessed 11.24.21).

Farrou, I., Kolokotroni, M., Santamouris, M., 2012. A method for energy classification of hotels: A case-study of Greece. Energy and Buildings 55, 553–562. https://doi.org/10.1016/j.enbuild.2012.08.010

Glaser, B.G., Strauss, A.L., 2010. The discovery of grounded theory: strategies for qualitative research, 5th ed. Aldine Transaction, New Brunswick.

Guix, M., 2020. The Materiality Balanced Scorecard_ A framework for stakeholder-led integration of sustainable hospitality management and reporting. International Journal of Hospitality Management 91, 1–12. https://doi.org/10.1016/j.ijhm.2020.102634

Guix, M., Bonilla-Priego, M.J., Font, X., 2018. The process of sustainability reporting in international hotel groups: an analysis of stakeholder inclusiveness, materiality and responsiveness. Journal of Sustainable Tourism 26, 1063–1084. https://doi.org/10.1080/09669582.2017.1410164

Hahn, R., Kühnen, M., 2013. Determinants of sustainability reporting: a review of results, trends, theory, and opportunities in an expanding field of research. Journal of Cleaner Production 59, 5–21. https://doi.org/10.1016/j.jclepro.2013.07.005

Han, H., Lee, J.-S., Trang, H.L.T., Kim, W., 2018. Water conservation and waste reduction management for increasing guest loyalty and green hotel practices. International Journal of Hospitality Management 75, 58–66. https://doi.org/10.1016/j.ijhm.2018.03.012

Hansen, E.G., Schaltegger, S., 2016. The Sustainability Balanced Scorecard: A Systematic Review of Architectures. Journal of Business Ethics 133, 193–221. https://doi.org/10.1007/s10551-014-2340-3

Huang, K.-T., Wang, J.C., Wang, Y.-C., 2015. Analysis and benchmarking of greenhouse gas emissions of luxury hotels. International Journal of Hospitality Management 51, 56–66. https://doi.org/10.1016/j.ijhm.2015.08.014

Jalali, S., Wohlin, C., 2012. Systematic Literature Studies: Database Searches vs. Backward Snowballing. Presented at the ESEM '12: Proceedings of the ACM-IEEE international symposium on Empirical software engineering and measurement, Sweden, pp. 29–38.

Jones, P., Hillier, D., Comfort, D., 2016. Sustainability in the hospitality industry: Some personal reflections on corporate challenges and research agendas. International Journal of Contemporary Hospitality Management 28, 36–67. https://doi.org/10.1108/IJCHM-11-2014-0572

Jones, P., Hillier, D., Comfort, D., 2014. Sustainability in the global hotel industry. International Journal of Contemporary Hospitality Management 26, 5–17. https://doi.org/10.1108/IJCHM-10-2012-0180

Juntunen, M., Lehenkari, M., 2021. A narrative literature review process for an academic business research thesis. Studies in Higher Education 46, 330–342. https://doi.org/10.1080/03075079.2019.1630813

Kang, J.-S., Chiang, C.-F., Huangthanapan, K., Downing, S., 2015. Corporate social responsibility and sustainability balanced scorecard: The case study of family-owned hotels. International Journal of Hospitality Management 48, 124–134. https://doi.org/10.1016/j.ijhm.2015.05.001

Karagiorgas, M., Tsoutsos, T., Moiá-Pol, A., 2007. A simulation of the energy consumption monitoring in Mediterranean hotels. Energy and Buildings 39, 416–426. https://doi.org/10.1016/j.enbuild.2006.07.008

Khemiri, A., Hassairi, M., 2005. Development of energy efficiency improvement in the Tunisian hotel sector: a case study. Renewable Energy 30, 903–911. https://doi.org/10.1016/j.renene.2004.09.021

Kim, H., Oldham, E., 2017. Long-term field investigation and modeling of electricity end-use patterns in hotel guest rooms. Energy and Buildings 155, 414–424. https://doi.org/10.1016/j.enbuild.2017.09.039

Kim, J.-Y., Hlee, S., Joun, Y., 2016. Green practices of the hotel industry: Analysis through the windows of smart tourism system. International Journal of Information Management 36, 1340–1349. https://doi.org/10.1016/j.ijinfomgt.2016.05.001

Kim, S.-H., Lee, K., Fairhurst, A., 2017. The review of “green” research in hospitality, 2000-2014: Current trends and future research directions. International Journal of Contemporary Hospitality Management 29, 226–247. https://doi.org/10.1108/IJCHM-11-2014-0562

Kirk, D., 1995. Environmental management in hotels. International Journal of Contemporary Hospitality Management 7, 3–8. https://doi.org/10.1108/09596119510095325

Lai, J.H.K., 2015. Carbon footprints of hotels: Analysis of three archetypes in Hong Kong. Sustainable Cities and Society 14, 334–341. https://doi.org/10.1016/j.scs.2013.09.005

Lam, J.C., Chan, A.L.S., 1994. Characteristics of electricity consumption in commercial buildings. Building Research & Information 22, 313–318. https://doi.org/10.1080/09613219408727410

Lanka Udawatta, Aruna Perera, Sanjeeva Witharana, 2010. Analysis of Sensory Information for Efficient Operation of Energy Management Systems in Commercial Hotels. Electronic Journal of Structural Engineering 1, 113–120. https://doi.org/10.56748/ejse.13701

Legrand, W., Huegel, E.B., Sloan, P., 2013. Learning from Best Practices: Sustainability Reporting in International Hotel Chains. Advances in Hospitality and Leisure, Advances in Hospitality and Leisure 9, 119–134. https://doi.org/10.1108/S1745-3542(2013)0000009010

Manganari, E.E., Dimara, E., Theotokis, A., 2016. Greening the lodging industry: Current status, trends and perspectives for green value. Current Issues in Tourism 19, 223–242. https://doi.org/10.1080/13683500.2015.1021668

Manning, T., 1999. Indicators of tourism sustainability. Tourism Management 20, 179–181. https://doi.org/10.1016/S0261-5177(98)00084-3

Nguyen, A.T., Rockwood, D., 2019. Developing an energy benchmarking for hotel buildings using the statistical method and the simulation-based approach. Journal of Green Building 14, 1–22. https://doi.org/10.3992/1943-4618.14.3.1

Okoli, C., 2015. A Guide to Conducting a Standalone Systematic Literature Review. Communications of the Association for Information Systems 37, 879–910. https://doi.org/10.17705/1CAIS.03743

Önüt, S., Soner, S., 2006. Energy efficiency assessment for the Antalya Region hotels in Turkey. Energy and Buildings 38, 964–971. https://doi.org/10.1016/j.enbuild.2005.11.006

Onwuegbuzie, A., Leech, N., Collins, K., 2015. Qualitative Analysis Techniques for the Review of the Literature. The Qualitative Report 17, 1–28. https://doi.org/10.46743/2160-3715/2012.1754

Pieri, S.P., Ioannis, T., Santamouris, M., 2015. Identifying energy consumption patterns in the Attica hotel sector using cluster analysis techniques with the aim of reducing hotels’ CO2 footprint. Energy and Buildings 94, 252–262. https://doi.org/10.1016/j.enbuild.2015.02.017

Pranugrahaning, A., 2021. Corporate sustainability assessments: A systematic literature review and conceptual framework. Journal of Cleaner Production 295, 1–14. https://doi.org/10.1016/j.jclepro.2021.126385

Prasad, K., Singh, A., 2015. Towards Low Carbon Hotels in the Pacific Region: A Study of Energy Consumption and Efficiency in Hotels Using Models Based on Energy Performance Indicators, in: Leal Filho, W. (Ed.), Climate Change in the Asia-Pacific Region. Springer, Berlin, pp. 357–374.

Priyadarsini, R., Xuchao, W., Eang, L.S., 2009. A study on energy performance of hotel buildings in Singapore. Energy and Buildings 41, 1319–1324. https://doi.org/10.1016/j.enbuild.2009.07.028

Qi, M., Shi, Y., Li, X., 2017. A Bottom-up Method to Assess Energy Consumption of Main Departments in Five-star Hotels in China. Presented at the 2017 Building Simulation Conference, pp. 816–824.

Reem, M., Rasoolimanesh, S.M., Sara, N.R.W., 2022. Sustainability Indicators in Hotels: A Systematic Literature Review. Asia-Pacific Journal of Innovation in Hospitality and Tourism 11, 149–178.

Ridley, D., 2012. The literature review: a step-by-step guide for students, 2nd ed. Sage, Los Angeles.

Rosselló-Batle, B., Moià, A., Cladera, A., Martínez, V., 2010. Energy use, CO2 emissions and waste throughout the life cycle of a sample of hotels in the Balearic Islands. Energy and Buildings 42, 547–558. https://doi.org/10.1016/j.enbuild.2009.10.024

Santamouris, M., Balaras, C.A., Dascalaki, E., Argiriou, A., Gaglia, A., 1996. Energy conservation and retrofitting potential in Hellenic hotels. Energy and Buildings 24, 65–75. https://doi.org/10.1016/0378-7788(95)00963-9

Santiago, D.E., 2021. Energy use in hotels: a case study in Gran Canaria. International Journal of Low-Carbon Technologies 16, 1264–1276. https://doi.org/10.1093/ijlct/ctab048

Saunders, M.N.K., Lewis, P., Thornhill, A., 2012. Research methods for business students, 6th ed. Pearson, New York.

Schaltegger, S., Christ, K.L., Wenzig, J., Burritt, R.L., 2022. Corporate sustainability management accounting and multi-level links for sustainability – A systematic review. International Journal of Management Reviews 1–21. https://doi.org/10.1111/ijmr.12288

Scholz, P., Linderová, I., Konečná, K., 2020. Green Management Tools as a Way to Sustainable Behaviour in the Hotel Industry: Case Study from Czechia. Sustainability 12, 10027. https://doi.org/10.3390/su122310027

Sheng, Y., Miao, Z., Zhang, J., Lin, X., Ma, H., 2018. Energy consumption model and energy benchmarks of five-star hotels in China. Energy and Buildings 165, 286–292. https://doi.org/10.1016/j.enbuild.2018.01.031

Snyder, H., 2019. Literature review as a research methodology: An overview and guidelines. Journal of Business Research 104, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Stechemesser, K., Guenther, E., 2012. Carbon accounting: a systematic literature review. Journal of Cleaner Production 36, 17–38. https://doi.org/10.1016/j.jclepro.2012.02.021

Tang, M., Fu, X., Cao, H., Shen, Y., Deng, H., Wu, G., 2016. Energy Performance of Hotel Buildings in Lijiang, China. Sustainability 8, 1–12. https://doi.org/10.3390/su8080780

Tao, Y., Huang, Z., 2014. Review of accounting for carbon dioxide emissions from tourism at different spatial scales. Acta Ecologica Sinica 34, 246–254. https://doi.org/10.1016/j.chnaes.2014.03.007

Templier, M., Paré, G., 2015. A Framework for Guiding and Evaluating Literature Reviews. CAIS 37, 112–137. https://doi.org/10.17705/1CAIS.03706

Teng, C.-C., Horng, J.-S., Hu, M.-L. (Monica), Chien, L.-H., Shen, Y.-C., 2012. Developing energy conservation and carbon reduction indicators for the hotel industry in Taiwan. International Journal of Hospitality Management 31, 199–208. https://doi.org/10.1016/j.ijhm.2011.06.006

Teng, Z.-R., Wu, C.-Y., Xu, Z.-Z., 2017. New energy benchmarking model for budget hotels. International Journal of Hospitality Management 67, 62–71. https://doi.org/10.1016/j.ijhm.2017.07.010

Tranfield, D., Denyer, D., Smart, P., 2003. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of Management 14, 207–222. https://doi.org/10.1111/1467-8551.00375

UN Environment Programme, 2020. 2020 Global Status Report for Buildings and Construction [WWW Document]. URL https://globalabc.org/sites/default/files/2021-03/Buildings-GSR-2020_Report_24-03-21_0.pdf (accessed 11.28.21).

United Nations, 2015. THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT [WWW Document]. URL https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf (accessed 8.29.22).

UNWTO, 2023. Climate Action in the Tourism Sector – An overview of methodologies and tools to measure greenhouse gas emissions [WWW Document]. URL https://www.e-unwto.org/doi/book/10.18111/9789284423927 (accessed 3.13.23).

UNWTO, 2019. Transport-related CO2 Emissions of the Tourism Sector [WWW Document]. URL https://www.e-unwto.org/doi/book/10.18111/9789284416660 (accessed 5.6.22).

Warren, C., Becken, S., 2017. Saving energy and water in tourist accommodation: A systematic literature review (1987–2015). International Journal of Tourism Research 19, 289–303. https://doi.org/10.1002/jtr.2112

Webster, J., Watson, R.T., 2002. Analyzing the Past to Prepare for the Future: Writing a Literature Review. MIS Quarterly 26, 8–23.

Wee, B.V., Banister, D., 2016. How to Write a Literature Review Paper? Transport Reviews 36, 278–288. https://doi.org/10.1080/01441647.2015.1065456

Wolfswinkel, J.F., Furtmueller, E., Wilderom, C.P.M., 2013. Using grounded theory as a method for rigorously reviewing literature. European Journal of Information Systems 22, 45–55. https://doi.org/10.1057/ejis.2011.51

Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., Pawson, R., 2013. RAMESES publication standards: realist syntheses. BMC Medicine 11, 1–14. https://doi.org/10.1186/1741-7015-11-21

Xiao, Y., Watson, M., 2019. Guidance on Conducting a Systematic Literature Review. Journal of Planning Education and Research 39, 93–112. https://doi.org/10.1177/0739456X17723971

Xin, Y., Lu, S., Zhu, N., Wu, W., 2012. Energy consumption quota of four and five star luxury hotel buildings in Hainan province, China. Energy and Buildings 45, 250–256. https://doi.org/10.1016/j.enbuild.2011.11.014

Xu, C.Q., Pan, S., Hui, Z., Wu, J.S., Wang, Y.M., Fan, L., Wang, X.R., 2014. Building Energy Audit and Energy-Saving Analysis for a Five-Star Hotel in Beijing. Applied Mechanics and Materials 507, 521–524. https://doi.org/10.4028/www.scientific.net/AMM.507.521

Xuchao, W., Priyadarsini, R., Siew Eang, L., 2010. Benchmarking energy use and greenhouse gas emissions in Singapore’s hotel industry. Energy Policy 38, 4520–4527. https://doi.org/10.1016/j.enpol.2010.04.006

Yao, Z., Zhuang, Z., Gu, W., 2015. Study on Energy Use Characteristics of Hotel Buildings in Shanghai. Procedia Engineering 121, 1977–1982. https://doi.org/10.1016/j.proeng.2015.09.195

Zmeureanu, R.G., Hanna, Z.A., Fazia, P., 1994. Energy performance of hotels in Ottawa. ASHRAE Transaction 100 314–322.