Energy efficiency opportunities in the hotel industry sector

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Executive summary

This report investigates the energy performance of hotels. It is based on a survey of around 50 mostly Australian hotels that was conducted in early 2000.

The main objective of the project was to raise the profile of hotel energy benchmarking as a valuable tool for hotel engineers, quantify and identify energy performance of a group of hotels, and identify major variables affecting energy efficiency in hotels.

The report includes an analysis of data and proposes benchmark indicators of best practice performance within the survey hotels as follows:

	MJ/Room	**MJ/m^2**
Accommodation Hotels	35,000	750
Business Hotels	95,000	1,050

Besides accommodation and business hotels, three other hotel categories were identified in the survey. These were general hotels, casinos and resorts. Insufficient data meant that no benchmark indicators could be proposed for these hotel types.

The report demonstrates that the energy consumption of a hotel is related to the size of the hotel and is relatively independent of the location or climate zone in which it operates. The accurate measurement of hotel size, or capacity, remains problematic but floor area and the number of accommodation rooms are proposed as reasonably available approximations. The use of throughput data, such as guest numbers or occupied room nights, is an inappropriate basis for comparing energy performance between hotels. However both climate data and throughput remain valuable in comparing the performance of a hotel against its own performance over time.

With occupancy rates showing little effect on energy consumption, the importance of part occupancy performance in future design and management of hotels is quite clear. This is particularly important when it is considered that average occupancy rates in Australia are only just over 60%.

The report shows that energy performance of hotels is best when there is strong management interest and a robust energy performance-monitoring program in place. There is also a strong correlation between water management and energy management with some of the biggest energy performance improvements coinciding with similar reductions in water consumption.

Case studies were carried out on a number of the better performing hotels.

Future, wider surveys of the hotel industry are encouraged as a means of developing best practice indicators for the remaining hotel types, and for refining the indicators proposed above.

Introduction

This report describes the outcomes of a survey of the energy performance of a group of hotels providing accommodation and other services. The primary aim of the project is to raise the profile of energy benchmarking as a valuable tool in hotel engineering, quantify the energy performance of a group of hotels, and identify major variables affecting energy efficiency within hotels.

This project was carried out in 2000 as a partnership between the Energy Efficiency Best Practice Program of the Department of Industry Tourism and Resources (ITR) and the Australian Hotels Association (AHA). It draws on earlier work done in Western Australia [1] and New Zealand [2], which helped focus the analysis of this study.

All of the hotels studied are located in Australia except for five that were added. This data was included in the analysis because it was readily available, it increased the sample size and it enabled additional overseas comparison.

This report uses data from the survey to develop benchmark indicators of best practice energy efficiency performance for the hotel industry. The initial intention was to subject the data to rigorous statistical analysis to develop these indicators. As the project evolved, however, it became apparent that there were neither enough participants nor a sufficient breakdown of energy use into end-use categories to perform this level of analysis. There was enough data, however, to carry out a graphical analysis and draw many useful conclusions.

While many hotels conduct a form of internal benchmarking by comparing their current performance with that of previous years, surveys such as this often give participants their first picture of how their performance compares with others in the same industry. This helps owners and managers make realistic assessments of relative performance and judge what is attainable from effective energy management programs. In a separate but related project, a number of the better performing hotels identified during the survey were examined in more detail, to identify the practices that contribute most to their energy performance. The results have been published as case studies.

The report looks at the results of the energy survey in detail, including the methodology used and the problems encountered, before looking at overall use of energy and the associated greenhouse emissions of the surveyed hotels. The report concludes with an analysis of the data and presents benchmark performance levels by hotel categories.

While this project focussed for the most part on energy, non-energy utilities such as water and waste disposal were also surveyed and, where available, the results are included in this report.

Because there is some commercial sensitivity about energy consumption and costs, hotels are not identified in this report except where the hotel has given permission to do so. To maintain confidentiality, each hotel was assigned an identification number and data is presented in a normalised form. This approach enables individual hotels to identify their own performance in a data set without identifying other participants.

Energy and the hotel industry

Energy use in hotels is around 0.5% of total energy consumption in Australia. Hotels are part of the commercial sector, which consumes around 6% of total energy in Australia but is responsible for around 12% of total energy related greenhouse gas emissions. [3] While these are not large percentages, the hotel industry is fast growing and, as with most buildings, electricity is the main source of energy used in hotels. Since electricity carries higher associated greenhouse gas emissions intensity than other forms of energy, it has a greater environmental impact.

According the Australian Bureau of Statistics (ABS) [4] there were just over 3,700 accommodation establishments in Australia in 1999 offering just under 200,000 rooms and providing around 40 million accommodation room nights at an occupancy rate of almost 60%. This study has drawn most of its data from the group of accommodation establishments referred to in the ABS report as *Licensed Hotels with Facilities*. In 1999, this group comprised around 750 establishments offering a total of just over 70,000 rooms. It provided 16.5 million room nights of accommodation at 63% occupancy.

The energy survey

Description

One hundred and ten hotels were invited to submit data to the survey, selected by the AHA, mainly on the basis of their prior involvement in the Greenhouse Challenge process.

An electronic template was used to collect the data to reduce handling time and to eliminate the possibility of transcription errors.

Some Important Definitions

End-Use Category:	A building or facility type that consumes energy (for example guestrooms, space cooling, and gardens)
Energy Type:	The type of energy that is consumed by an end-use category (for example, electricity, natural gas, and domestic hot water)
Normalisation Factor:	A physical characteristic of the hotel (such as floor area, number of guestrooms) or a measure of hotel throughput (such as number of guests or the number of occupied rooms). Energy consumption is divided by normalisation factors to produce a performance indicator that can be used to compare different hotels (for example MJ/m²/annum, MJ/guest)
Megajoule (MJ):	A unit of energy equal to 10^6 joules. A kilowatt-hour of electricity equals 3.6 MJ.
Gigajoule (GJ):	A unit of energy equal to 10^9 joules, or 10^3 MJ. A kilowatt-hour of electricity equals 0.0036 GJ.

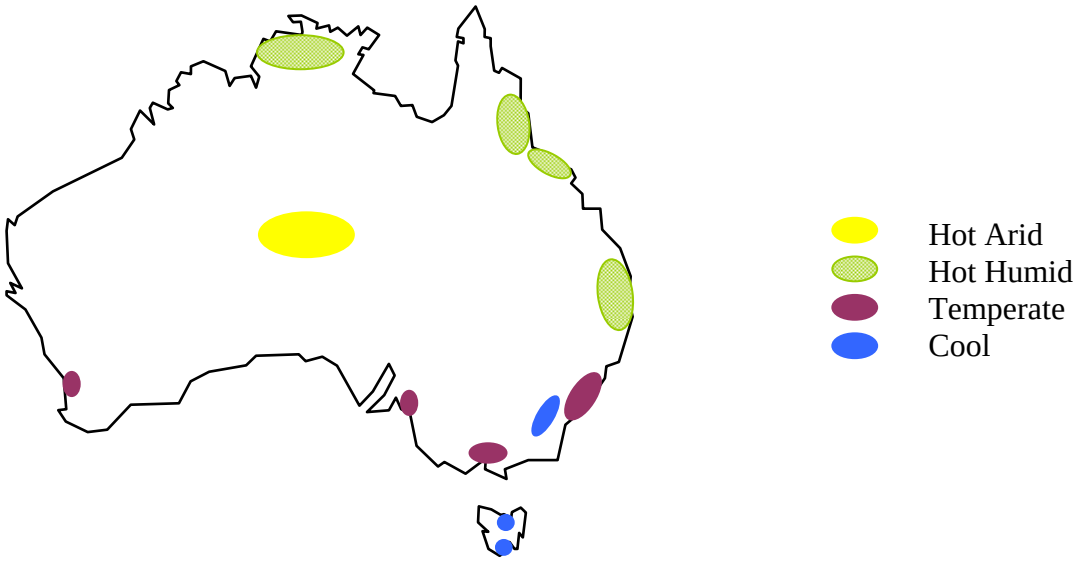
At a minimum, hotels were asked to submit energy consumption for a full year for each energy type used. They were asked to provide normalisation factor data for the same period. Finally, hotels were asked to provide additional data where possible, including on energy consumption by end-use category, on non-energy utilities like water, sewerage and waste.

Fifty-one hotels submitted data. Twenty-two reported a single year of data and the remainder up to nine years. Most hotels were only able to report on total energy consumption and cost against energy types. Some provided water use, waste, sewerage, maintenance information and breakdowns of energy use against end-use categories. Generally, the quality of the data was sound. However, less data was received than expected.

Geography

Figure 1 shows where participating hotels are represented, by region and by climate. The hotels are geographically dispersed over a wide range of climatic conditions. Five hotels from one other country were included in the project, to increase the sample size and provide a point of comparison from outside Australia.

Figure 1 Regions represented in the survey



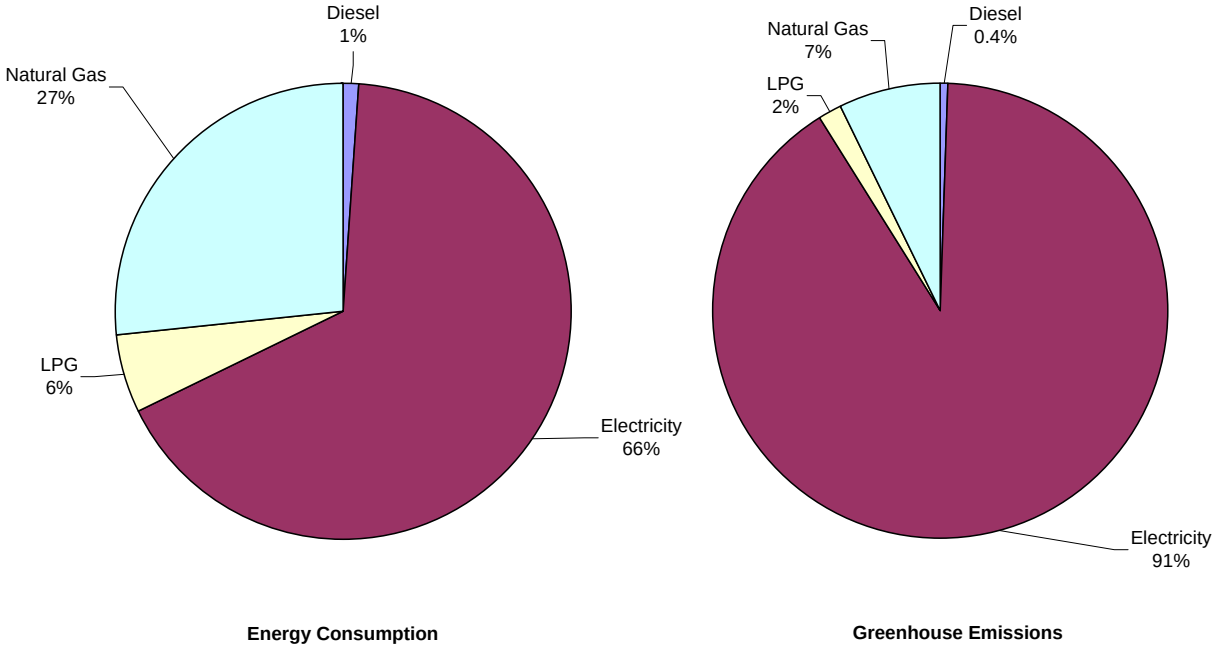
Energy consumption & greenhouse emissions

Electricity is the most common form of energy used by the hotels in this study. This is illustrated in Figure 2, which shows that electricity represents 66% of total consumption during the calendar year 1999, followed by natural gas with 25% consumption. Unless stated otherwise, references in this report are for energy consumed in 1999.

The small amount of reported diesel consumption is for on-site electricity generation in some of the remote hotels participating in the survey. One of the hotels that reported diesel for electricity generation has since been connected to the grid. In order to facilitate comparisons with future performances, its diesel consumption was deleted from the data and replaced by the amount of electricity that it had generated. This also makes its performance more comparable with the other hotels in the survey.

The higher cost of on-site generation is likely to make the application of renewable energy technologies more cost effective. The actual contribution of any renewable energy sources to overall energy consumption was not sought in the survey but will be considered for inclusion in any future surveys. However, the issue of measurement must be included in this consideration. While something like wind or photovoltaic electricity generation might be metered, it is less likely that contributions from sources such as solar hot water services would normally be measured. These sorts of contributions should show up in the form of lower energy intensities and may well be highlighted in case studies of better performing hotels.

Figure 2 Total energy consumption and greenhouse gas emissions



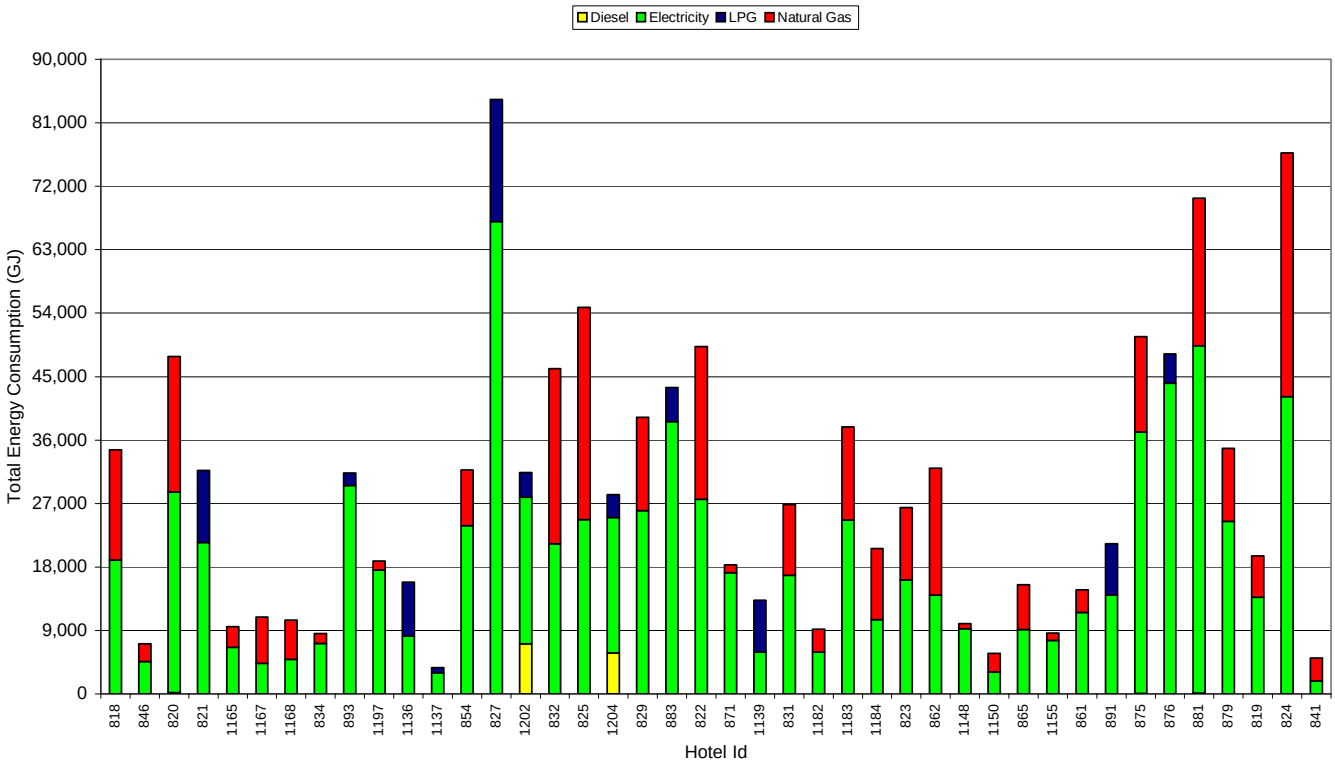
The effect of the high greenhouse intensity of electricity is clearly illustrated when greenhouse emissions are compared with energy consumption in Figure 2. Although electricity makes up 66% of total energy use, it contributes over 90% of total greenhouse gas emissions due to its high greenhouse intensity. This high intensity results from the relatively low thermal efficiency of the predominantly coal-fired power stations in which the electricity is generated, combined with the relatively high greenhouse intensity of coal as a fuel.

The greenhouse emissions are calculated from national average intensities and, of course, individual hotels would be subject to local intensities that would vary with the method of generation of electricity in that location.

Energy consumption by hotel

The total energy consumption of each hotel during 1999 showing the relative proportions of each energy source is presented in Figure 3. This presentation makes no correction for the size and location of a particular hotel and clearly illustrates the wide variation of energy use between hotels. When natural gas is used in a hotel, it typically represents up to 50% of total energy consumption. In fact, there is a tendency for hotels to have overall higher energy consumption when gas consumption increases as a proportion of total consumption. This tendency is not uncommon in buildings and is usually associated with poor system design or a controls failure that lets air conditioning systems heat and cool at the same time.

Figure 3 Hotel energy consumption



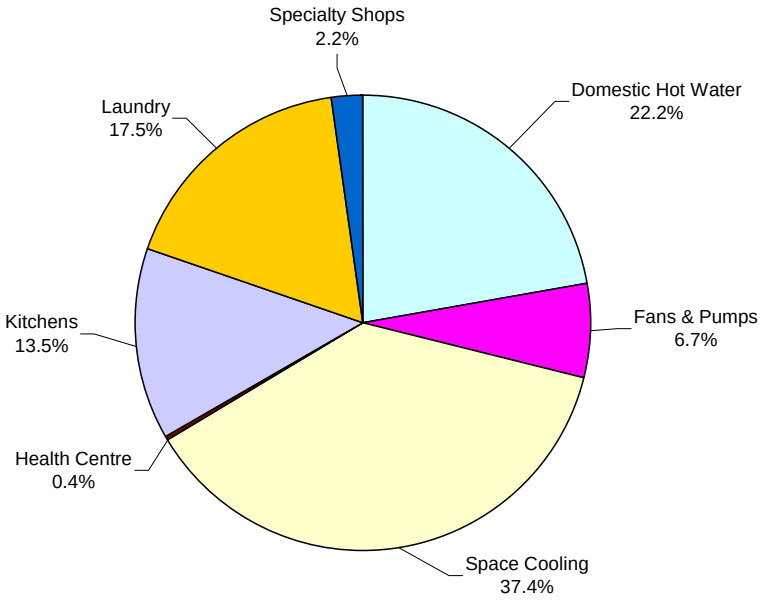
Energy end-use

There are significant management benefits from being able to identify where energy is being consumed in a hotel. Good sub-metering and a robust monitoring program is a characteristic of a well performing hotel.

Many hotels in this study were able to report only on total energy use. A few could break this into some end-use categories. The Cairns Hilton provided the best breakdown of energy consumption against end-use categories (Figure 4). The hotel uses LPG for producing steam for the laundry and for heating domestic hot water, and uses electricity for all remaining services. The hotel is located in a hot and humid climate and, as can be expected, uses a large proportion of energy for cooling and dehumidification. Understandably, the hotel does not have a space heating system. The hotel also provides a contract laundry service and this has an effect on the energy consumption of the laundry and possibly also the domestic hot water system.

Other hotels provided less detailed breakdowns of energy end-use (details of which are included in the appendices). Case studies have additional information for selected hotels.

Figure 4 Energy end-use – Cairns Hilton



Data analysis

Benchmarking

One of the purposes of this study is to develop benchmark indicators of best practice energy efficiency performance. A benchmark is a standard or point of reference against which comparisons can be made. Before a benchmark can be set for hotels, appropriate performance indicators of energy efficiency that widely apply across the industry have to be established. Ideally, these indicators should normalise the energy performance of a hotel for variables beyond the control of the energy manager, such as the size or location of the hotel or the number of guests. An example of normalising energy consumption for hotel size is to express performance as energy use per square metre of floor area per year, and expressions like MJ/m²/annum are used throughout this report to express this. Similarly, figures of MJ/guest are used to normalise energy performance for guest occupancy.

The climate zone in which a hotel is located may affect energy performance. A common technique used to compensate for local climate uses daily average temperatures often presented in terms of degree days from a base temperature.

A real indicator of energy efficiency in a facility that holds functions and conferences and deals with processes as diverse as those encountered in a typical hotel is unlikely to incorporate only a single variable but is likely to contain variables relating to each of the processes contributing to energy consumption. However, determining such indicators requires an enormous amount of data, and this is rarely available. Also, there has to be compromise between accuracy, and ease of use, if the indicator is to have widespread use in the industry.

It is important that performance indicators be expressed in common units. Indicators expressed in cost terms are of little benefit outside local markets, particularly given the wide variation in energy prices that exists in Australia. One of the biggest challenges is to find an indicator that is efficient, easy to obtain and reliable. A number of indicators are proposed in this report.

Categories

Five energy performance groups emerged from an early review of the data provided by the hotels in the survey. Further examination of the data revealed that it was not just energy performance that placed a hotel into these groups. Other background indicators, beyond energy performance, were identified that could be used to categorise each hotel. These included:

- an informed judgement on the relative amount of accommodation to other hotel uses;
- the number of food covers per occupied room; and
- the total floor area per room.

So, while energy performance first identified the existence of hotel categories, it was found that a hotel could be categorised using background indicators without knowing anything about its energy performance. The advantage of this approach is that once a hotel has been categorised, its energy performance can be predicted.

Each hotel in the survey was categorised using the background indicators and the results provided in Table 1.

Table 1 Hotel categories

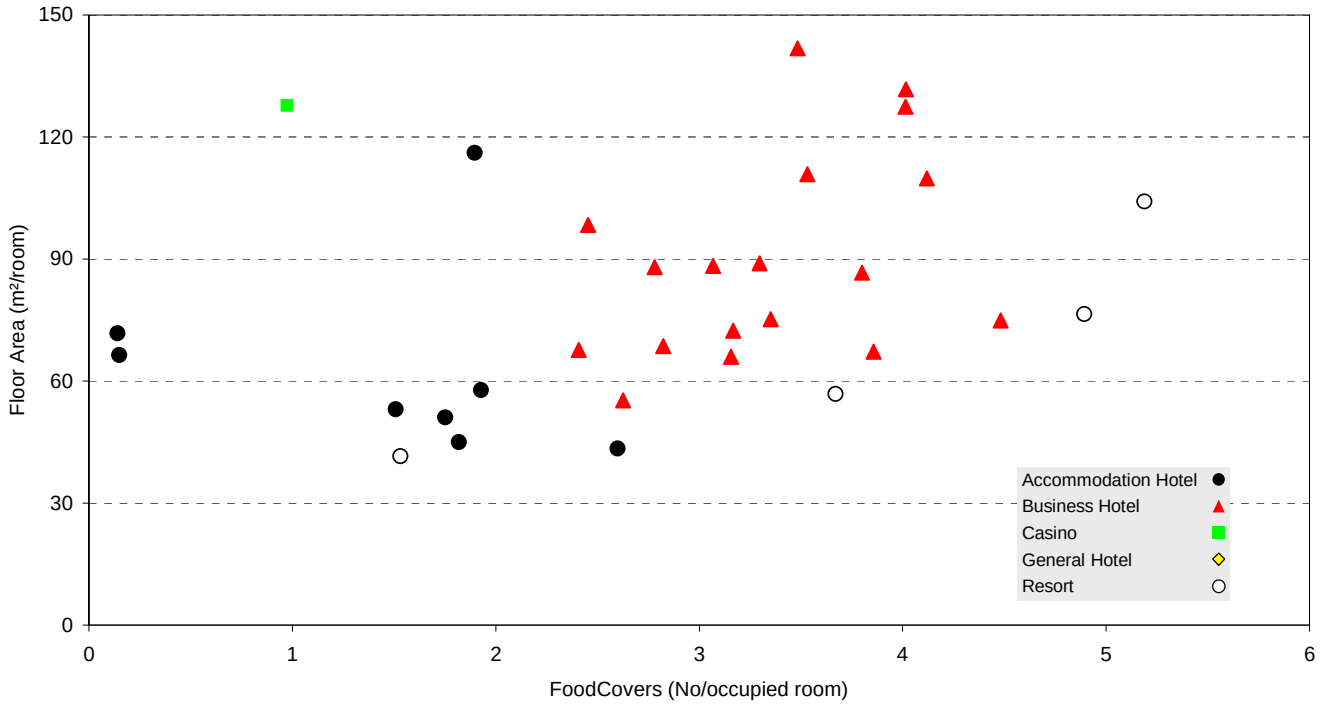
Category	Definition	Code	Number Reported
Accommodation	Business and holiday hotels with the main purpose of providing accommodation. Restaurants, bars and function rooms occupy a relatively small proportion of total floor area.	A	10
Business	Business hotels that provide a high standard of accommodation and also significant areas for functions, dining and entertainment.	B	28
Casino	Hotels with the prime business of gaming. Accommodation, functions, dining and entertainment are an adjunct.	C	2
General	Hotels with the prime business of providing bars and gaming areas These hotels have a minor emphasis on accommodation.	G	1
Resort	Hotels in a holiday location. They provide daytime activities and guests depend on the resort for daytime entertainment. The guests could be "captive" at the resort for evening meals/breakfast etc. These hotels could have large areas of swimming pools, gardens and other amenities such as golf courses. Guests tend to stay for several days with multiple occupancy.	R	10

These categories are indicative only, and it is recognised that some hotels may overlap two or more categories. Also, some hotels that had shown up in one category on energy performance ended up in a different category when classified by the background indicators. They were placed in the category of best fit.

Different hotel categories are indicated on the graphs and charts used in this report through the legend.

The strongest determinant of the category is the basic use of the hotel. For casinos, resorts and general hotels, this is almost the only determinant. For accommodation and business hotels, room areas and catering rates are also considered. Typically, accommodation hotels serve two or less food covers per day and have less than $60m^2$ of gross floor area per accommodation room. This is demonstrated in Figure 5 where accommodation hotels are grouped in the bottom left and business hotels in the top right.

Figure 5 Hotel category indicators



This same information is presented slightly differently in Figure 6 and Figure 7 where the gross floor area per room and the number of food covers per occupied room are separately charted for each hotel in the survey.

Figure 6 Gross floor area per accommodation room

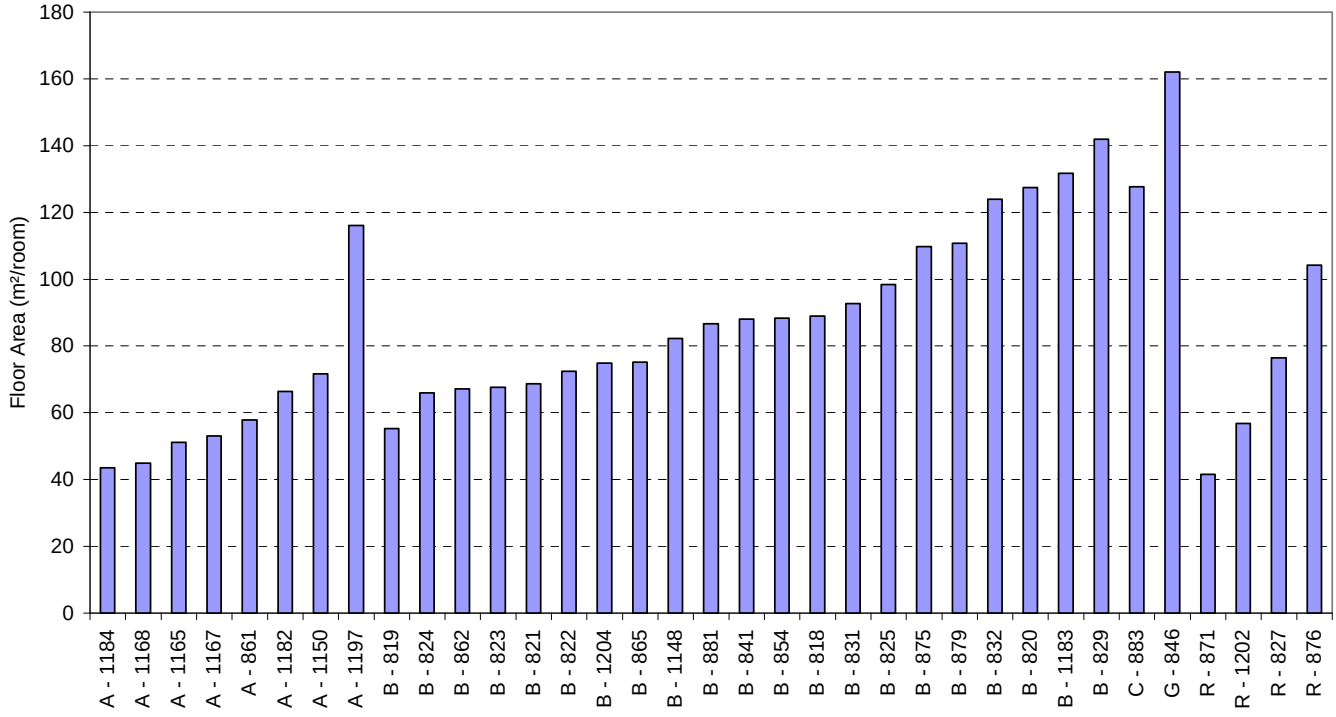
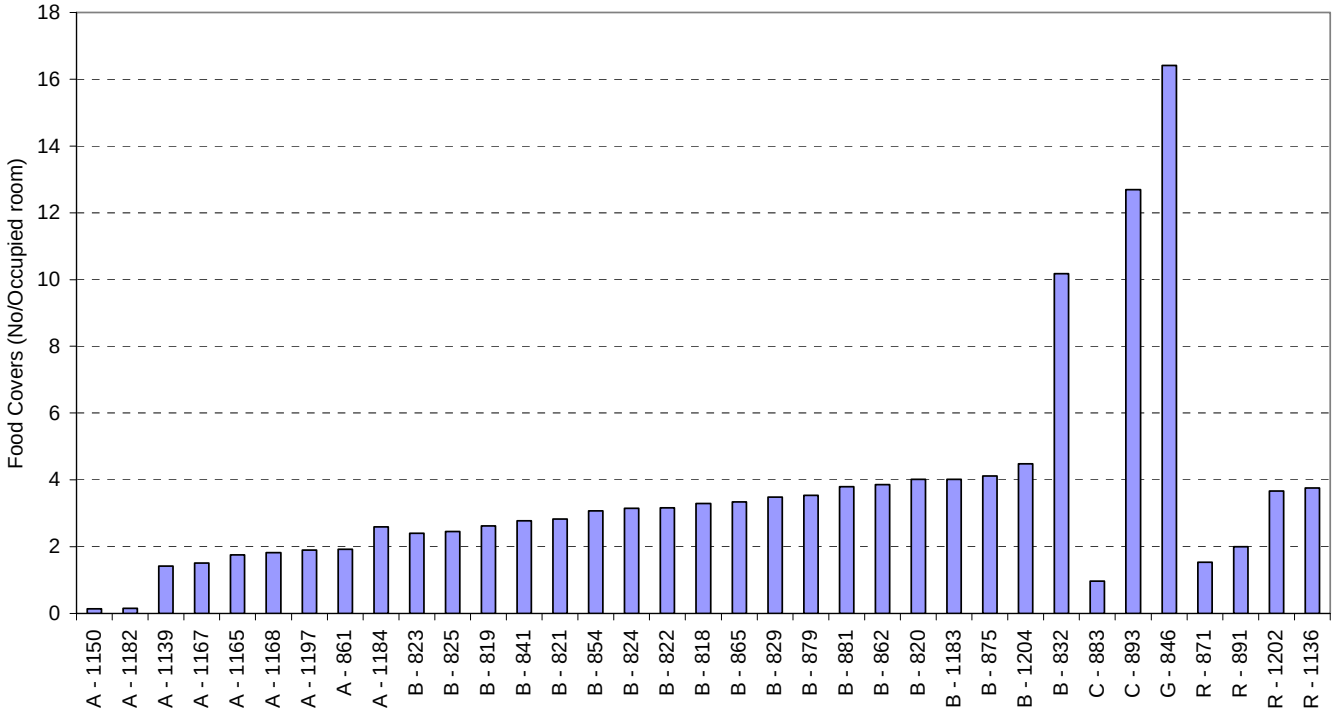


Figure 7 Number of food covers per occupied room



Capacity

General

It has been argued that comparing energy consumption against hotel capacity will provide the simplest and most robust measure of energy efficiency performance. [5]. What is not so simple is the measurement of capacity. There are a number of potential measures, and these include floor area, building volume, number of beds, number of guestrooms etc or a combination of two or more of these. Most hotels in the survey reported numbers of guestrooms and floor area and these were investigated for use as measures of capacity to normalise energy consumption.

Approximately half of the hotels contributed multiple years of data and approximately half a single year. The most common year for data was 1999 and, as a result, this was selected as the basis for comparing the relative performance of the hotels.

Floor area

Figure 8 shows the total floor area and energy consumption of each hotel during 1999. Results are presented graphically because there was insufficient data available for alternate statistical analysis.

Figure 8 Total energy consumption versus area for all hotels

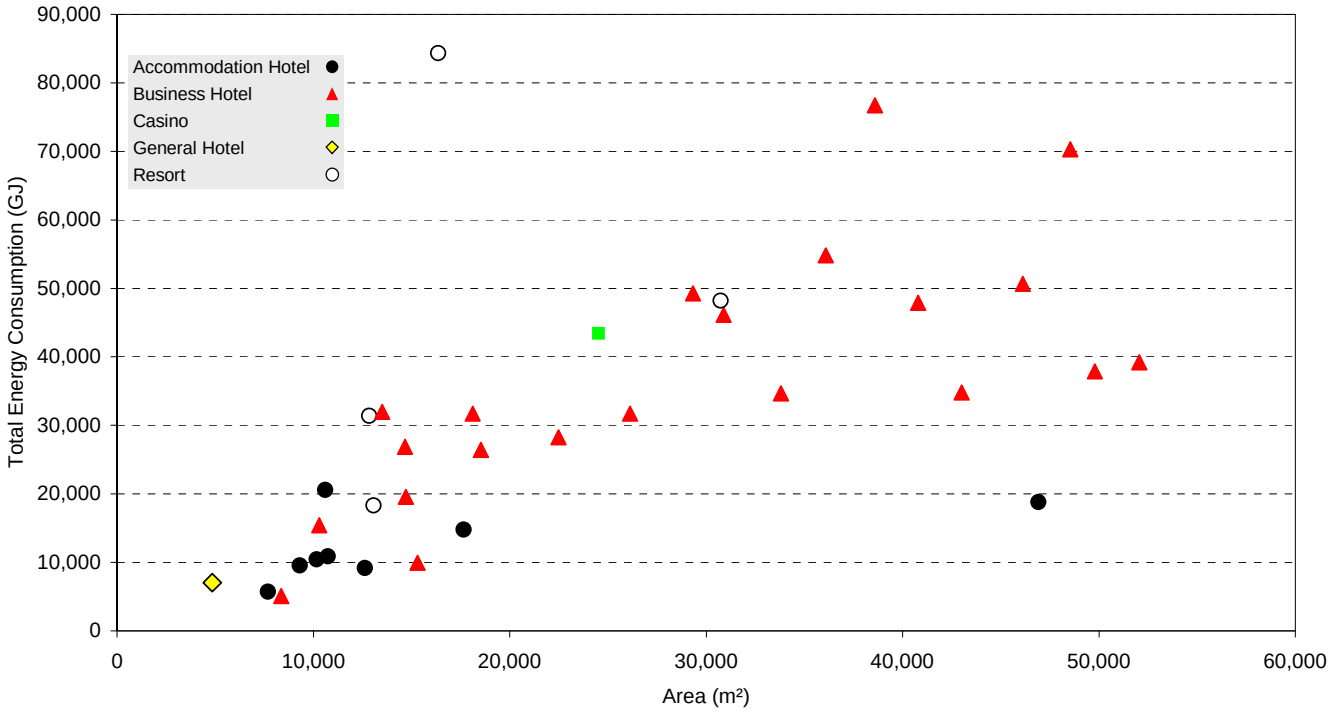


Figure 8 suggests that there is a simple relationship between total energy consumption and floor area. However, a closer look reveals that this relationship varies between hotel types. The relationship between energy consumption and floor area is not particularly strong for accommodation hotels and resorts, for example, but the relationship is much stronger for business hotels. The relatively few data points in the figure for accommodation hotels and resorts may be contributing to the weaker relationship of energy consumption to floor area. Also, while it looks like energy consumption spreads out at larger floor areas, this spread is a fairly consistent proportion of average as total energy consumption increases.

Figure 9 Linear regression of energy consumption against floor area

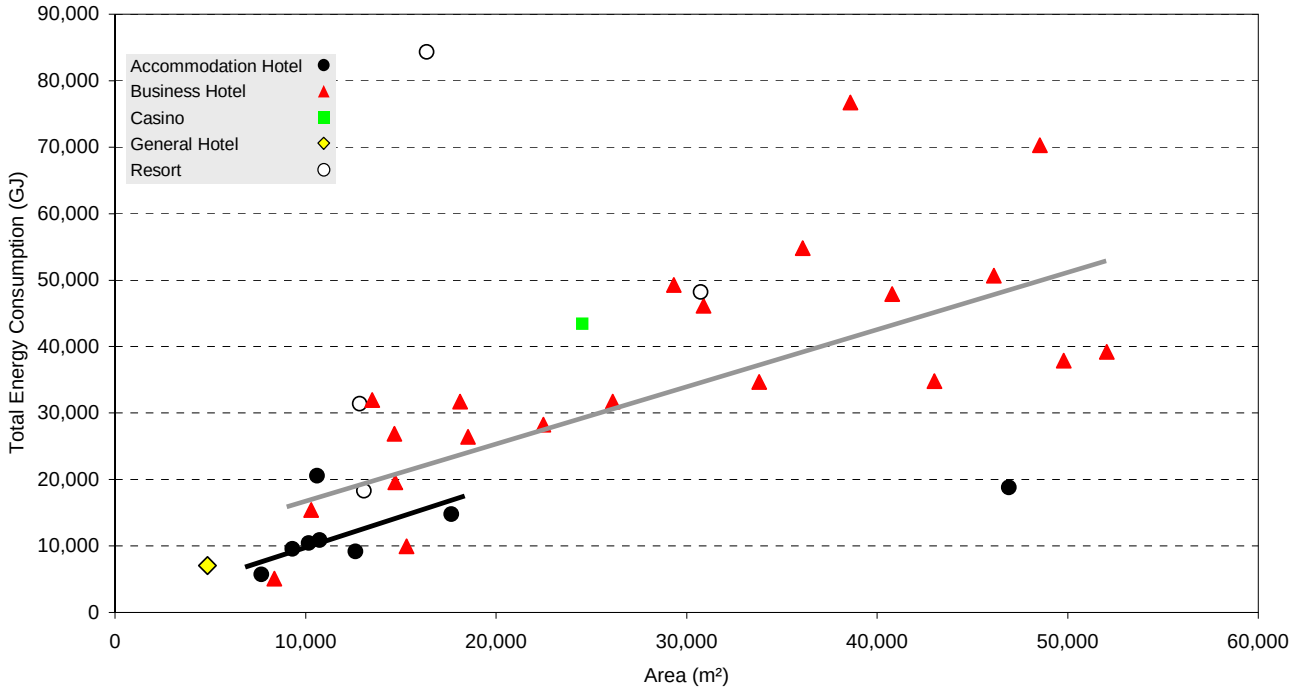


Figure 9 shows the approximate trend lines for the energy consumption of business hotels and accommodation hotels. These lines do not represent statistical calculations but have simply been inserted by eye to demonstrate the approximate relationship.

Guestrooms

Figure 10 shows the relationship between the energy consumption and the number of guestrooms in each survey hotel. The graph shows that there is a strong relationship between total energy consumption and number of rooms for accommodation hotels and a reasonable relationship, although much more dispersed for business hotels. This dispersal is understandable because business hotels, by definition, provide much more than just accommodation as represented by the number of rooms, while this is the core business of accommodation hotels.

Similarly, Figure 11 proposes approximate trend lines for energy consumption against the number of guest rooms for business and accommodation hotels.

While resorts, casinos and general hotels are represented in both Figure 9 and Figure 11, there are insufficient data points to propose any trend lines.

Figure 10 Total energy consumption versus number of guestrooms

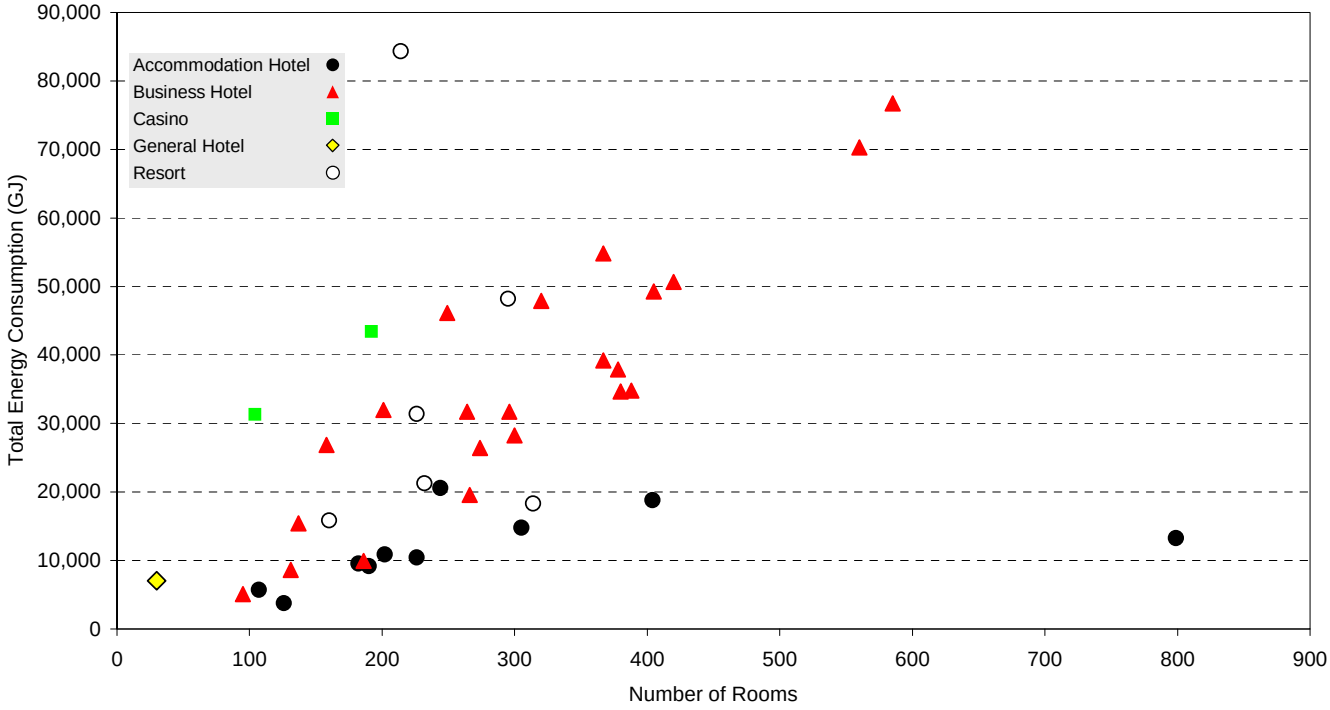
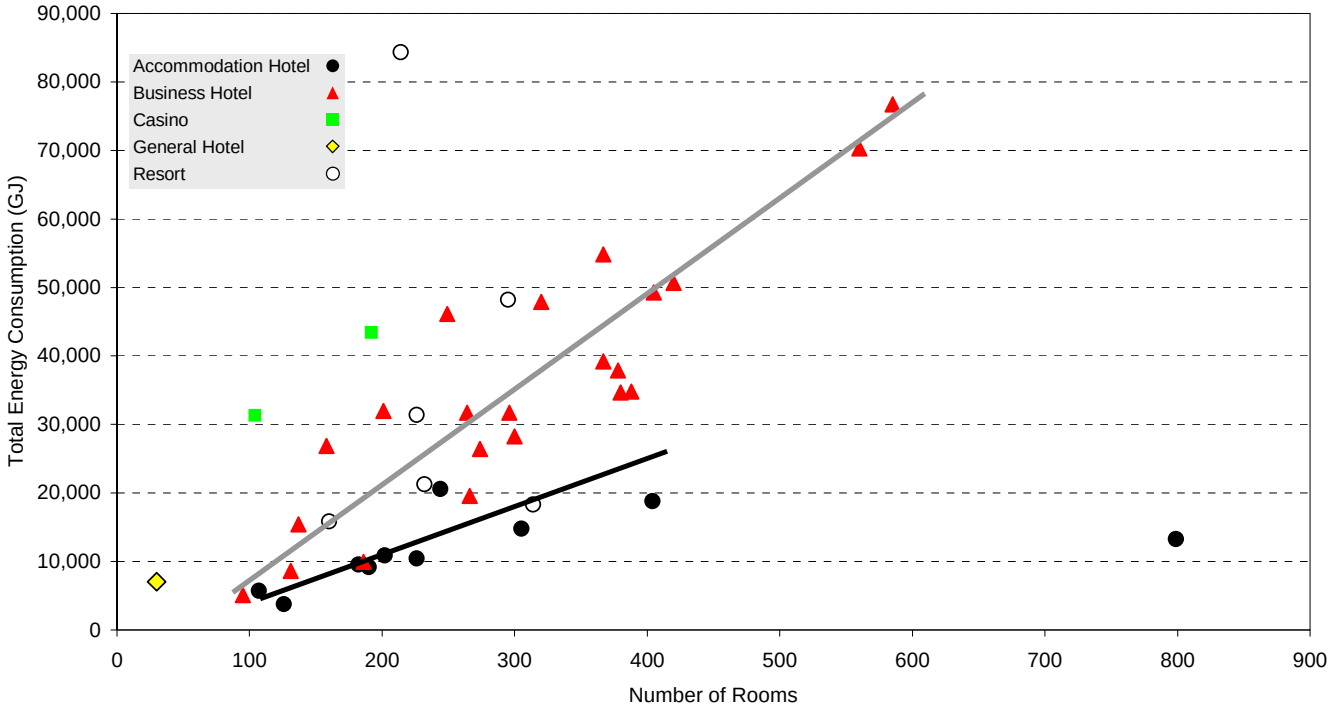


Figure 11 Linear regression of energy consumption versus number of guestrooms



Discussion

It is quite clear that both floor area and number of rooms can be used as measures of hotel capacity and therefore used to predict hotel energy consumption. However neither is perfect and there are unquestionably a number of other factors that come into play in determining overall energy use.

Floor area could be an excellent measure of capacity since it encapsulates the space required for the disparate functions of a hotel. Currently, however, the term is not well defined and is subject to varying interpretations of what is included in 'floor area'. This was an issue when analysing the data - an issue that required the hotels to provide updates and/or further information on the floor area data initially provided.

The appendices included in this report discuss floor area measurement and recommend a common definition for future studies. There are other issues relating to using floor area. It assumes, for example, that all functions within a hotel have roughly uniform energy intensity and it does not measure the extent of hotel operations outside of the building itself.

The number of guestrooms provides a very simple and well-known measure of hotel capacity. Like floor area, it has its shortcomings as it does not measure the extent of external operations but more importantly, it does not measure the extent of operations other than accommodation within the hotel itself.

Floor area is arguably a better measure of size but the lack of a standard definition reduces its reliability. The number of rooms is less effective as a measure but it is clearly defined and readily available. It is recommended that hotels select the measurement that is most appropriate to their needs.

Other factors like weather, occupancy and utilisation of function, restaurant and bar space are also expected to contribute to energy consumption. The extent to which they contribute will be explored later.

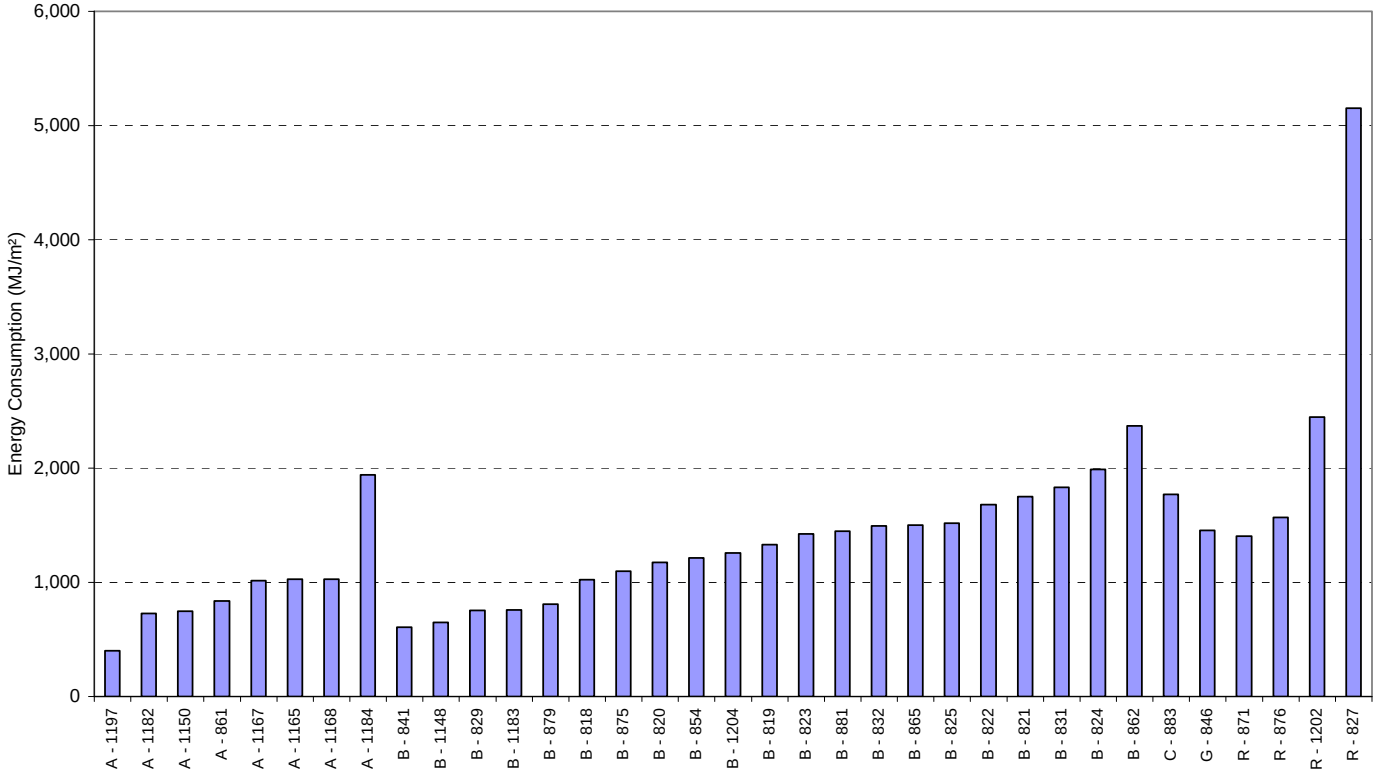
Energy intensity

Although the scatter plots of Figure 8 to Figure 11 are useful for demonstrating trends, they are less useful for comparing the performance of one hotel against another. Performance comparison is much easier using energy intensities that are calculated by dividing the total energy consumption by a normalising factor. In hotels, these factors could be capacity measures like floor area, or number of rooms, or throughput measures like number of guests. Respective energy intensities would be expressed as MJ/m^2, MJ/room or MJ/guest, where the megajoule (MJ) is a standard measure of energy consumption. (There are 3.6 MJ in a kWh).

This section concentrates on MJ/m^2 and MJ/room. The effect of guest numbers, or occupancy, will be examined later.

Figure 12 shows each of the hotels grouped by type and in ascending order of MJ/m^2 intensity. Energy intensities also provide a convenient method of providing performance data while preserving anonymity. Each participating hotel, by knowing its identification number, can identify itself on the chart and compare its performance against all other participants.

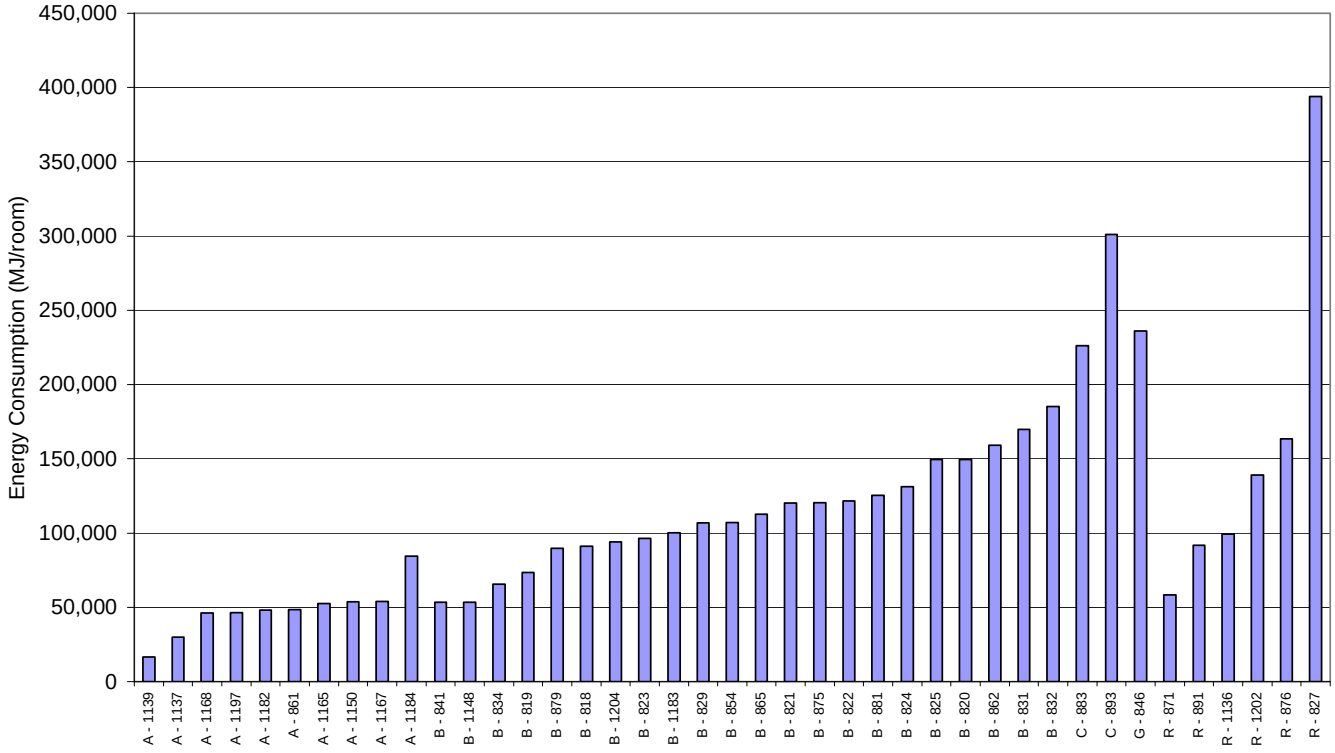
Figure 12 MJ/m² for each hotel



These results are fairly consistent with the APEC report, *Institutionalization of a Benchmarking System for Data on the Energy Use in Commercial and Industrial Buildings* [6], which reports an average energy intensity of around 1,250 MJ/m^2 for a group of 158 hotels in the US. It also reports an average intensity of around 1,070 MJ/m^2, 1,400 MJ/m^2 and 1,250 MJ/m^2 for smaller groups of hotels in Hong Kong, Singapore and Chinese Taipei respectively.

Figure 13 is a similar presentation but this time showing the performance as MJ/guestroom.

Figure 13 – MJ/room for each hotel



These figures demonstrate the different energy performance levels of the different hotel categories. As with all surveys, there will be some hotels performing better or worse than the average of their category. The better performing hotels in each category have been written up in case studies, which outline some of the reasons for their enhanced performance. Hotels performing below averages might consider a review of operations to identify opportunities for energy efficiency improvement.

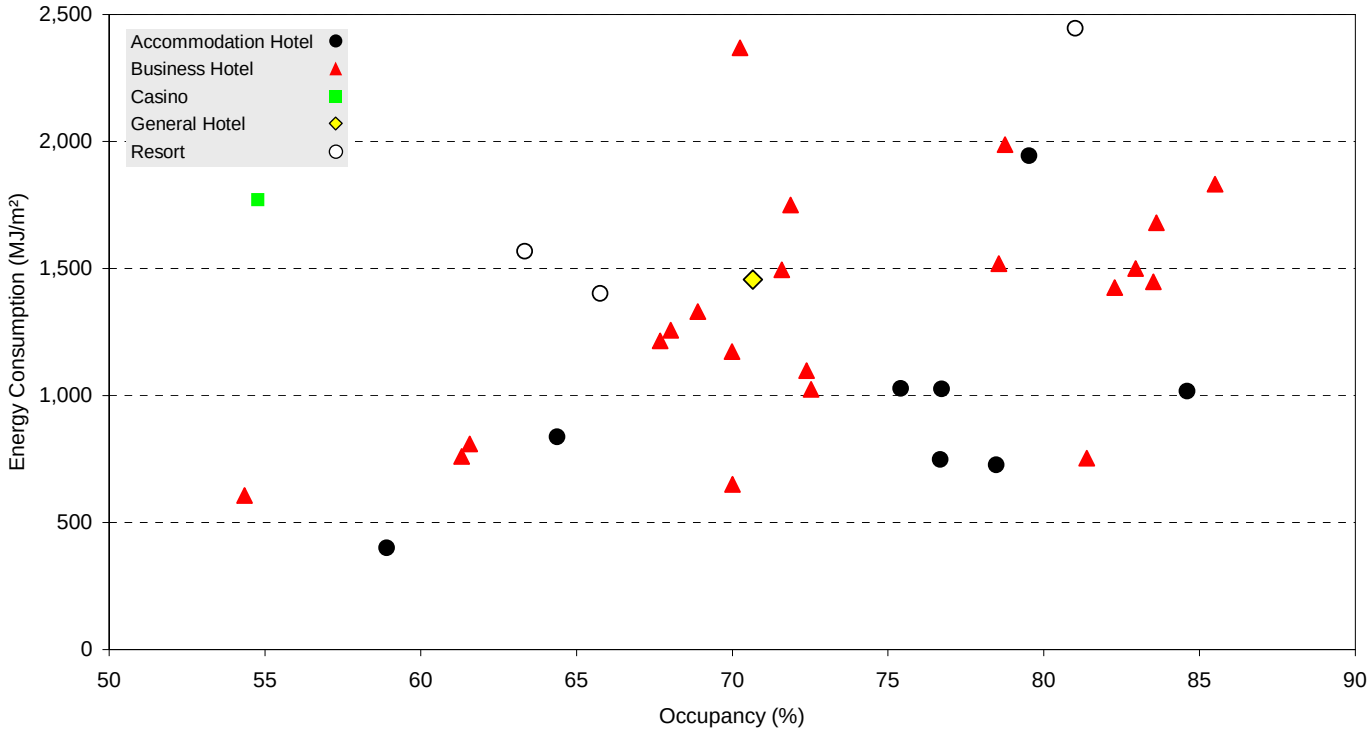
Hotel occupancy

Figure 14 and Figure 15 indicate that the relationship between occupancy and either MJ/m² or MJ/room is not straightforward. While it is difficult to draw firm conclusions from the small data set, it appears that with room occupancy rates between 70 and 100% there is little effect on the energy consumption of a hotel and energy intensity only starts to drop off when occupancy rates fall below 70%.

This is particularly true for business hotels. Accommodation hotels show almost no change in energy consumption regardless of occupancy levels although no conclusions can be drawn from occupancies less than 50% due to the lack of data. The position of the casino on the graph indicates that occupancy probably has very little bearing on casino energy consumption and is mostly driven by level of activity within gaming spaces.

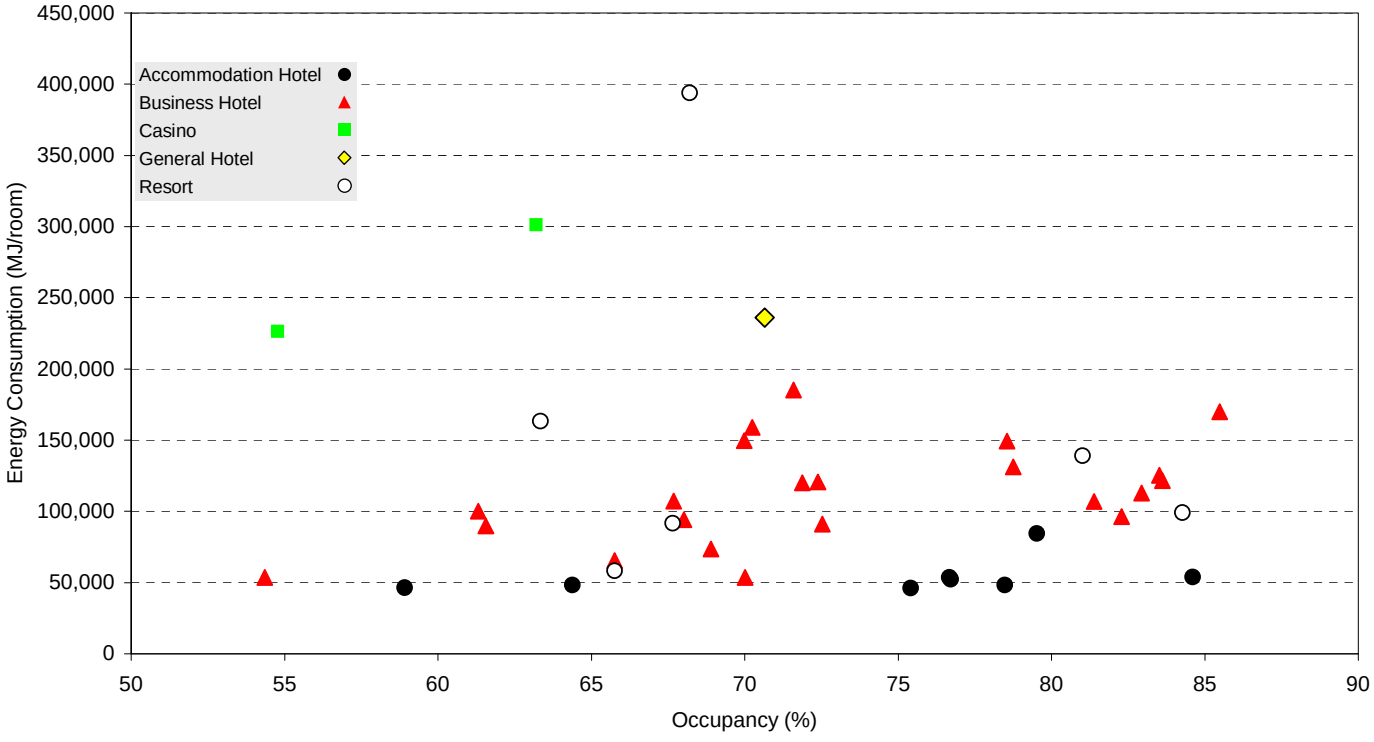
Occupancy:	The number of guestrooms occupied during a period compared with the number of guestrooms available during that period.

Figure 14 MJ/m² vs occupancy



This data supports the proposition that at high occupancies, hotel energy consumption is relatively independent of guest numbers and that any benchmarking comparisons between hotels based on energy consumption per guest could result in misleading conclusions.

Figure 15 MJ/room vs occupancy



It is expected that the relationship between energy consumption and occupancy will be hotel-specific and would reflect the way in which hotel design and operation allows for certain areas of the hotel to be closed down during periods of lower occupancy. It is recommended, therefore, that energy consumption per guest only be used for internal benchmarking. That is, it should only be used to compare the current performance of a hotel with a previous period of performance and even then, it should be used with caution, taking into account the weather and preferably making comparisons against previous periods of similar occupancy. Over time, a picture of the part occupancy energy performance of a hotel can be developed and contribute to a more effective analysis of energy consumption.

It is interesting to note that in the ABS publication *Tourist Accommodation Australia* [4], the average national room occupancy for what they termed *Licensed Hotels with Facilities* was 63% during 1999. This indicates that a primary consideration in improving the energy efficiency of the hotel industry should be improvements to the part occupancy energy performance of the buildings.

Benchmarks

The following indices are suggested as a guide to the energy consumption of relatively energy-efficient accommodation and business hotels. Deviations from these estimates may not reflect poor management but may be the result of an unmeasured but uncontrollable variable.

Table 2 Benchmark performance indices

	MJ/Room	**MJ/m^2**
Accommodation	35,000	750
Business	95,000	1,050

Lack of data makes it impossible to set a benchmark figure for any of the other hotel types, and derivation of such figures is dependent on a more extensive future survey. Such a survey might also allow an improvement in the quality of the existing benchmarking figures by giving them amore substantial statistical base and by allowing them to be modified for climate, occupancy, business mix etc. These factors may not be greatly significant in affecting overall hotel energy performance, but they do have some impact, and as the hotel industry becomes more energy aware, these factors will take on more significance.

Performance range

The histograms in Figure 16 and Figure 17 give some idea of the range of hotel performances around each of the proposed benchmarks.

Figure 16 Histogram of MJ/room

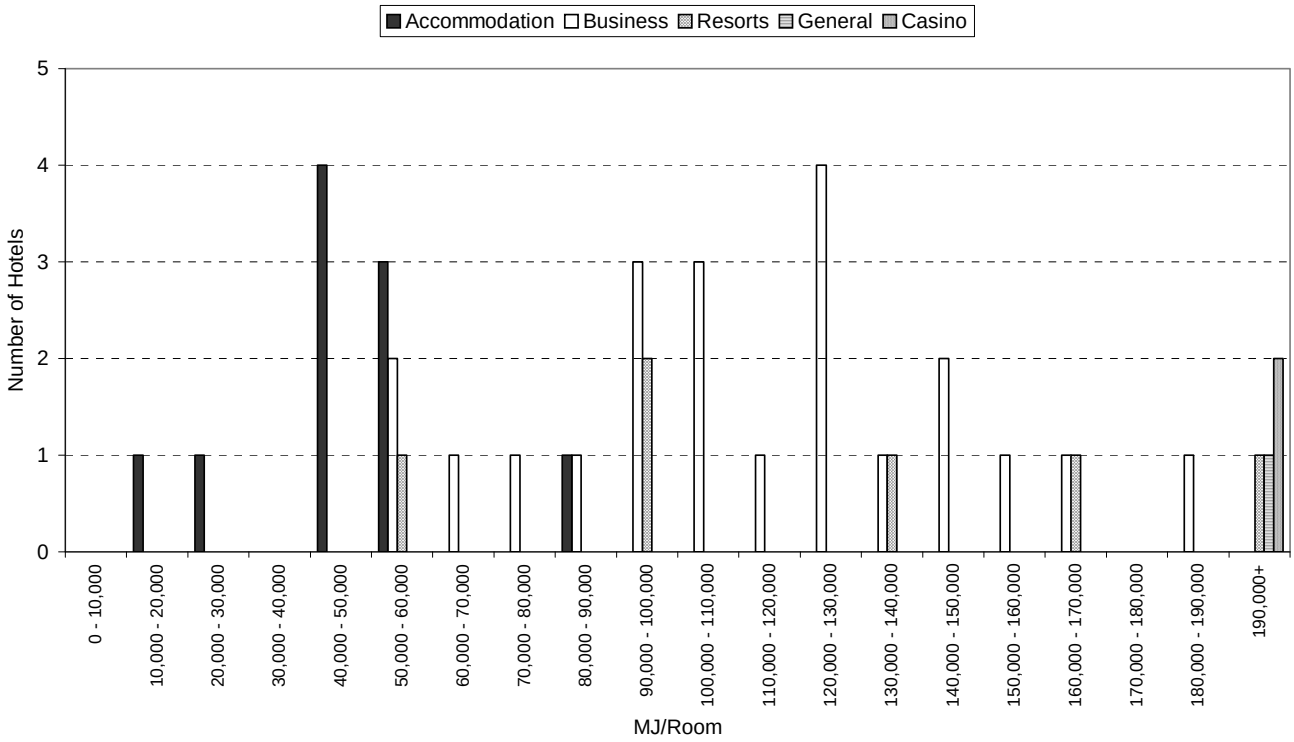
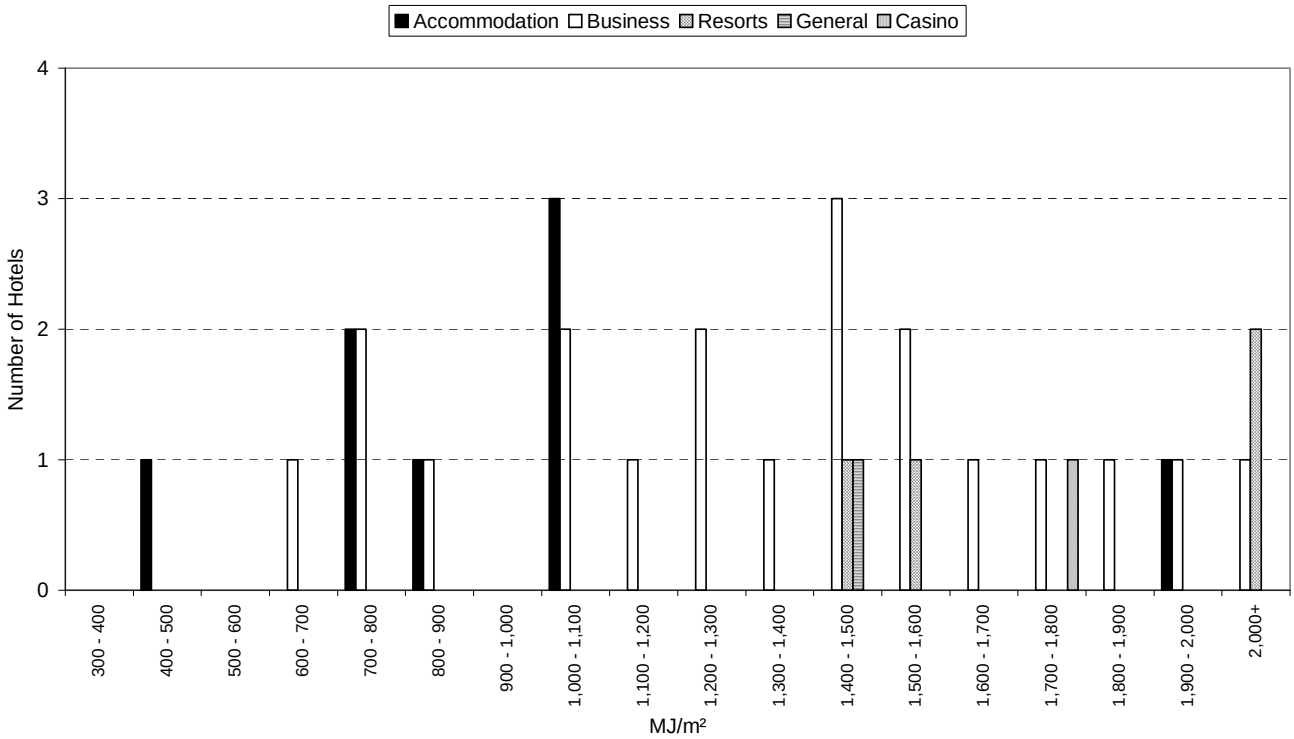


Figure 17 Histogram of MJ/m^2



Climate effects

Figure 18 and Figure 19 show how the performance of accommodation and business hotels varies with climate zone. More correctly, they indicate that climate has very little effect when comparing the performance of different hotels.

Climate is still important in tracking the performance of a single hotel over time. And it should become more important as hotels become more efficient, and respond more directly to their environment and to the production of services.

This characteristic of hotels to perform relatively independently of the local climate was first observed in the New Zealand *Commercial Building Energy Survey: HOTELS* [2].

Figure 18 Accommodation hotels and climate zones

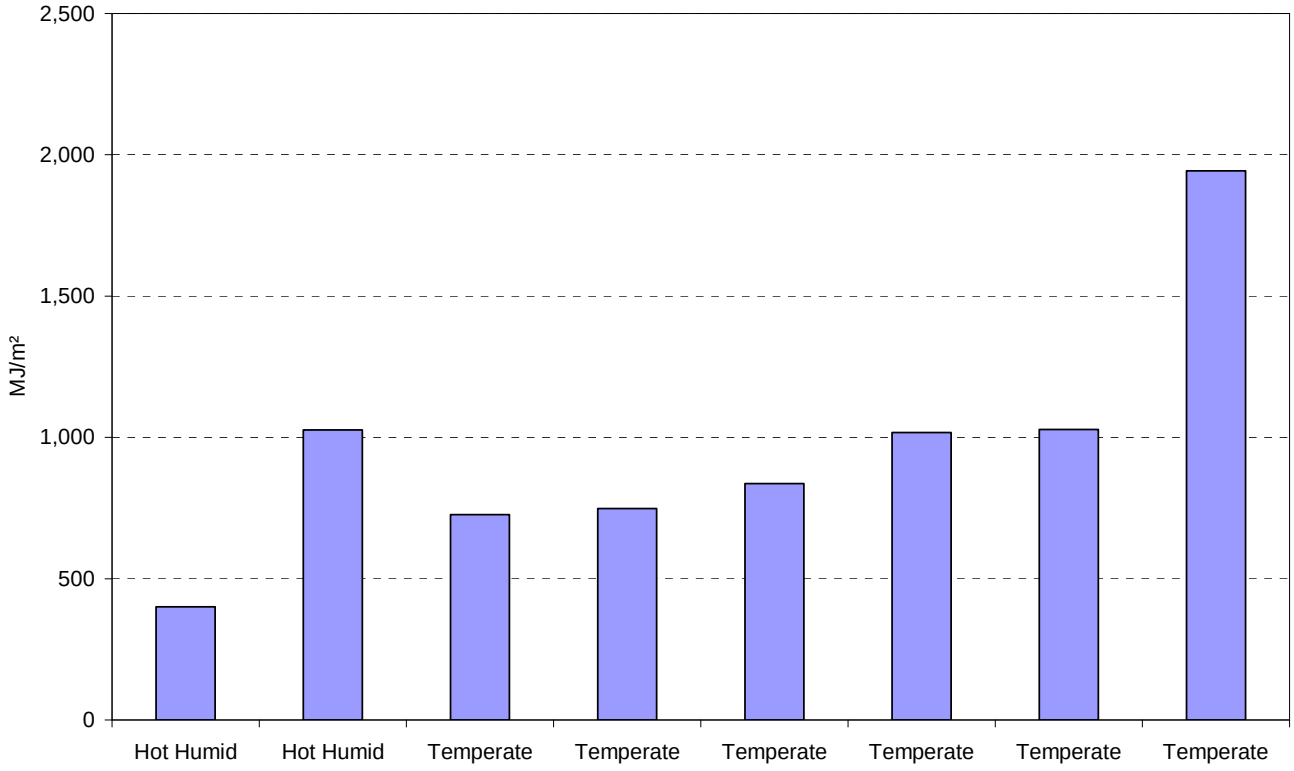
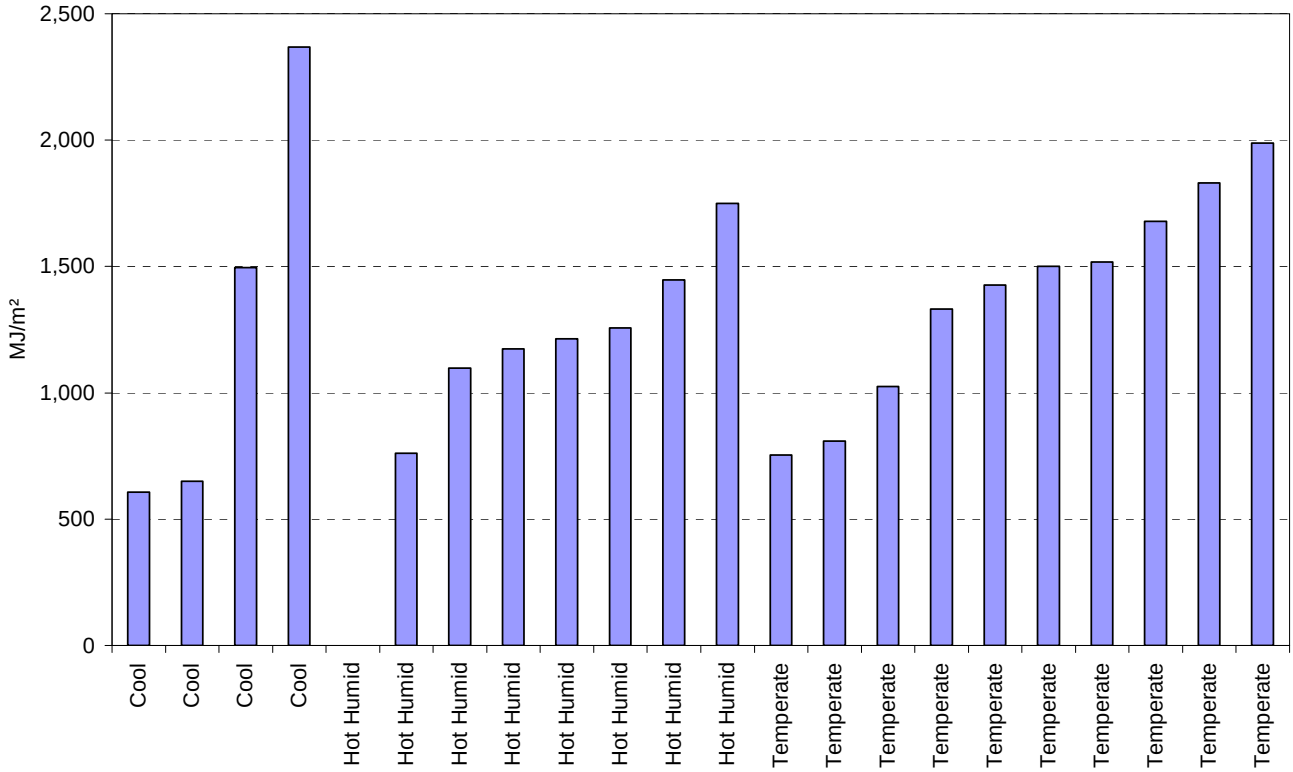


Figure 19 Business hotels and climate zones



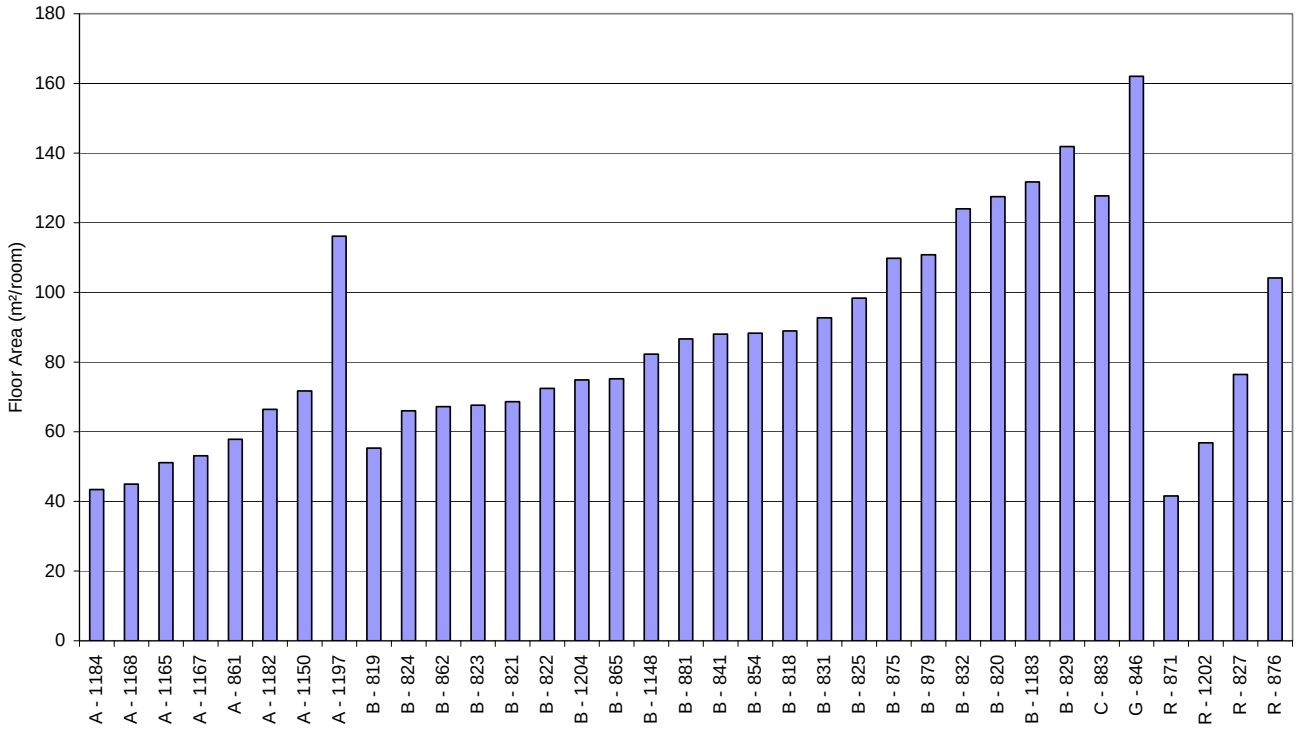
Miscellaneous intensities

There are many factors that contribute to the overall energy performance of a hotel. Some of these have been used to categorise hotels and all may be of interest to managers and engineers seeking to optimise the operations of their hotel. These factors are discussed below in terms of intensity.

Relative room area

Figure 20 shows the ratio of total floor area to the number of guestrooms in each hotel. It must be emphasised that this ratio, expressed as m²/room, does not represent average room size because it compares the number of guestrooms with the total hotel floor area, not the floor area of guest accommodation. It is better described as an indicator of the relative importance of accommodation services to overall hotel business.

Figure 20 m²/room for each hotel



In general, accommodation hotels have lower m²/room ratios while business hotels, casinos and drinking hotels have a higher m²/room due to their larger public areas. Although resorts have large public areas, these tend to be outside of the building and so are not included in total area.

Food covers

Food covers per occupied room are an important determinant of hotel type - particularly for separating business and accommodation hotels. Typically, business hotels with their higher proportion of conference and function business will have a higher rate of food covers per occupied room.

Figure 21 demonstrates that the production of food covers is roughly proportional to the number of rooms, although this relationship depends on hotel type.

Figure 21 Food covers vs number of rooms

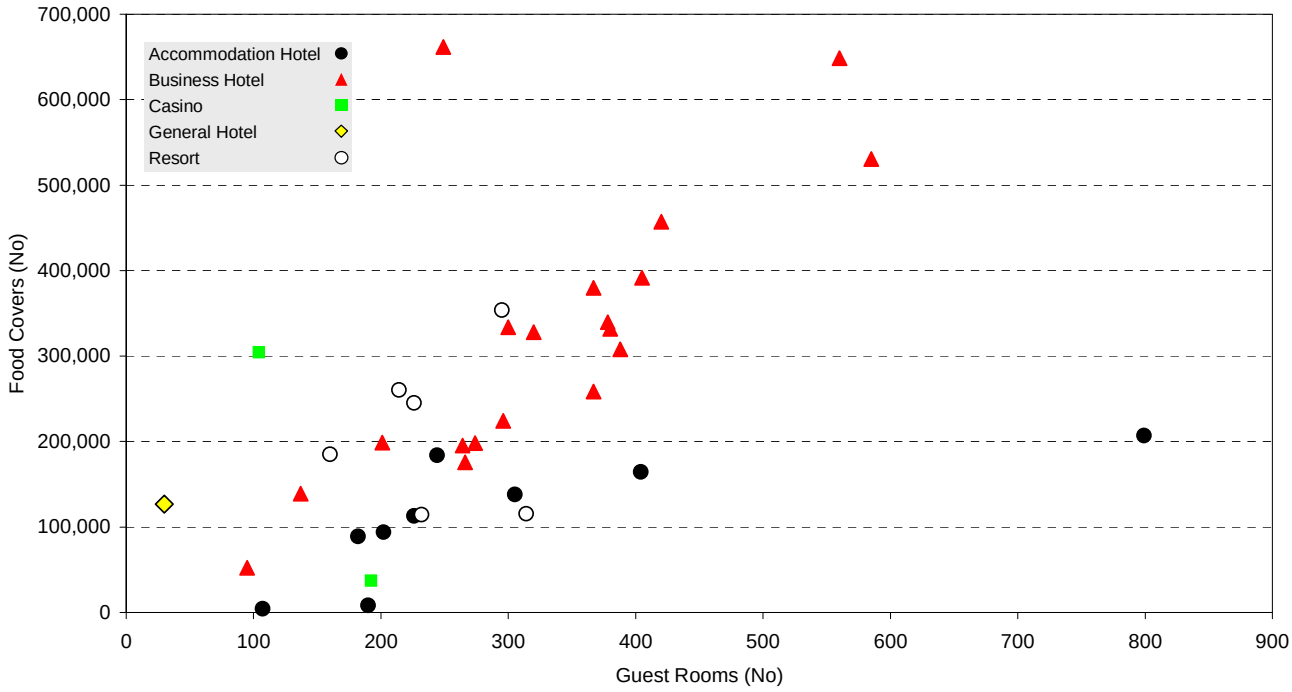
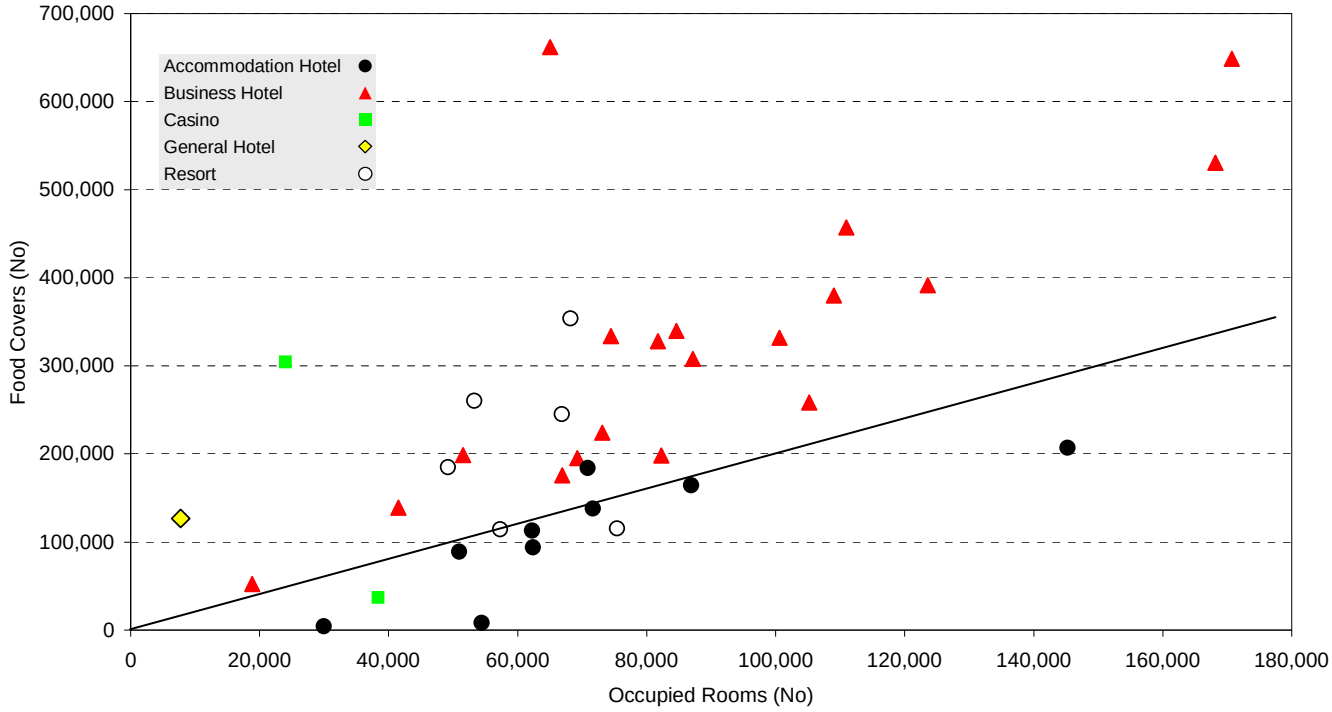


Figure 22 demonstrates how the relationship between food covers and occupied rooms varies between hotel types.

Figure 22 Food covers vs occupied rooms

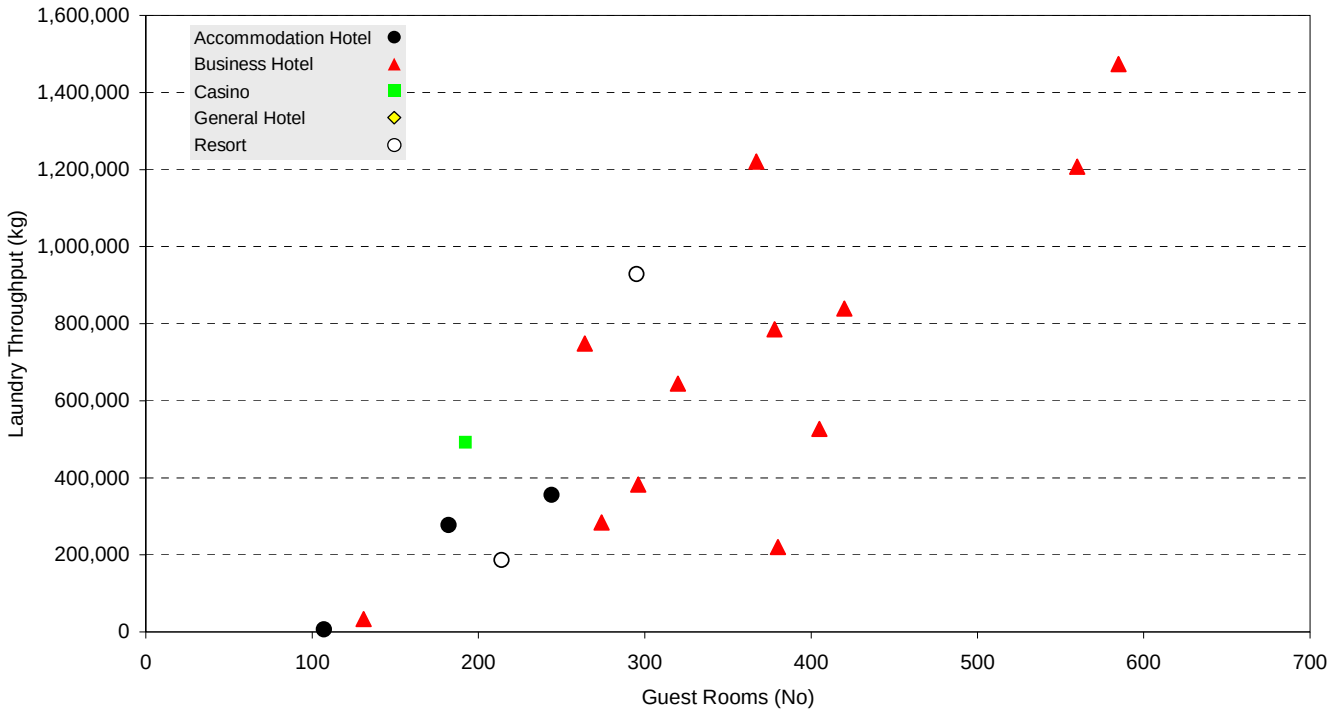


The line on Figure 22 represents two food covers per occupied room.

Laundry

Figure 23 shows the expected relationship between laundry requirements and size of hotel. With laundries using a significant proportion of total energy consumption (over 15% in two cases) it seems that hotels with towel re-use schemes are on the right track. The relationship between laundry requirements and hotel size is influenced by whether a hotel contracts laundry out or brings laundry in from another outlet.

Figure 23 Laundry vs number of rooms



Water

Figure 24 Water/room vs GJ/room

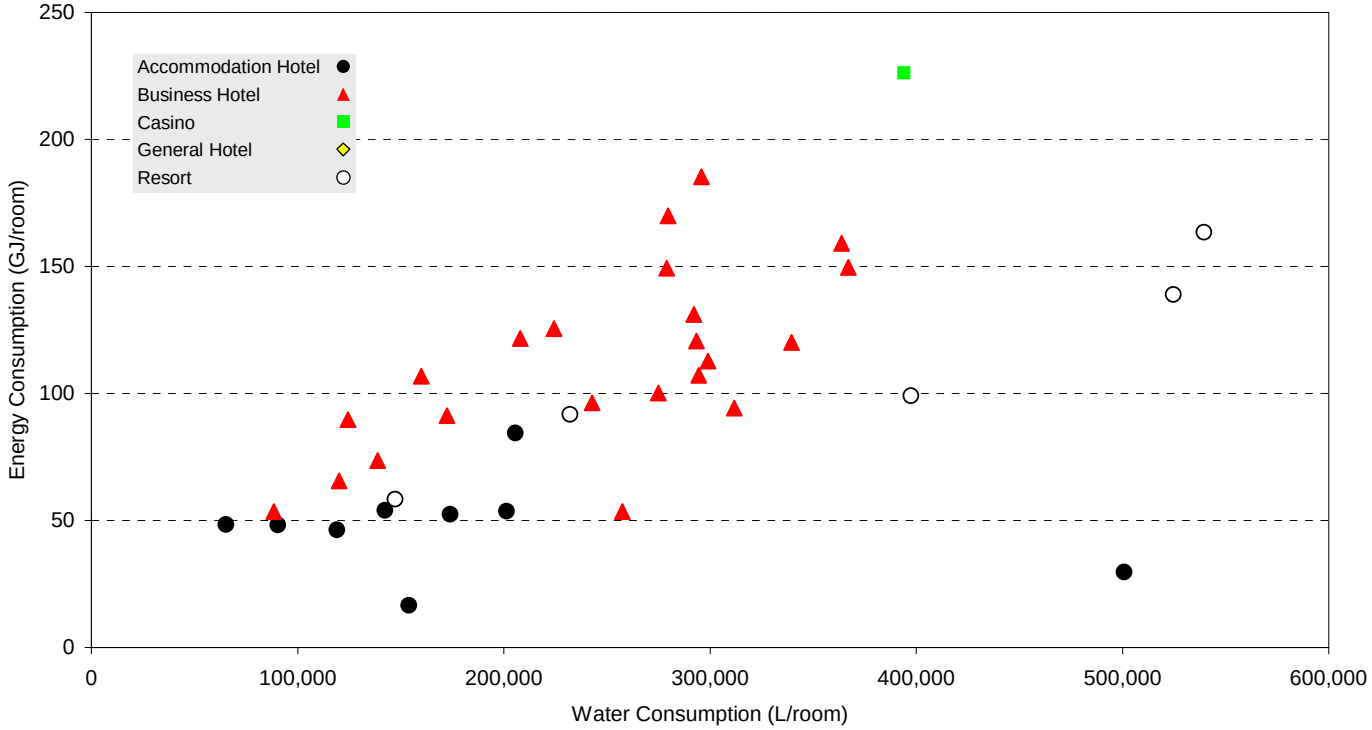
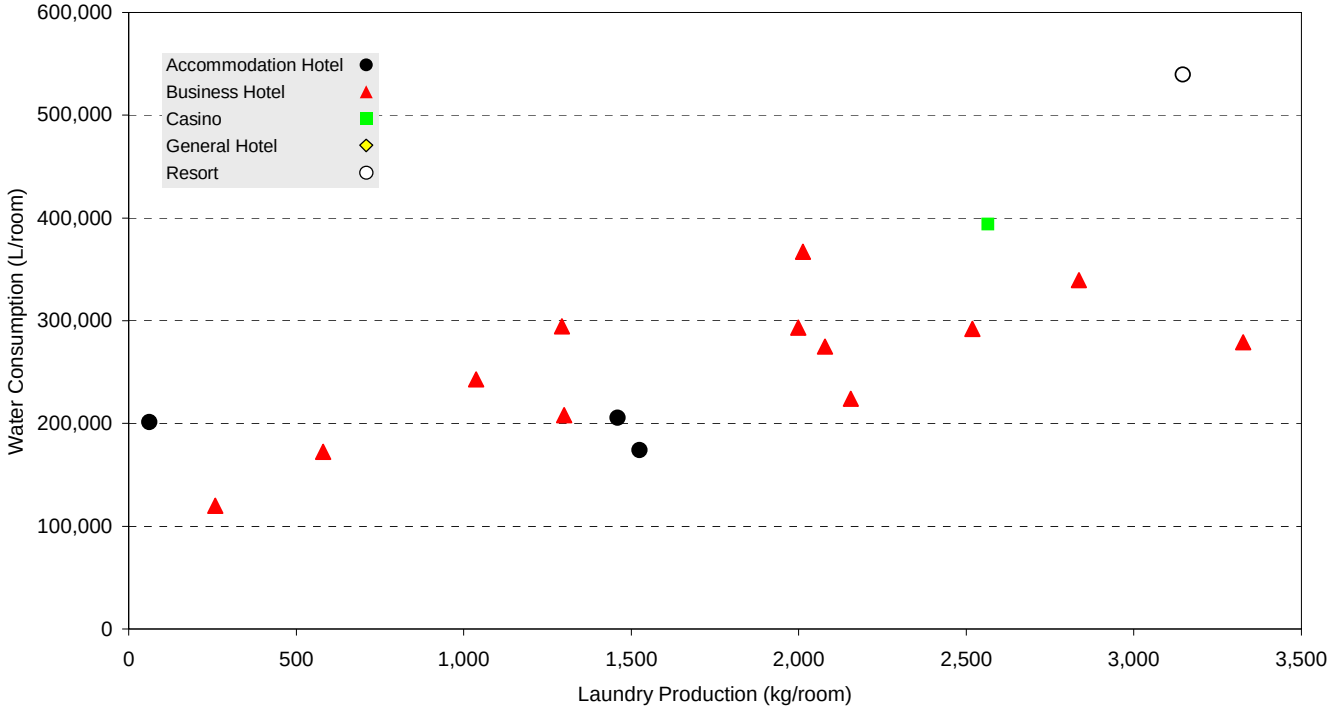


Figure 24 shows a strong relationship between water consumption and energy consumption. To an extent, this reflects on the energy requirements of pumping and the heating of domestic hot water and confirms the benefits of hotel water management programs. The relationship also possibly reflects a culture of resource management in which energy management initiatives prove to be effective when they are incorporated into an overall energy management program. Resorts tend to use a lot more water, possibly due to their higher use of pools and areas like gardens that need to be watered.

Figure 25 Litres water/room vs kg laundry/room



Conclusion

This report has produced a summary of the energy performance of a group of just over fifty hotels. Most of the group was located in Australia and all states and territories were represented in the sample. A few overseas hotels were included in the analysis because the data was available. This increased the sample size and allowed an additional international comparison.

The available data was sufficient for an extensive graphical analysis but insufficient for detailed statistical analysis. When the hotels were separated into five distinctive categories representing their core business activities, some distinctive energy consumption patterns were revealed. There was sufficient data to propose some benchmark performance levels for two categories: accommodation hotels and business hotels. The other categories will require additional data before similar benchmarks can be set but, in the meantime, some useful comparative data has been provided.

The energy consumption of a hotel is related to the size of the hotel and relatively independent of the location or climate zone in which it operates. The accurate measurement of hotel size, or capacity, remains problematic but floor area and the number of accommodation rooms are proposed as reasonably available approximations. The use of throughput data, such as guest numbers or occupied room nights, is an inappropriate basis for comparing energy performance between hotels. However both climate data and throughput remain valuable in comparing the performance of a hotel against its own performance over time.

With occupancy rates having little effect on energy consumption, the importance of part occupancy performance in future design and management of hotels is quite clear. This is particularly important when it is considered that average occupancy rates in Australia are only just over 60%.

The energy performance of hotels is best when there is strong management interest and a robust energy performance-monitoring program in place. There is also a strong correlation between water management and energy management with some of the biggest energy performance improvements coinciding with similar reductions in water consumption.

The refinement of the proposed benchmarks and their extension into other hotel categories will require further energy surveys in the future. Desirably, these surveys will be carried out annually with wider representation from the industry. With systems in place, the task is not difficult, and the benefits in terms of better informed decision making is tangible. Such an approach could provide the blueprint for other commercial building sectors to emulate.

Appendices

Appendix 1 Performance averages

The table on the next pages is a summary of the performance of all hotels against a wide range of performance indicators. It provides maximum, minimum and average figures for all hotel categories and for all hotels in the survey as a single group.

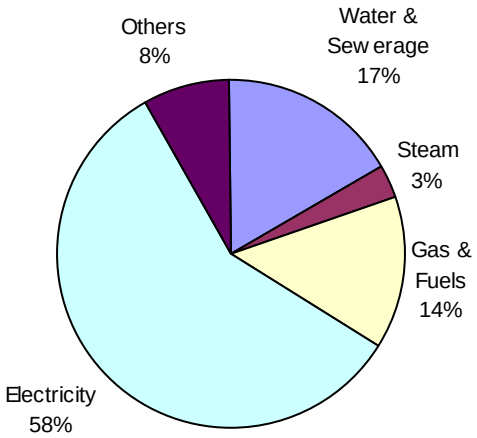
	Occu-pancy	m²/ Room	GJ/ Room	MJ /OccRoom	MJ/ Guest	Lwater /Guest	FoodCovers /Room	MJ/m2	Lwater /m2	kgLaundry /Room	kgLaundry /OccRoom	MJ/ Room	FoodCovers /Occ Room
Accommodation													
Average	68	68	42	180	116	462	377	796	2,490	1,201	4.2	42,024	1.6
min	38	43	17	92	63	184	39	401	1,127	62	0.2	16,637	0.1
max	85	116	84	291	199	2,724	754	1,943	4,732	1,524	5.4	84,434	2.6
Business													
Average	73	93	116	429	291	634	984	1,259	2,720	1,910	7.0	115,639	3.7
min	54	55	53	209	86	157	552	607	1,005	259	1.1	53,483	2.4
max	85	142	185	709	502	1,081	2,657	2,368	5,413	3,326	11.6	185,364	10.2
Casino													
Average	59	128	253	1,199	730	1,271	1,155	1,772	3,085	2,564	12.8	252,574	5.5
min	55	128	226	1,132	730	1,271	194	1,772	3,085	2,564	12.8	226,254	1.0
max	63	128	301	1,306	730	1,271	2,928	1,772	3,085	2,564	12.8	301,164	12.7
General													
Average	71	162	236	915	528		4,233	1,456				235,931	16.4
min	71	162	236	915	528		4,233	1,456				235,931	16.4
max	71	162	236	915	528		4,233	1,456				235,931	16.4
Resort													
Average	72	70	152	593	305	722	885	2,497	5,720	2,191	9.2	152,250	3.4
min	63	42	58	243	78	198	367	1,403	3,543	873	3.5	58,317	1.5
max	84	104	394	1,582	780	1,428	1,218	5,152	9,230	3,146	13.6	393,993	5.2
All Hotels													
Average	71	86	106	412	256	620	833	1,313	2,928	1,891	7.0	106,053	3.2
min	38	42	17	92	63	157	39	401	1,005	62	0.2	16,637	39.3
max	85	162	394	1,582	780	2,724	4,233	5,152	9,230	3,326	13.6	393,993	16.4

Appendix 2 Hotel energy end-use

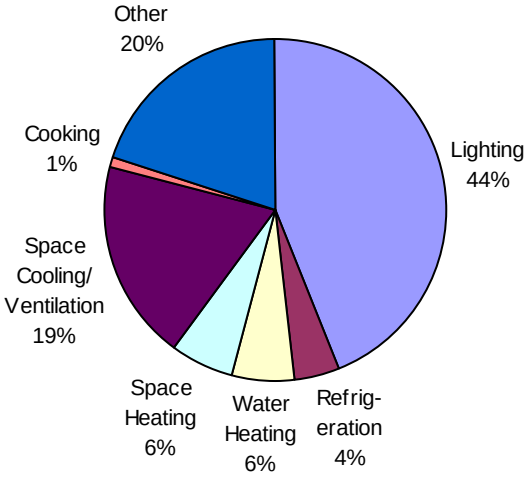
Only a few hotels were able to provide a reasonably detailed break down of energy end-use. The Cairns Hilton provided the best figures and these were included in the body of the text. Other hotels were able to provide less detail with large proportions of energy end-use not being allocated to any specific end-use. A number of other studies have attempted to identify the end-use of energy in hotels and these conclusions are summarised in this appendix

E-Source

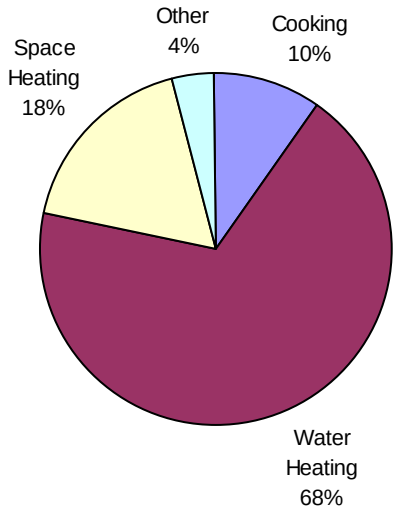
The data presented below is from the report *Delivered Energy and Energy Services to Hotels & Motels* [7] prepared for the organisation E Source Inc. It provides a break up of general utility costs and energy use in American hotels.



Utility Costs



Electricity

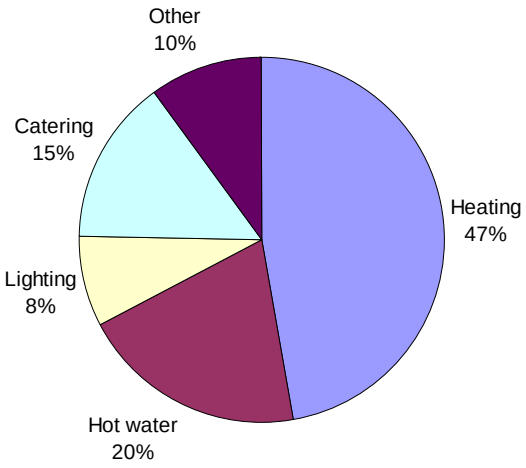


Natural Gas

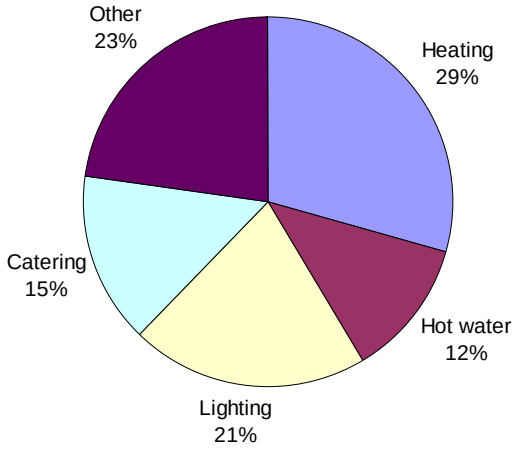
Energy Efficiency Best Practice Programme

This is the UK Energy Efficiency Best Practice Programme and the following details are from their Energy Consumption Guide – *Energy Efficiency in Hotels – A Guide to Owners and Managers*.[8]

The charts below depict what the guide considered to be the energy consumption and cost break down of a typical hotel in the UK.



Energy Consumption

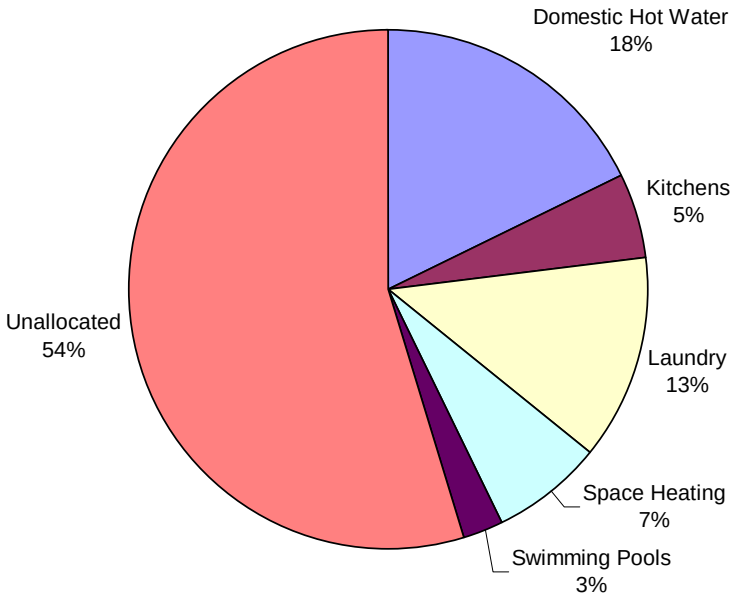


Energy Cost

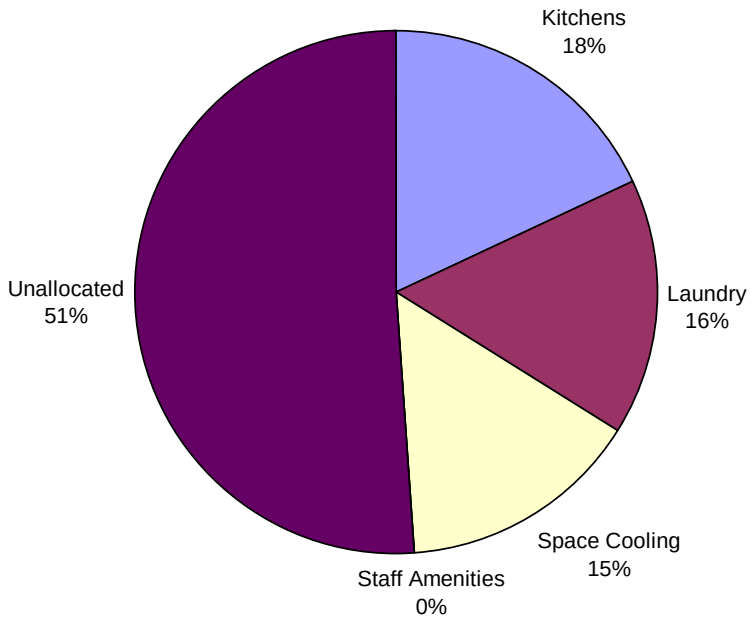
Current Study

The following data is from a number of hotels in the current study. The data is of varying quality and usefulness but is included as a guide to performance. Each pie represents a different hotel and the title indicates what is measured (consumption or cost) and the climate zone of the hotel.

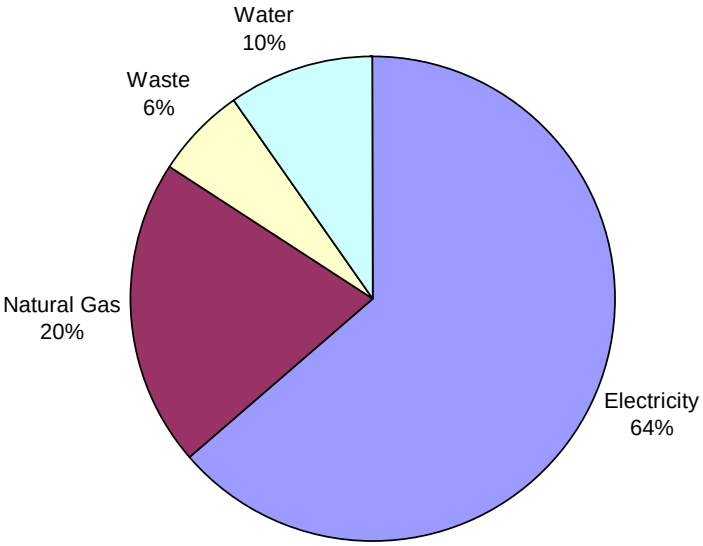
Energy consumption in a temperate zone hotel



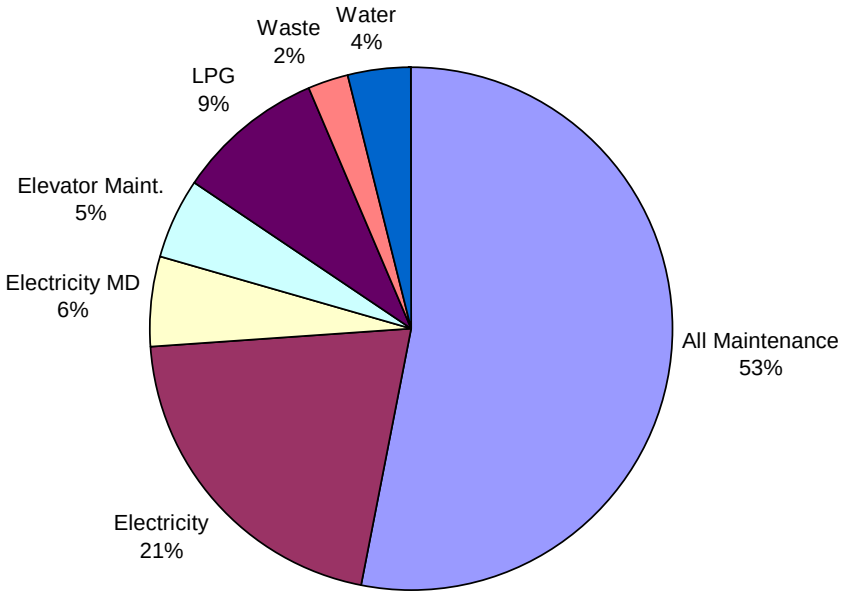
Energy consumption in a hot humid zone hotel



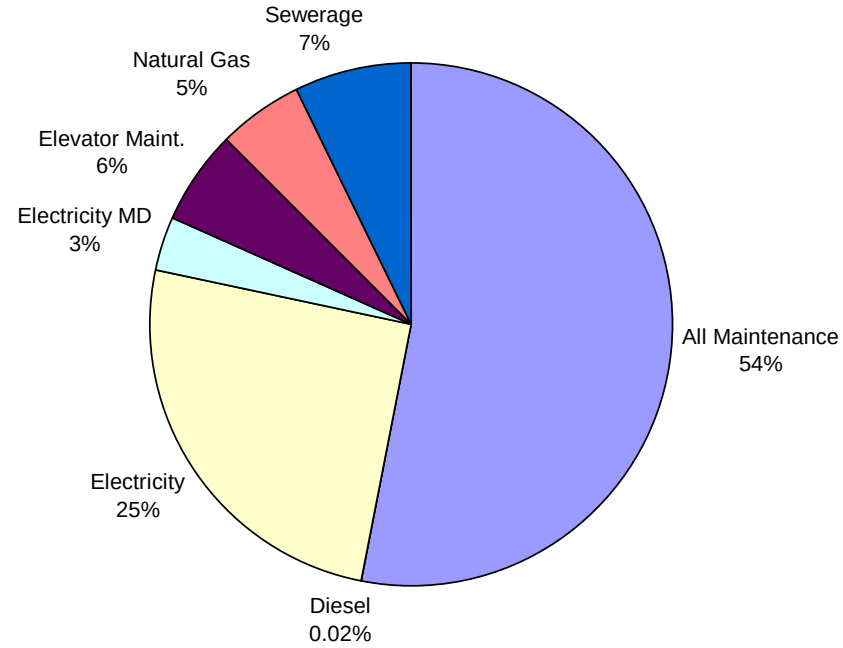
Utility cost in a temperate zone hotel



Utility cost in a hot humid zone hotel



Utility cost in a hot humid zone hotel



Appendix 3 Hotel area

A key indicator of hotel energy performance identified in this study is energy consumed per square metre. The energy consumption should be fairly accurate as it is derived from meters or utility accounts. This is not however the case with the area. The area provided not only can have measurement and calculation errors but is more likely to have data skewed due to differing interpretations of the areas to be included. E.g. are plant rooms, outdoor swimming pools or porte cocheres included?

The hotel industry does not have a uniform definition of area to be used in calculations such as these. Most hotels will know the area of their guestroom and the banquet rooms as they use these for marketing purposes. Most hotels that report their energy consumption to a central body should be reporting with reference to their area so that comparisons between hotels, and not just with last year, can be made - but this is not always the case. It is felt that even the hotels that do internally benchmark do not have an adequate definition of area to enable consistency in calculation. So it is usually left to the person doing the calculation to apply their interpretation of the area to be included.

It is felt that the hotel industry should develop an area definition that can be used universally. The industry already has “A Uniform System of Accounts for Hotels” and always has available statistics for covers, occupancy, number of guests, etc.

There are several loose definitions that are used like total building area or air-conditioned space, but these can vary widely depending on interpretation. The air-conditioned space should include ventilated and exhausted spaces like toilets etc as these places all consume energy. Fully enclosed car parks are often not include, but they do have ventilation for fumes and have lighting, albeit at a low level.

The Property Council of Australia has standard definitions, but these relate to office buildings. The Net Lettable Area (NLA) as defined in their “Method for the Measurement of Buildings” is the sum of all rentable areas. This measurement is widely understood and used but is not applicable to hotels.

The Australian Institute of Quantity Surveyors has several area definitions that relate to buildings. This organisation has written the “Book of Areas” for analysis and comparison of buildings, which is often referred to as the AIQS Book of Areas. The definitions contained within this document are widely used in the building and property industries. They are used for planning and construction and for comparison of buildings during acquisition, establishment of building space efficiencies etc.

There are five key areas of measurement and they are

1. Gross Floor Area
2. Fully Enclosed Area
3. Unenclosed Area
4. Gross Building Area
5. Useable Floor Area

Of these, the Fully Enclosed Area seems to be the most appropriate for application to hotels for normalising energy consumption.

The Fully Enclosed Area is

“The sum of all such areas at all building floor levels, including basements (except unexcavated portions), floored roof spaces and attics, garages, penthouses enclosed porches and attached enclosed covered ways alongside building, equipment rooms, lift shafts, vertical ducts, staircases and any other full enclosed spaces and useable areas of the building, computed by measuring from the normal inside face of exterior walls but ignoring any projections such as plinths, columns, piers and the like which project from the normal inside face of exterior walls. It shall not include open courts, light wells, connecting or isolated covered ways and net open areas of upper portions of rooms, lobbies, halls interstitial spaces and the like which extend through the storey being computed.”

Bibliography

1. Millar,G. and Knox I. *Benchmarking*, *The Australian Institute of Hotel Engineering Update '96*. 1996. Gold Coast.
2. Isaacs, N. and Crocker,N. *Commercial Building Energy Survey: Hotels*. 1996, Centre for Building Performance Research
3. Bush, S., Harris, J., and L. Ho Trieu *Australian Energy Consumption and Production - Historical Trends and projections to 2009-10*. 1997, Australian Bureau of Agriculture and Research Economics: Canberra.
4. ABS, *Tourist Accommodation Australia - December Quarter 1999*. 2000, Australian Bureau of Statistics: Canberra
5. Deer, L., *Benchmarking Energy Efficiency in Hotels*. The Hotel Engineer, 1999(Spring 1999).
6. Bloyd, C.N., Mixon, W. R., and Sharp, T., *Institutionalization of a Benchmarking System for Data on the Energy Use in Commercial and Industrial Buildings*. 1999, Asia-Pacific Sustainable Development Centre East West Centre for APEC: Honolulu.
7. Eisenberg, G., Friedmann, B., and Komor, P., *Delivering Energy and Energy Services to Hotels and Motels*. 1998, E Source, Inc.: Boulder, Colorado, USA.
8. Energy Efficiency Best Practice Programme, *Energy Efficiency in Hotels - A Guide for Owners and Managers*. 1993, Department of the Environment: Watford UK.
9. Energetics: *Study of Energy Use and the Potential for Increased Energy Efficiency in the Accommodation Industry*. 1995, Energetics Pty Ltd. p. 81.
10. International Hotels Environment Initiative, *Environmental Management for Hotels*. 1996.
11. Touche Ross Management Consultants, *Environmental Action Pack for Hotels*. 1995, International Hotels Association
12. U.S. Department of Energy - Energy Information Administration, *A Look at Commercial Buildings in 1995: Characteristics, Energy Consumption, and Energy Expenditures"*. 1998.