

17th ERES Conference,  
Milan, Italy, June 2010

# Electricity Use Trends in New Zealand Office Buildings, 1990-2008

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**Key Words:** energy, electricity, efficiency, office, building, consumption, trends, survey, New Zealand, sustainability, green buildings, renewable, Property Council, benchmark.

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## Abstract

The built environment has been assessed as accounting for 70% of electricity consumption in the USA (Nicolay 2007) and globally the built environment accounts for 40% of energy consumption (Kolokotsa et. al. 2009). While New Zealand generates most of its electricity from renewable hydro electric sources, there are limited opportunities to expand such generation. As a result, the NZ government has been promoting energy efficiency as a means to reduce growth in electricity demand, with the focus to date on the residential sector. Efficiency policies relating to office buildings have recently been proposed, but little prior research has been carried out on this sector in NZ. This research identifies trends in office building electricity consumption over the period 1990-2008 using data from the Property Council of New Zealand annual survey of building operating expenses. This will help establish a base line against which future energy efficiency initiatives can be assessed. Findings include relatively stable electricity consumption rates over the study period but a surprising decline in real electricity prices for this sector until 2002 followed by increases since.

## Introduction

The built environment is responsible for a large percentage of global energy consumption. This is both in terms of energy used in the operation of the building on a day to day basis plus the energy embodied in the fabric of the building during construction, refurbishment and eventual demolition.

Various estimates of the scale of this use of energy have been made. For example the built environment has been assessed as accounting for 70% of electricity consumption in the USA (Nicolay 2007), and globally the built environment accounts for 40% of energy consumption (Kolokotsa et. al. 2009). Treloar et al (2001) found high rise office buildings have 60% more embodied energy per square metre NLA than low rise buildings. However, these total estimates vary considerably from sector to sector and from country to country and are also influenced by how energy consumption is defined. Nevertheless it is self evident that

however measured, buildings are an important factor in global energy consumption and therefore a likely significant contributor to climate change.

More importantly, it is generally possible to use a variety of different sources of energy to provide the required services within a building and to readily monitor and control the extent and pattern of energy consumption. The knowledge and technology already exists to take advantage of the energy efficiency potential that greater control and monitoring offers. This is not always the case in other sectors. In addition the scale and capital intensity of the largest buildings in developed countries helps make the application of existing and still emerging technologies (such as co-generation) economically viable, again in contrast with other sectors.

Seeking energy efficiency from the built environment is not new and in most developed countries there has been development of various building code regulations, as well as efficiency programmes and other incentives, since the first oil shocks of the 1970's. But the focus on energy efficiency has been sporadic and at times it has been more about energy source switching rather than energy saving. The recent concern over climate change has forced a refocus on the energy consumption of buildings and this time the emphasis has been on increased efficiency as most sources of energy generation contribute to global warming to some extent.

New Zealand already has a "clean green" reputation, part of which is based on the fact that the majority of our electricity supply (72% - NZ Energy Quarterly, Sep 2009, Ministry of Economic Development) comes from renewable "green" hydroelectric sources. It is also a small country with an economy focussed on agriculture and tourism. During the last twenty years economic restructuring, developments in information technology and changing work practices have seen the need for traditional CBD office space reduce in relative terms. These factors in combination seem to have led to little pressure to consider the potential for improvements in energy efficiency of office buildings.

However, there are limited opportunities to expand hydroelectric generation and, as a result, the NZ government has recently been promoting energy efficiency as a means to reduce growth in electricity demand. As in other countries, the focus to date has been on the residential sector which consumes 36% of the countries electricity compared with 20.7% for the whole commercial sector, which includes retail and tourist facilities as well as office space (Ministry of Economic Development 2009). Efficiency policies relating to office buildings have recently been proposed, but little prior research on actual electricity consumption has been carried out on this sector in NZ.

Comparison with benchmarks from overseas is made more difficult by the less typical economic base for a developed country and the scale and characteristics of our office building stock. The research presented here attempts to establish trends in office building energy consumption in New Zealand over the last twenty years as some form of base line against which future energy efficiency initiatives can be measured.

## Literature Review

The New Zealand Government is considering introducing compulsory disclosure of energy use performance for office buildings. However, in order to establish an appropriate benchmark and to determine if improvements in energy efficiency are taking place it is important to consider current performance and past trends to establish a “business as usual level of performance” against which improvements can be measured (Lee and Yik 2004, Haji-Sapar and Lee (2005)).

There is still debate about the efficacy of compulsory minimum standards, vs. compulsory disclosure, vs. voluntary standards vs. labelling (Lee and Yik 2004, Holmes and Hudson 2002, Ghanbari Parsa and Akhavan Farshchi 1996). But whichever option or combination is adopted, some indication of the starting point for improvement is necessary (Love and Bullen 2009). This is not easy. Haji-Sapar and Lee (2005) state “The main challenges .... are in collecting sufficient numbers of buildings to establish a statistically reliable database and to encourage each country to develop their own national benchmark.....”. They also comment “Benchmarking ....is the starting point of energy efficient design and management”.

This type of energy use benchmarking research has been carried by academics, other research organisations and industry bodies in some locations for a long period of time. As a result various energy use benchmarks are now well established in some countries, either on a stand alone basis or as a component of more comprehensive measures of overall building sustainability. But the methodologies, benchmark figures and observed energy use trends are not necessarily transferable from one country to another because of the markedly varying economic and legal structures that may apply, as well as differing energy sources, price differences, climate variation and cultural and business practice variations.

The closest comparable country to New Zealand, especially in relation to culture, business practice, legal structures, and building construction is Australia and so consideration of the findings of research there provides some worthwhile insights.

Reed and Wilkinson (2005) conducted a wide ranging review of the literature on building sustainability with a particular focus on office building energy use. They found there was a wealth of information on technical aspects of energy conservation, but that incorporating improvements into the existing building stock was a slow process – inhibited by institutional barriers and research gaps. They also concluded statutory minimum standards then being introduced in Australia would only have a minor effect. In summing up they said that energy efficiency in office building was an important emerging research area but that it falls between environmental studies and research into the built environment. Bridging the gap between the technical side and the business side of energy efficiency improvement is an important step on the way forward.

Subsequently, Wilkinson and Reed (2006) examined energy consumption and carbon emissions of Melbourne office buildings in detail. They faced similar difficulties as were found in this research in that some respondents were unwilling or unable to provide the energy use data on their buildings to a depth ideal for carrying out the research. This was especially the case if their building was likely to be identified as an energy “guzzler”. A partial

solution in both cases was via the Property Council of Australia (and Property Council of New Zealand) who are trusted custodians of energy use data for many office building owners.

Other researchers are also active in this area in Australia and their findings provide good insights to the New Zealand situation, but both the climate and the energy supply situation in Australia is very different from New Zealand so it was important to search for previous research into energy use in office buildings in New Zealand as a basis for this study.

Unfortunately this proved to be a rather fruitless task. A search of the usual academic databases using the keywords of energy, electricity, survey and New Zealand only resulted in three hits and of these only one proved to be relevant to this research. This was a Property Council of New Zealand report from 2000 which reported the energy consumption of thirty five CBD office buildings in Auckland and Wellington during 1998 and 1999. As will be seen in the methodology section below this report provided important reference points for this research. A similar unpublished study of 22 buildings in Christchurch was carried out by Lincoln University staff and students in 1990.

The search was then widened to Google which resulted in the identification of a number of official government reports which proved useful.

The Building Research Association of New Zealand (BRANZ) commissioned Bricknell Moss Raines and Stevens Ltd. to carry out an analysis of 15 office building from 1983 -1986 to try and develop a theoretical model for calculating energy use. Data on the buildings was collected but very high levels of variability amongst the sample caused problems in developing a model.

The Ministry of Economic Development carries out an annual survey of electricity supply, demand and prices. The results are available via their web site and published in the New Zealand Energy Data File. While a wealth of aggregate time series data is recorded it is not broken down as far as electricity use is concerned beyond the categories “large commercial”, “medium commercial” and “small commercial” (each of which would include a variety of uses) or alternatively into various SIC codes of which office use would be best represented by “ financial property, hiring, professional and administrative services” Unfortunately there is no area recorded for these categories – only “connections” – but as can be seen in the methodology section – the time series price data was useful in converting dollar expenditure for surveyed buildings to KWh. .

In 2007 research was carried out by Kema on behalf of the Electricity Commission of New Zealand into the potential for electricity efficiency gains in New Zealand. They found significant cost effective potential for around 23% in savings via efficiency measures, but these were concentrated in the residential sector. The commercial sector had the lowest potential and within this the greatest contribution was from changes in lighting technology.

The Energy Efficiency and Conservation Authority (EECA) is a NZ government body supporting initiatives aimed at improving energy efficiency. Thirty six research reports related to this topic were found on their web site but none related to office building

electricity use trends. There were links to office building case studies, but as in much of the other research identified, these generally represent exemplars rather than typical buildings.

There was one report that tracked energy use trends over the period 2001-2007 (EECA 2009) but as in the case of the Ministry of Economic Development surveys, and the Electricity Commission report mentioned above, this only considered the “commercial sector” as a whole. Findings included a drop in total energy use over the seven years from 48.4 PJ to 47.4PJ (2.1%) even though there was rapid growth in floor areas, employment and economic activity over the same period. Of this 4.7 PJ was attributed to energy efficiency improvements. The commercial sector represented 9% of energy use while contributing 64% of GDP in 2007.

During this research the author also became aware of another major study currently under way and also supported by BRANZ entitled the Building Energy End-use Study (Build 2010). This is not yet complete but is gathering energy use data directly from energy suppliers (after obtaining customer consent) on a variety of non-residential buildings (including offices). When complete, the anticipated results have the potential to refine the results of the research presented in this paper, which are inevitably limited by the assumptions made and the deficiencies in the historic Property Council data, which was collected from a diverse range of respondents for an entirely different purpose.

## **Methodology**

### **Data Source**

The Property Council of New Zealand is a body that represents the owners of office buildings and other substantial investment properties, such as shopping centres, throughout the country.

Since the early 1990’s the Property Council has carried out an annual survey of office building operating expenses in the major metropolitan areas of Auckland, Wellington, and Christchurch, and more recently Hamilton. The survey includes both central business district buildings and suburban office buildings where these are a significant component of the local office market. The buildings in this annual survey represent the vast majority of the top quality and large scale office buildings in New Zealand, and also a substantial proportion of the remainder of the investment grade office market.

The Property Council of New Zealand kindly made available for this research the results of this office operating expense survey in relation to energy consumption for the period since 1990. Unfortunately data for one year – 1999 was missing as the survey was not carried out that year due to Property Council restructuring.

This data was received in spreadsheet format, and while this covered 418 individual buildings, the figures were not continuous throughout the study period as some buildings dropped in and out of the survey depending on changes in ownership and management. However, for many properties a continuous sequence of energy related operating expenditure was available for lengthy periods within the last 20 years.

The raw data items obtained for each building included a building identification code, the city the property was located in, the location within the city, the year of the survey, the total net lettable area that the operating expenses surveyed applied to, the percentage of the net lettable area actually occupied in that year, the total electricity cost, additional explanatory comments on electricity used, gas and oil costs, and additional explanatory comments on gas and oil costs.

The quality of the building according to the Property Council of New Zealand grading system was also recorded. This includes grades A, B, C and “other” grades as defined in Appendix A but many buildings had initially not been assessed and were recorded as un-graded. This problem reduced substantially over time and it is most likely that un-graded buildings represent predominantly C and “other” lower graded buildings as owners tend to ensure the grading of their building is recorded if they qualify for the higher categories.

The raw data was initially checked for obvious entry errors and also cross checked against other sources of operating expense information to try and determine other clear errors that could be corrected or alternatively should be deleted. In addition those properties for which there was only a single year of energy cost figures were deleted from the analysis unless the figures reported could be substantiated by reference to other sources.

From this amended data an initial figure of electricity cost per annum in dollars, per square metre of net lettable area, for each building, for each year data was available, was calculated.

This dollar per square metre figure was again scrutinised for any suspected entry errors or other discrepancies. In some cases errors identified were able to be rectified and the amended figures were included in the data base used for further analysis.

A problem with the Property Council survey data is that the figures recorded for energy expenditure generally relate only to those services identified as “common area and central services”. These generally include common area lighting, external and car park lighting, elevator power and heating, ventilation and air-conditioning services delivered throughout the building as a common service to all property occupiers. Under the net leases common in New Zealand, these costs are then recovered along with other operating expenses (for example cleaning, insurance and property taxes) from the tenants.

Electricity expenditure metered and charged separately to exclusively occupied tenant areas is not usually included in the data collected by the Property Council. As will be detailed later, an attempt was made to adjust the Property Council data to reflect total electricity consumption (in kwh/m<sup>2</sup>) for the buildings in the survey.

### **Electricity Cost Trends**

The next step in the analysis was to sort the electricity expenditure data for all buildings by year of the survey and then calculate the mean electricity expenditure per square metre of net lettable area of all the buildings in each survey year. The mean annual electricity expenditure figures were then plotted on a graph.

The next analysis similarly considered each year of data but split the sample into office building quality grades according to the Property Council categorisation. The mean annual electricity expenditure per square metre was then calculated for each class of property in each year and graphed.

Another step involved the same analysis process but this time the mean annual electricity expenditure per square metre for office buildings was compared between each city in each year of the survey.

### **Electricity Consumption Trends - Common Areas and Central Services**

As already noted, the data collected by the Property Council over the last twenty years primarily identified dollars of expenditure for electricity rather than kilowatt hours consumed. To assess actual electricity consumption patterns (rather than expenditure) was problematic because the Property Council did not generally have kilowatt hour consumption figures for each building in the survey (though there were exceptions) and over the survey period the price per kilowatt hour for electricity supplied to office buildings in New Zealand has changed.

The kilowatt hour figures for some buildings in some years were recorded in the additional explanatory comment part of the survey, so in those cases it was possible to additionally calculate the kwh/m<sup>2</sup> rate and the price paid per kwh for “common area and central services” electricity.

In addition, in 1999 the Property Council carried out a separate more comprehensive analysis of the energy consumption of 38 office buildings in Auckland and Wellington. In these cases both kilowatt hour consumption and price per kilowatt hour consumed were collected.

In combination these figures gave an indication of both electricity prices and kilowatt hours per square metre applicable to typical office buildings at various points over the last 20 years.

However, these actual prices were not available for all years and locations and there are a number of electricity suppliers in New Zealand with different pricing structures. In addition, individual electricity suppliers also have different prices, often related to the scale of the building supplied and the pattern of electricity consumption, e.g. substantial discounts offered for limiting electricity use during times of peak demand.

It was therefore necessary to cross check the likely impact of these different prices on typical electricity prices applicable to office buildings throughout the survey period.

As mentioned above, the electricity consumption figures and electricity prices paid for 38 individual office buildings were available via the in depth 1999 Property Council survey. Additional figures applying to particular buildings were also identified via the annual Property Council survey and from various other industry sources. These indicated office

building electricity consumption and prices typically fell in the “large commercial” category of user as defined by the Electricity Commission.

Historic electricity prices for all electricity suppliers in New Zealand are publicly available from the Electricity Commission and the Ministry of Economic development. Therefore, the mean prices charged nationally for the “large commercial” category and by the major suppliers in each of the cities surveyed was obtained for the period 1990 - 2008. Another source of electricity pricing information was a publication of the Ministry of Economic Development entitled “The New Zealand Energy Data File”. On page 131 of the 2008 edition it lists the national average price of electricity in cents per kilowatt hour and dollars per gigajoule for the years from 1974 to 2008. The prices are separated in residential, industrial and commercial categories.

The national average electricity price data for commercial uses above includes not only large office buildings but commercial buildings of all types including small offices, CBD and suburban retail buildings and shopping centres, hospitals, educational institutions etc. The electricity prices in this series were therefore compared to those identified as applying nationally to ‘large commercial’ buildings as well as the prices charged by the major suppliers in the large cities to this category.

Finally these average electricity prices were compared to the known actual prices applying to particular office buildings. The objective was to try and identify which electricity price index most accurately reflected actual office building electricity prices over the survey period. In the end, all three indices were similar to actual building data and are included in the results.

It was then possible to divide the annual mean electricity expenditure per square metre from the Property Council survey by the average price paid per kilowatt hour in that year, to arrive at an estimate of electricity consumption (rather than energy expenditure) for common area and central services over the last twenty years.

It is clearly a weakness of the analysis that a generic national average figure is used as a proxy for actual price per kilo watt for the buildings in the sample but in the absence of better historic information this was the best option available.

### **Electricity Consumption Trends – Whole Office Buildings**

The final step in the analysis was a calculation to try and estimate electricity consumption trends for whole office buildings. This involved a major assumption – that whole building electricity consumption will reflect common area and central services consumption. This is likely to be invalid in many cases, as the electricity consumption of both tenants and the central services is highly dependent on their activities and equipment and this can vary markedly from building to building and even within a building. However, the analysis was still considered worth doing taking into account the moderating effect the large sample would have and the need to at least provide a rough basis for future studies and international comparison.

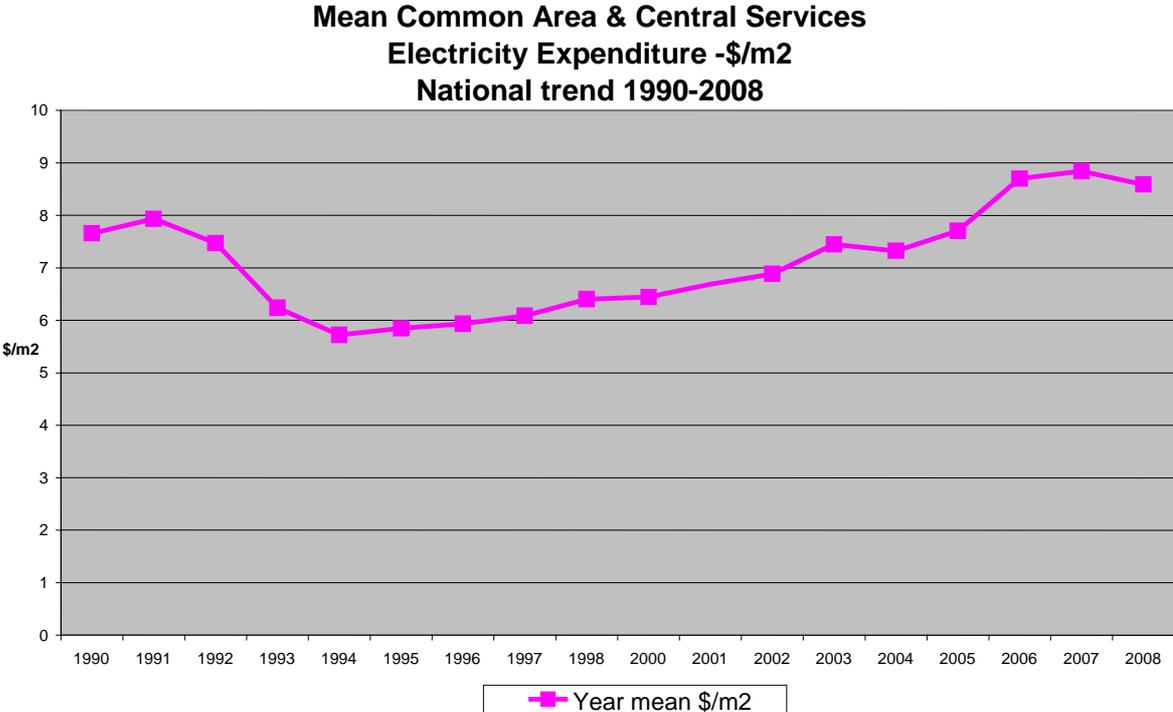
Both common area and central services and total electricity consumption were available for 23 buildings in the survey. The ratio of common area and central services to total electricity consumption was calculated for all these buildings and ranged from 0.16 to 0.65. The standard deviation was 0.12 and the mean 0.36 indicating an approximately normal distribution. The common area and central services figures for all the buildings in the survey were then divided by this figure and aggregated into years to arrive at an indication of total building energy costs and usage trends over the last 20 years.

As reported in the literature review, there is currently underway a comprehensive research project entitled the Building Energy End-use Study which is collecting data on actual building energy use in New Zealand. This will provide more comprehensive and much needed energy consumption data for NZ buildings. In addition it is recommended that future Property Council surveys collect both energy cost and energy use data for all buildings in the survey, not only for the common areas and central services but for the building as a whole as well. This will help address the serious data deficiencies identified in trying to carry out this research.

**Results**

**Electricity Expenditure**

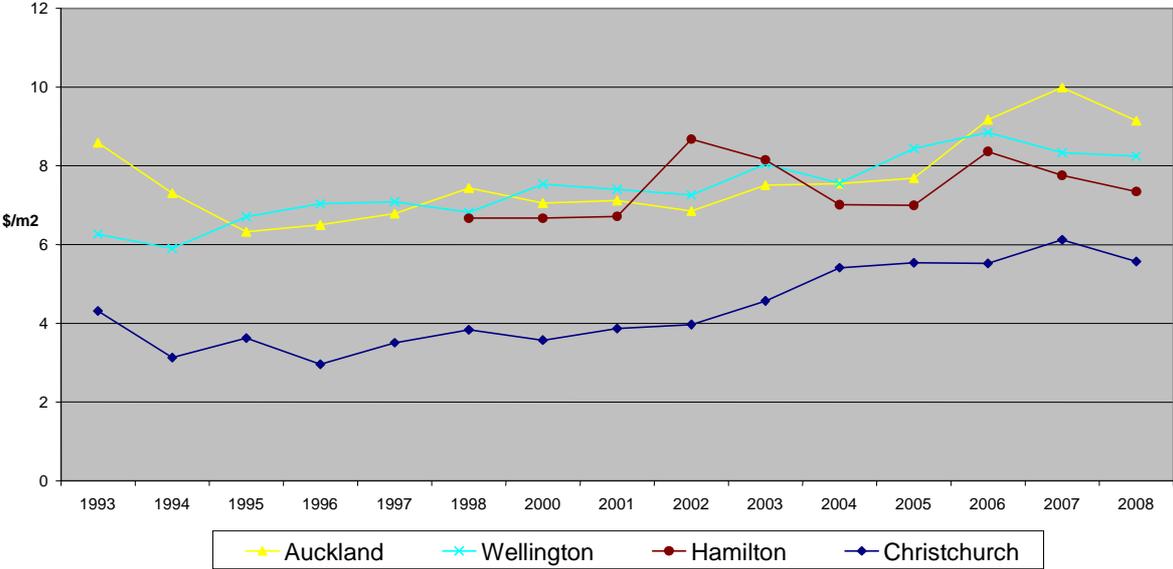
The graph below shows the trend in annual average expenditure for electricity supplied to the common area and central services of all the buildings in the Property Council operating expense survey.



There was an initial reduction from \$7.66 /m<sup>2</sup> in 1990 to \$5.72 /m<sup>2</sup> in 1994 but these results should be treated with caution, as in the early years of the Property Council survey there were relatively few buildings included in the survey and it is likely there was some variability in the reporting of the data by respondents new to the process. Subsequently there was a slow but steady increase in electricity expenditure over the next 14 years. The initial expenditure level of \$ 7.66 per square was not again reached until 2005.

The building data was then split to show average electricity expenditure in the four cities in New Zealand with substantial office markets – Auckland, Wellington, Christchurch and Hamilton. Buildings included in the survey for the three largest cities were insufficient in number to allow meaningful analysis until 1993 and collection of data from Hamilton only commenced in 1996.

**Mean Common Area & Central Services  
Electricity Expenditure - \$/m<sup>2</sup>  
City comparison**



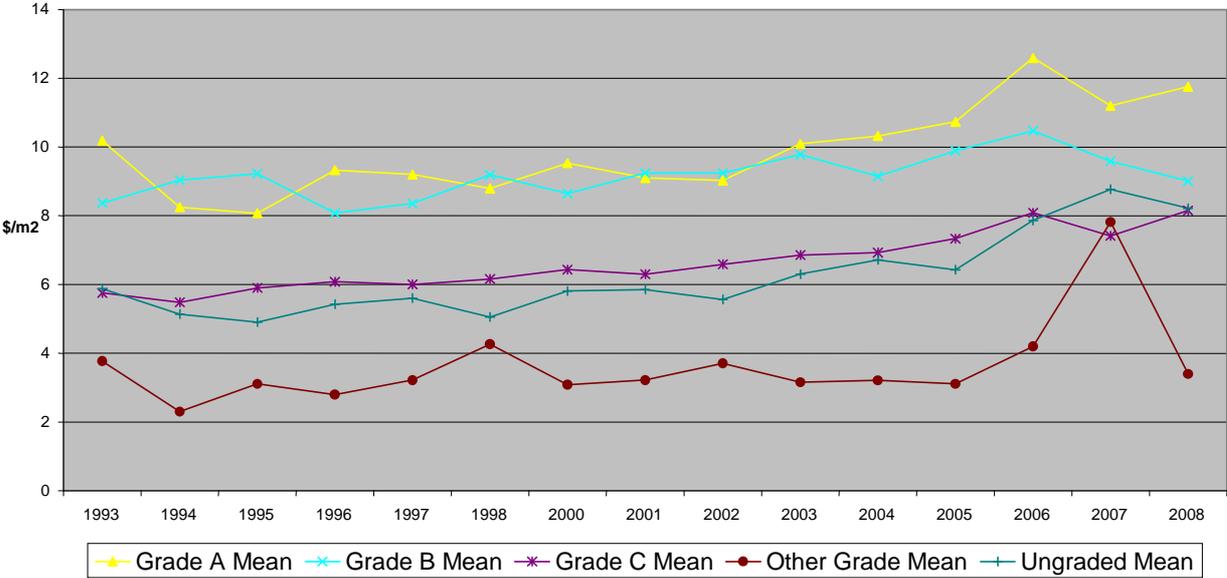
The pattern of slow increases since 1994 was mirrored in the three larger cities except for a more substantial increase in Auckland from 2005 -2007. The figures for Hamilton were more volatile, probably for the same data problems alluded to above in relation to other cities in the earlier years of the survey.

Of note though was the similar trend, but significantly lower level of electricity expenditure in Christchurch buildings. This ranged from below \$4.00/m<sup>2</sup> in the early years to approximately \$6.00/ m<sup>2</sup> in 2008 – generally more than 25% below the other cities.

The data was then split on a different basis to show average electricity expenditure in the four different building quality categories as defined by the Property Council of New Zealand (see Appendix A).

Again there were data problems, especially in relation to a large number of un-graded buildings, but as discussed in the methodology section it is highly likely these would be in the lower quality grades. The results of this analysis are shown below.

**Mean Common Area and Central Services  
Electricity Expenditure \$/m2  
Office Grade Comparison**

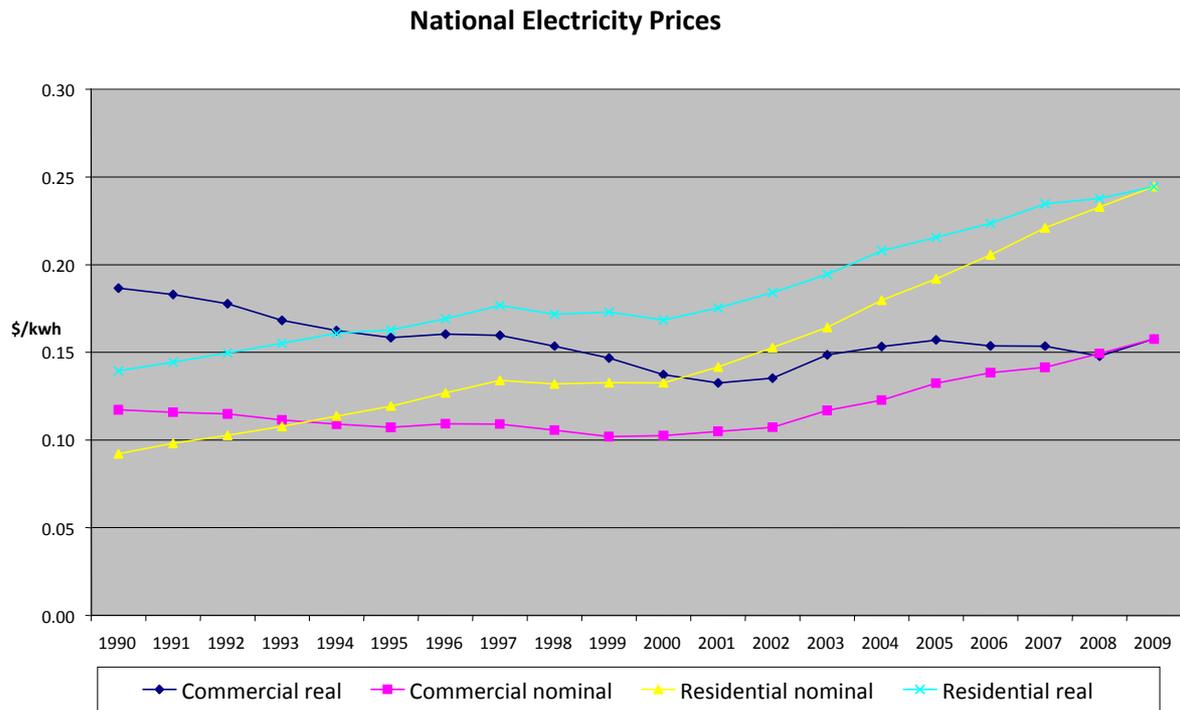


Again all quality categories generally exhibited slow growth in common area and central services electricity expenditure. The A and B quality buildings had similar levels of expenditure as did the C and un-graded categories – but somewhat lower as shown above. The “other” category was lower again – the spike in the 2007 year explained by the very small number of survey respondents now reporting their buildings as being in these lower categories.

These results, in particular the shallow slopes of the graphs were somewhat surprising. Electricity expenditure increases were lower than the general level of inflation over the same time period and in contrast to the common perception that electricity prices were increasing. The next step was therefore to examine changes in the price per kilowatt hour for electricity since 1990.

## Electricity Prices

The graph below shows the national average electricity prices for the period 1990 to 2009 according to figures published by the Ministry of Economic Development. Nominal commercial electricity prices are shown in pink and real commercial prices are shown in blue. Nominal domestic electricity prices are shown in yellow and real domestic prices in turquoise for comparison.



It can be seen there has been a radical change in the electricity pricing structure in New Zealand over the survey period. This is most likely the result of the change from a centralised and government regulated electricity market to a partially privatised and competitive market. This commenced in the late 1980's and continued throughout the 1990's.

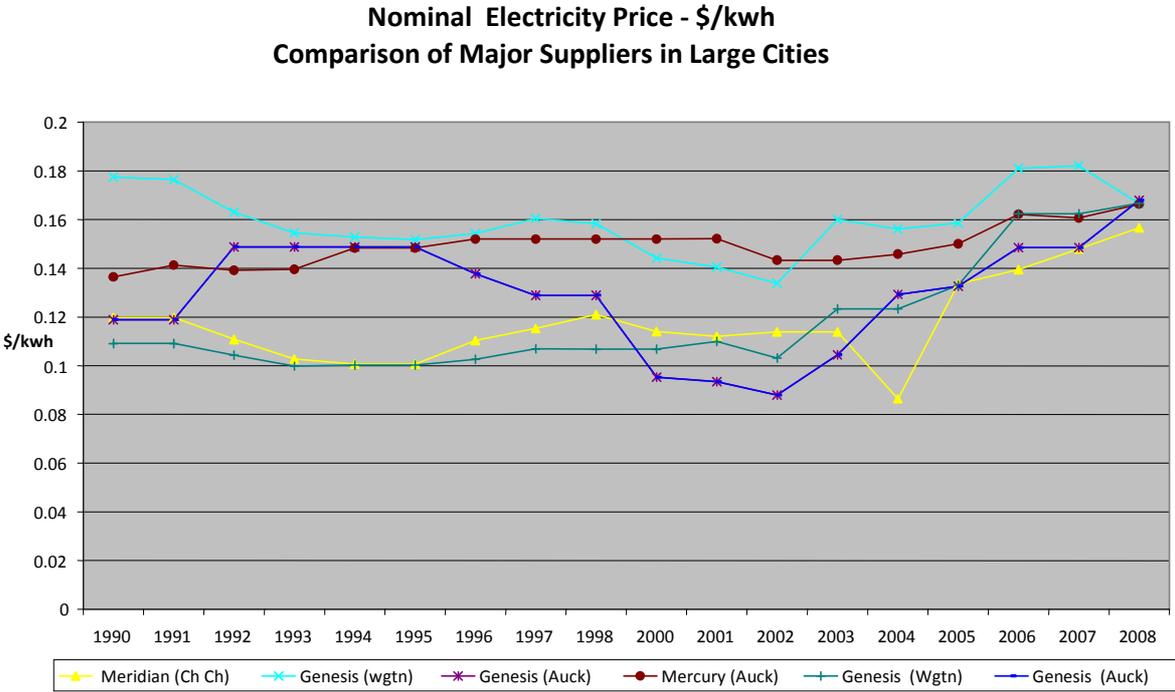
It has seen the nominal price of domestic electricity increase by 156.9% and the real price increase by 73.55% over the study period. In contrast, the nominal commercial price has only increased by 29.6% and in real terms has decreased by 23.6% over the same period. This outcome has probably been contributed to by efforts to reduce the need for new generation capacity by offering substantial price discounts to users willing to manage their electricity load profile. This has been relatively easy amongst the large users in the commercial sector, but much more difficult in the domestic sector.

It also appears that the discounts offered to the commercial sector for load management have reduced in recent years as energy management has improved and there is less off-peak energy available.

The national average electricity price data for commercial uses discussed above includes not only large office buildings but commercial buildings of all types including small offices, CBD and suburban retail buildings and shopping centres, hospitals, educational institutions etc.

As outlined in the methodology section, an attempt was made to cross check electricity prices from various indices against known actual prices applying to particular office buildings. The objective was to try and identify the most suitable electricity price index via which the electricity expenditure data collected by the Property Council could be converted to electricity consumption in kilowatt hours per square metre.

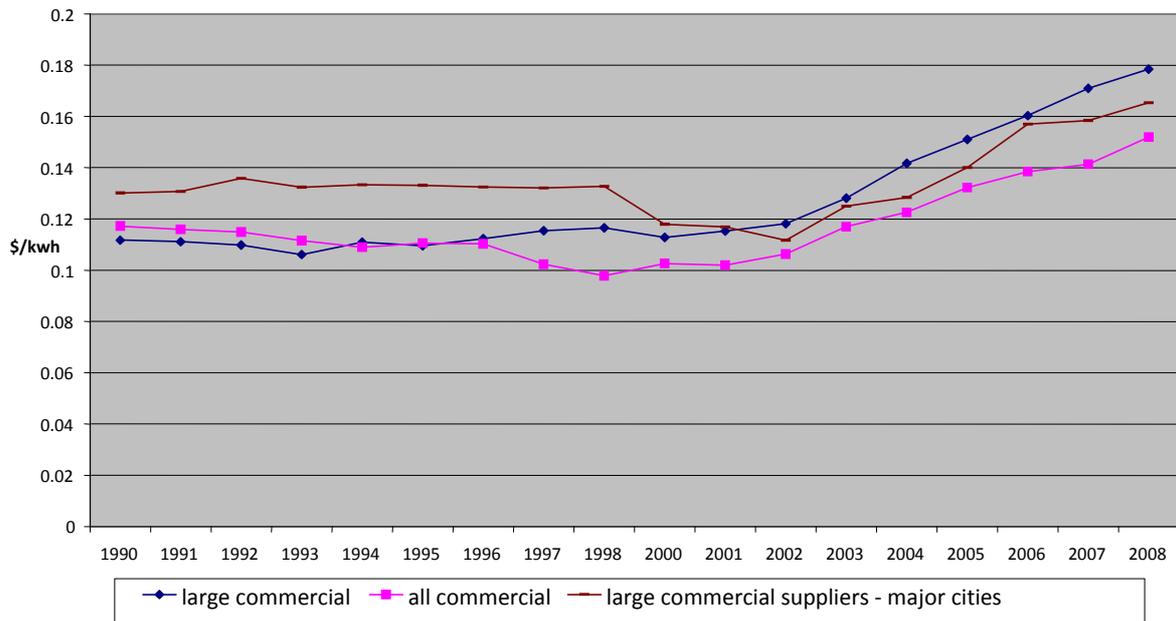
The graph below shows the average electricity prices charged to large commercial uses by the major electricity suppliers in the cities in the study.



It can be seen there was considerable price variation, especially in the earlier years of the survey, perhaps as a result of the immaturity of the electricity market at the time, differing approaches to load management in earlier years and different customer profiles. In the last four years the price range has narrowed considerably.

The prices from these different major suppliers were averaged and then compared to two other indices. One was the national average electricity price series for all commercial users mentioned above and the other an index of prices applying to users classified as “large commercial”. All prices were based on Electricity Commission and Ministry of Economic Development raw data. The results of this comparison are shown below.

### Nominal Electricity Price - \$/kwh Comparison of Electricity Price Indices



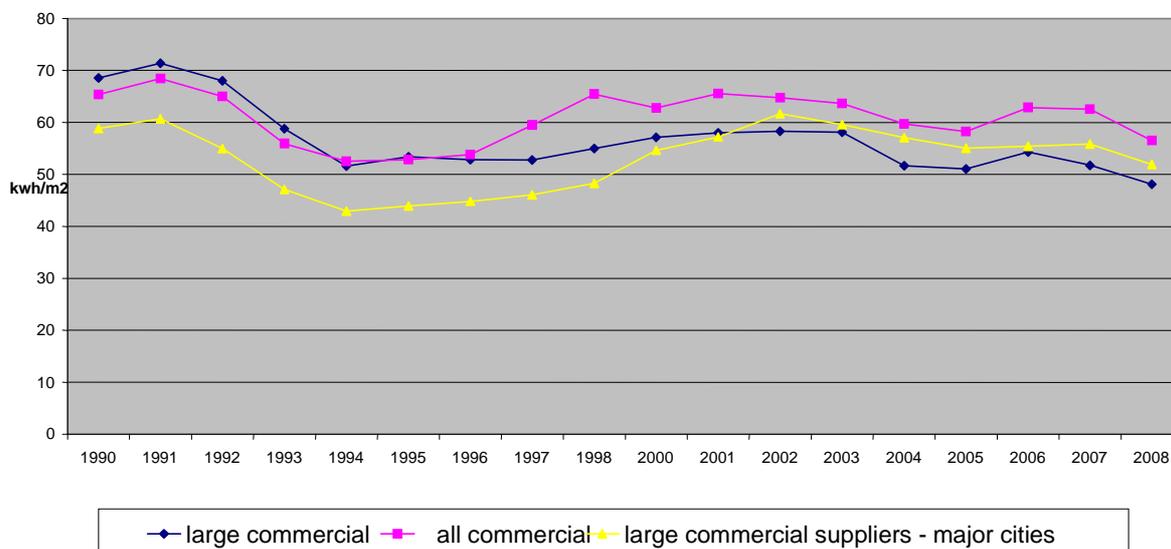
It can be seen the price trends are similar, but the national “All Commercial” figures are generally lower – probably reflecting a larger range of building types and possibly lower cost electricity suppliers being included in these national averages as compared to the main city data represented above.

### Electricity Consumption

A limited amount of electricity price information for individual office buildings was available from the Property Council survey and other sources throughout the research period of 1990-2008. This was cross checked against the three indices shown above and it was found actual electricity prices paid were generally similar to the indices. Therefore, dividing the average annual electricity expenditure for common area and core services for each year of the survey by the average electricity prices applying to large commercial users in that year provided a reasonable estimate of electricity consumption trends in kilowatt hours per square metre.

The results of this process for all three price indices are shown below.

**Electricity Consumption  
Common Area and Central Services - kwh/m2  
Mean Expenditure Divided by Electricity Price Indices**



It can be seen from the graph that electricity consumption for common area and core services in office buildings appears to have remained relatively constant over the period from 1990 to 2008. If anything there may have been a slight decline since around 2002. However, to confirm this is actually the situation, improved detail and consistency in electricity consumption data collection (rather than just expenditure) is needed.

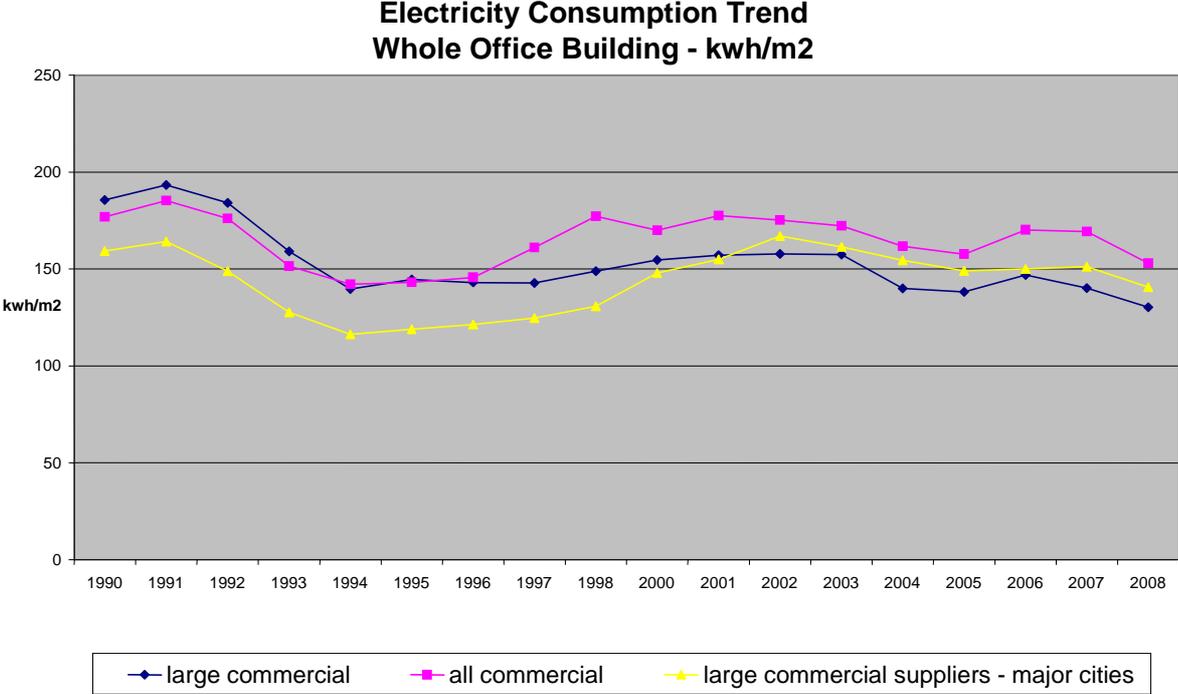
The final step in this part of the research was to try and estimate trends in energy consumption for entire office buildings, rather than just for the common area and central services component.

With the limited historical data available this involved some major and potentially tenuous assumptions regarding there being a fixed ratio between common area and central services electricity consumption and that of the entire office building.

In many buildings this is likely to be highly variable due to, amongst other things, the varying activities and equipment of the occupants, the nature of the electrical systems in the building, the relative sizes of common areas and existence of atriums, the number of levels and elevators, variations in operating expense apportionment due to metering arrangements and lease terms etc.

Nevertheless, in light of the number of buildings in the survey and the consequent averaging effect, it was considered worthwhile to calculate the figures – though of course they should be treated with caution.

As indicated in the methodology section, for the buildings on which both common area and core services and total building electricity consumption data was available, the average ratio of common area and core services to total building electricity consumption was 36%. Applying this ratio to the common area and core services data above resulted in the graph below.



This indicates most large office buildings in New Zealand consume in the region of 150kwh/m2 of net lettable floor area. This level of electricity consumption has also been relatively constant over the last 20 years but may be starting to trend downwards.

**Conclusions and Further Research**

This research has found that the expenditure on electricity for common areas and central services in typical New Zealand office buildings has remained relatively constant over the last twenty years. This trend applies to all the main cities, and also applies when the office buildings are split into quality categories.

While the trend is similar there are significant differences between average levels of expenditure, with lower quality buildings and buildings located in Christchurch both having lower levels of electricity expense per square metre net lettable area. These results may be related to differences in the prevalence of air conditioning in different building quality categories as well as temperature and relative humidity differences between cities.

The trends identified above can at least be partially explained by the fact that the cost of electricity supplied to large commercial premises in New Zealand has increased only slightly in nominal terms and in fact decreased in real terms for most of the survey period. This stable price period may be coming to an end, but future price increases may be offset by improvements in energy efficiency.

This tends to be confirmed by the conversion of electricity expenditure into consumption in kwh/m<sup>2</sup>. It was observed that in recent years when electricity price increases have been more apparent, electricity usage in kwh/m<sup>2</sup> has remained flat or declined slightly. More research appears to currently be underway which may confirm this trend.

The conversion of common area and central services electricity consumption to whole building consumption relied on limited data and a somewhat tenuous assumption. However, it did indicate that average electricity consumption in New Zealand office buildings is in the vicinity of 150kwh/m<sup>2</sup> and has been at that level for sometime.

In some ways the most important finding of this research is the need to collect better data. It was necessary to combine primary and secondary data and make major assumptions in order to try and identify the trends reported. Further statistical analysis of this data is anticipated over the coming months but the findings would be far more robust if accurate electricity expenditure and electricity consumption in kwh had been collected for both common areas and central services and the building as a whole for all the properties in the survey.

Hopefully such detail will become a feature of future operating expense surveys, which would result in more meaning being able to be extracted from the data.

## References

Bricknell Moss Raines and Stevens Ltd. *Energy Conservation in Commercial Buildings*. Research report R49 Building Research Association of New Zealand 1986.

Build Magazine, *BEES Buzzing*. pp. 70-71 February March 2010.

Energy Efficiency and Conservation Authority, *Energy Efficiency and Renewable Energy in New Zealand Year Six Report: March 2001 to 2007*. Wellington, March 2009

Ghanbari Parsa AR, Akhavan Farshchi M. *Environmental Regulations and the Real Estate Industry*, Property Management, 1996, Vol 14. No.1, pg.6.

Haji-Sapar M, Lee SE. *Establishment of Energy Management Tools for Facilities Managers in the Tropical Region*. Facilities. Bradford: 2005. Vol. 23, Iss.9/10; pg.416.

Holmes J, Hudson G. *The Application of BREEAM in Corporate Real Estate: A Case Study in the Design and Marketing of a City Centre Office Development*. Journal of Corporate Real Estate. Bingley: Dec 2002. Vol. 5, Iss. 1; pg .66.

Kema. *New Zealand Electric Energy-Efficiency Potential Study*. Electricity Commission, Wellington, New Zealand. September 2007.

Kolokotsa, D. Diakaki, C. Grigoroudis, E. Stavrakakis, G. Kalaitzakis, K. *Decision Support Methodologies on the Energy Efficiency and Energy Management in Buildings*. Advances in Building Energy Research. 2009 pp. 121-146.

Lee WL, Yik FWH. *Regulatory and Voluntary Approaches for Enhancing Building Energy Efficiency*. Progress in Energy and Combustion Science. 2004. Issue 30pg. 477.

Lincoln University. *A Study of Christchurch C.B.D. Office Expenses*. Unpublished research report 1990.

Love P, Bullen PA. *Toward the Sustainable Adaptation of Existing Facilities*. Facilities. Bradford: 2009. Vol.27, Iss. 9/10; pg. 357.

Ministry of Economic Development. *New Zealand Energy Quarterly*, Wellington, September 2009.

Ministry of Economic Development *New Zealand Energy Data File* Wellington, 2009.

Nicolay, C. *The Greening of Real Estate Appraisal: As Sustainable Building Gains Momentum Through Standards, Legislation and Public Desire, the Appraisal Community Responds*. Valuation Insights & Perspectives, Vol. 12.2, Spring 2007.

Property Council of New Zealand. *Office Building Energy Consumption Benchmarks*. 2000.

Reed R.G. Wilkinson S.J. *The Increasing Importance of Sustainability for Building Ownership*. Journal of Corporate Real Estate. Bingley: 2005. Vol.7 Iss. 4; pg.339.

Treloar GJ, Fay R, Ilozor B, Love PED, *An Analysis of the Embodied Energy of Office Buildings by Height*. Facilities. Bradford: May/June 2001. Vol.19, Iss. 5/6

Wilkinson S.J. Reed R.G. *Office Building Characteristics and the Link with Carbon Emissions*. Structural Survey. Bradford: 2006 Vol.24 Iss 3 pj. 240.

# CBD Office Building Quality Grading Matrix

Grade	Size	Floorplate	Finish	Technical Services
A	Generally >20,000 sqm	Generally >1,000 sqm, largely column free	<p>A landmark office building located in major CBD office markets which is a pace setter in establishment rents and includes:</p> <ul style="list-style-type: none"> <li>• Ample natural light;</li> <li>• Good views/outlook;</li> <li>• Prestige lobby finish;</li> <li>• On-site undercover parking;</li> <li>• Quality access to/from an attractive street setting; and,</li> <li>• Premium presentation and maintenance</li> </ul>	<p>State of the art technical services will typically include:</p> <ul style="list-style-type: none"> <li>• <b>Heating, Ventilation &amp; Air-conditioning System</b> – Multiple zones of approximately 70 sqm with around 25 watts per sqm for tenant equipment. The system should also have a supplementary fresh air system, auxiliary condenser water loop for tenant and capacity for tenant exhaust risers.</li> <li>• <b>Lifts</b> – Waiting interval not to exceed 25 seconds, handling capacity in excess of 15% and a high quality ride with low noise. At least one dedicated goods lift.</li> <li>• <b>Power</b> – Minimum of 25 watts per sqm load capacity. Dedicated data risers should be available.</li> <li>• <b>Lighting</b> – High quality ultra low brightness fittings.</li> <li>• <b>Building Intelligence</b> – High quality building automation system, 24 hour access (card key), after hours air-conditioning dial-up, energy and stand-by power management, manned control room, perimeter security, and closed circuit TV.</li> <li>• <b>Standby Power</b> – Full power for all essential services and ventilation and at least 50% for lighting and lifts.</li> </ul>
B	Generally >10,000 sqm	Generally >600 sqm, largely column free	<p>High quality space including:</p> <ul style="list-style-type: none"> <li>• Good views/outlook;</li> <li>• Quality lobby finish;</li> <li>• On-site undercover parking;</li> <li>• Quality access to/from an attractive street setting; and,</li> <li>• Quality presentation and maintenance.</li> </ul>	<p>High quality technical services will typically include:</p> <ul style="list-style-type: none"> <li>• <b>Heating Ventilation &amp; Air-conditioning System</b> – Multiple zones of approximately 100 sqm with around 15 watts per sqm for tenant equipment. The HVAC should have an auxiliary condenser water loop for tenant use.</li> <li>• <b>Lifts</b> – Waiting interval not to exceed 30 seconds, handling capacity around 14% to 15% and a good quality ride.</li> <li>• <b>Power</b> – Minimum of 15 watts per sqm load capacity.</li> <li>• <b>Lighting</b> – Lower ultra low brightness fittings.</li> <li>• <b>Building Intelligence</b> – Direct digital controls, 24 hour access with card key and off site alarm monitoring, key switch after hours air-conditioning.</li> <li>• <b>Standby Power</b> – Full power for all essential services and full ventilation.</li> </ul>
C	Any size	Any size	<p>Good quality space with a reasonable standard of finish and maintenance. Tenant car parking facilities should be available.</p>	<p>A basic standard of technical services that will generally include most of the following:</p> <ul style="list-style-type: none"> <li>• <b>Heating, Ventilation &amp; Air-conditioning System</b> – Comprises a reasonable system with one controllable zone per building face.</li> <li>• <b>Lifts</b> – Waiting not to exceed 35 seconds, handling capacity around 13% to 14%.</li> <li>• <b>Power</b> – Load capacity 10 watts per sqm.</li> <li>• <b>Lighting</b> – Recessed prismatic fittings.</li> <li>• <b>Building Intelligence</b> – Electronic controls, 24 hours access with key card, key switch for after hours air-conditioning.</li> <li>• <b>Standby Power</b> – None.</li> </ul>
Other	Any size	Any size	<p>Office space with lower or poor quality finish.</p>	<p>Services fall below the minimum requirement for a C grade.</p>