Barriers and drivers towards the transition to a low carbon built environment.

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SUMMARY

The Stern Report (HMSO, 2006) highlighted economic and social consequences for mankind globally with limited action addressing climate change - it asserted that only stringent action now would reduce the extent of irreversible climate changes. After years of reporting the need for action on climate change, the message appears to have been taken on board by the governments of countries like the US, who were hitherto unconvinced by the scientific research. If a greater political will to act is now in place, the property and construction industry needs to move quickly and decisively to reduce building related carbon emissions. Stern's view (2006) is that the window in which we need to make stringent change is open between 2016 and 2021, otherwise humankind faces 'climatic disaster'.

This paper examines the total office building stock of a typical global city, Melbourne, over a 15 year time frame to 2020 with reference to greenhouse gas emissions. The focus is placed on introducing measures that will deliver the reductions noted by Stern. A comprehensive examination was undertaken of characteristics relating to all office buildings in the CBD including age, quality, floor area, energy use, number of employees and prevailing market conditions. Uniquely, a longitudinal analysis profiled the entire office stock and CO_2 emissions during 2005, 2010, 2015 and 2020. To understand the full implications of change, four alternative scenarios were used over this time period based on 'no change', 'minor change', 'intermediate change' or 'major change'. The research identified clear links between characteristics of office buildings located in a CBD *and* their respective consumption of energy plus CO_2 emissions. The process produced results that were both reliable and accurate in respect of the energy consumption and CO_2 emissions for a global city. Five major findings and recommendations for addressing the contribution of office buildings towards climate change were produced. In conducting this research there was evidence that hurdles still exist that severely inhibit attempts to fully embrace climate change, where these barriers are partly political, social and economic. To embrace change requires commitment from all stakeholders – anything less will result in a lack of understanding, disillusion and the type of fragmented approach that arguably exists today.

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ABSTRACT

The Stern Report (HMSO, 2006) highlighted the economic and social consequences for mankind globally of limited action on climate change and asserted that only stringent action now would reduce the extent of irreversible climate changes. After many years of reporting the need for action on climate change, the message appears to have been taken on board by the governments of countries like the US and Australia, who were not fully unconvinced by the scientific research. In November 2006 Australia's Prime Minister Howard agreed to negotiate on carbon trading. If a greater political will to act is now being set in place, the property and construction industry needs to move decisively to reduce building related carbon emissions. Stern's view (2006) is that the window in which we need to make stringent change is open between 2016 and 2021, otherwise society in general will face climatic disaster. This paper explores the extent of measures required to the office building stock of a typical global city, Melbourne, over a 15 year time frame to 2020 that will deliver the reductions noted by Stern.

1. Introduction

This paper commences by discussing the results of the first stage of a research project funded by the Royal Institution of Chartered Surveyors (RICS) into carbon emissions from a central business district (CBD) (or downtown) office buildings in a global city, Melbourne, Australia (Wilkinson and Reed, 2006). This research has recently been further extended and work is underway to profile the carbon emissions from other prooperty sectors such as retail, residential, hotel, recreational and educational buildings also located in the CBD (or downtown district). The aim of the research is (a) to determine how a city performs in terms of carbon emissions and (b) to identify a range of measures to target optimimum reductions in carbon emissions across the stock. The Melbourne City Council is committed to making Melbourne a carbon neutral city by 2020 - therefore to pomote this policy policy makers need to know which sectors to target for reductions. The learning outcomes of this research and others conducted by the authors has identified various barriers against and drivers towards a low carbon built environment.

The paper also examines recent developments towards universal accpetance of global warming and climate change by politicians - for example the much publicised Stren Report

(HMSO, 2006) and the IPCC report in 2007. Along with other social, economic and environmental drivers these developments are practically forcing humankind to making widespread changes in the living and working standards, particularly in the design, construction and occupation of buildings. Overall these changes are beginning to occur more rapidly than previously envisaged, however there is still resistance to change still in some quarters.

Profiling the carbon emissions of the Melbourne CBD office stock.

The research comprised an analysis of all office buildings in the Melbourne CBD and scrutinised variables such as building size, number of employees in each building, occupancy levels, visual appearance, and the age of each building. Each variable was used to examine the Melbourne CBD and then to calculate existing and future levels of carbon emissions. It should be noted that CBDs are relevant because all major cities have a CBD, often with an aging stock of high rise buildings (Jones Lang LaSalle, 2005). There are other implications from CBDs with an associated higher density of office buildings, with many having contributed to the provision of a poorer environmental quality for city workers and residents. As cities grow, improving the quality of the CBD stock is important for investors, occupiers, policy makers and the community. This research analysed all office buildings to a high level of detail and the results give a valuable insight into CBD office buildings and climate change.

Scope and Limitations

Studies into energy efficiency often examine factors that relate to the consumption and emissions of CO_2, however there are other aspects of energy efficiency that would be evaluated if additional resources were available. Two of these additional aspects are (a) embodied and (b) transport energy, which both require more attention than was possible to allocate in this study. Although pilot investigations into these areas were undertaken during the study, this paper does not include direct reference to these areas and reference should be made to the original paper (Wilkinson & Reed, 2006). Although the original paper evaluated the impact of green power in the reduction of CO_2 emissions, it did not consider micro-generation of energy although was acknowledged as an emerging and important aspect of energy efficiency.

Methodology and data collection

In the original project a full census was undertaken of all Melbourne CBD office buildings. During this process a detailed database was compiled based on inspections of every office building, evaluating relevant characteristics for each building including:

- age;
- net lettable area (NLA);
- gross floor area (GFA);
- physical location; and
- the usage of electricity and gas.

The 2nd stage of the research was to model the data via a longitudinal analysis over 5, 10 and 15 year timeframes. This approach enabled the research team to examine change over time, and alternative approaches to reducing CO_2 emissions in the office stock. The data used in this research is founded on reliable sources of information based on individual buildings without sampling only a proportion of the research population. The final results were confirmed as reliable by a check method and designed to provide an insight into office buildings and climate change over time.

Sources of detailed building characteristics

The central data file was compiled with limited reference to existing databases. Two primary databases were used, although there were issues resolved regarding access to the databases and extensive data 'cleaning' for the study. The two databases employed were the City of Melbourne's 'Census of Land Use and Employment' (CLUE) and 'Cityscope'. The databases assisted profiling the office stock in Melbourne CBD but did not include data about energy consumption or energy efficiency. CLUE is an information system about land use, employment and economic activity across Melbourne (www.melbourne.vic.gov.au/clue). Note: the information in this database was aggregated to a building level and not information was available that would permit identification of individual buildings. Cityscope information was used to compile part of the main data file of office buildings. It is a commercially available database and claims to be the 'most detailed, accurate and extensive CBD property information service available' in Australia (Cityscope, 2005). The type of office building data held on the database include parameters such as street frontage, zoning information and site area, detail of development applications, building progress and completion, title and property details such as building services. Over 3000 Melbourne CBD properties are included on the database which is updated annually. Cityscope was used with CLUE to provide data for the modelling and forecasting of baseline carbon emissions for the CBD offices. This research was supported by the 2005 version of Cityscope. Another key data source was a questionnaire survey to establish information regarding energy consumption and use within the buildings, as well as existing data about office buildings. The survey provided supplementary information to support the data not available from other sources such as the CLUE and Cityscope databases.

Carbon emissions

After data collection was completed and the database assembled, the research team used a greenhouse rating diagnostic tool to convert energy consumption into carbon emissions. All data used in this process was obtained from reliable sources and verified. This process was undertaken using information and data from the following ABARE, Australian Energy paper 05.9, Australian Building Greenhouse Rating (www.abgr.com.au), AGO 2004, *Stationary Sector GHG Emission Projections*, Vicpool Information Bulletin 3, 43, Department of Infrastructure. 2005. Energy retail tariffs for 2005, ESAA, *Electricity Gas Australia 2005*, OECD IEA 2005, *Electricity Information* (2003 data); and TXU **-** schedule of distribution use of system tariffs.

With regards to green power, the following rates were adopted for the baseline data calculations: *Premium* and *A Grade* - 5%, *B Grade* - 2%, *C Grade* - 1%, and *D Grade* - 0%. In Australia office buildings are graded alphabetically according to quality. Higher quality buildings use more green power than lower grade stock. It is noted the buildings in the returned surveys had higher levels of green power however the researchers felt that the sample was biased to buildings where more green power was used and references to other sources confirmed this view and indicated uptake across the stock was lower. All buildings on the main data file were processed in order to calculate carbon emissions.

Research process and data validation

The research population for the profiling of stock comprised all Melbourne CBD offices. To ensure the validity of the database a direct survey was also conducted, where the research population for the questionnaire survey comprised a sample of owners of office property and Property Council of Australia (PCA) members in Melbourne. Twenty-six questionnaires were distributed to owners of Melbourne CBD office buildings in October and November 2005 by the Property Council of Australia in Sydney. Fourteen returns were received, equating to a responses rate of approximately 50%.

The database was 'cleaned' by the research team and all non-office property that included less than 50% of a core office component was removed. The survey helped to ensure that the information in the database was accurate and reliable. The following steps in Table 1 below were undertaken:

Table 1. Research approach

Steps	Activity
Step 1	Assemble preliminary dataset of all Melbourne CBD buildings including non-conforming property (e.g. carparks and residential).
Step 2	Add other data including details from the CLUE database -physical building characteristics and physical characteristics (note: this data was examined in aggregate format and individual floors or tenancies could not be isolated).
Step 3	Using GIS mapping and Cityscope, and individual inspections, each building was examined and the database was reduced from 1,354 to 328 office buildings with an office component of at least 50%.
Step 4	Additional information relating to individual buildings was added to the database and resulted in comprehensive and detailed information set.
Step 5	The data from the survey were input to the database and checked against existing data
Step 6	Rating for CO^2 emissions for all 328 CBD office building in database. The AGBR online diagnostic tool was used (www.agbr.com.au). Data based on rated area, occupancy hours, number of employees, electricity and gas consumption per annum (kWh and MJ) and amounts of green power used. The rates used for energy consumption sourced from the PCA Benchmarks Survey of Operating Costs 2005 for Melbourne (PCA, 2005) on a pro-rata basis using current energy tariffs for Victoria.
Step 7	An analysis of energy consumption and emissions for all 328 office buildings for all scenarios was conducted for 3 time periods, 2010, 2015 and 2020. The results formed the basis for profiling the office stock in 5, 10 and 15 years.

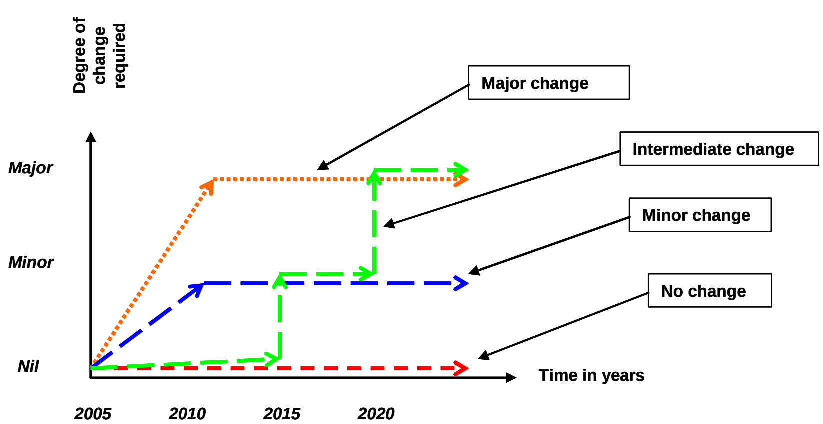
Forecasting and modelling the research scenarios

The study examined four different scenarios: (a) no change, (b) minor change, (c) intermediate change and (d) major change – table 2 lists the variables altered in three of the scenarios. The intermediate scenario was a hybrid between the minor and major scenarios, adopting a more realistic approach to the introduction of change into the office market. The intermediate approach commences with no change, then a minor change followed by major change. The three scenario time frames were 2010, 2015 and 2020 in figure 1.

Table 2. Variables altered in no change, minor and major scenarios

Variable	**Scenario 1 - no change**	**Scenario 2 - minor change**	**Scenario 3 - major change**
Number of employees	No change	Increase by 10%	Increase by 25%
Green power use by Grade (premium, A, B, C and D)	5%,2%, 1%, 0%	10%,5%, 2%, 1%	50%,25%, 10%, 5%
Electricity consumption (kWh)	No reduction	Less 10%	Less 25%
Gas (MJ)	No reduction	Less 10%	Less 25%

Figure 1. Varying change over time for each scenario



Major findings and recommendations

This research comprised a detailed analysis of all office buildings in Melbourne, a global CBD, analysing existing stock as at 2005, and modelling emissions for 2010, 2015 and 2020. Given to three alternative scenarios (in figure 1) and the changes listed in table 2, the major findings are discussed further below with accompanying recommendations.

Finding 1

Emissions from office buildings will increase in the future if no action is taken.

There is clear evidence to indicate that, if remaining unchanged, emissions in the CBD office market will rise on both an 'aggregate' and 'per person' basis. These increases are due to the factors such as the ageing of the office stock over time and the volume of new stock under construction that will soon be released onto the market.

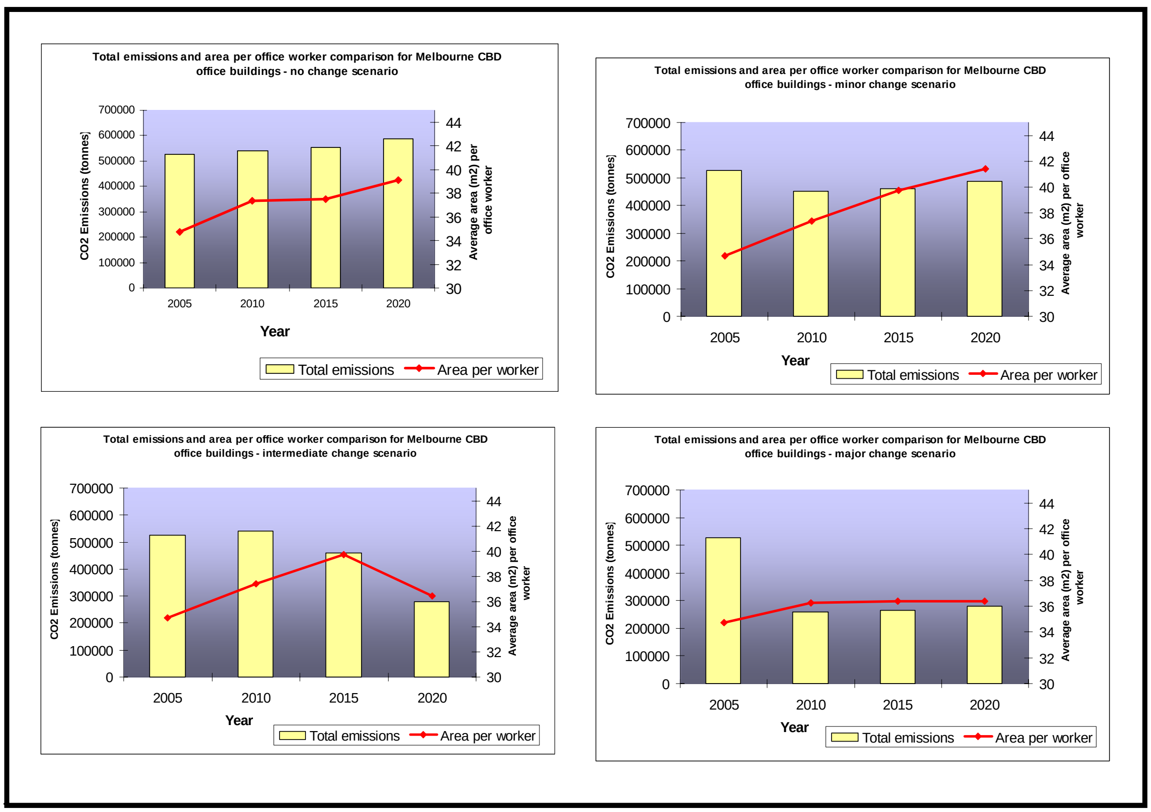
The recommendation is that steps are taken to reduce the level of emissions from office buildings, and the best course of action would be to adopt the intermediate scenario. It is recommended that this process would commence with no change in the first five years (allowing for professional and industry related education), followed by a minor change in the next five years and then a major change over the ensuing five years. Following this course of action will lead to a decrease in emissions using an incremental and viable approach.

Key finding 2

The level of emissions is closely linked to the amount of office space per worker.

As emissions increase in 2005 and over the next 5, 10 and 15 years, there will also be a corresponding increase in the net lettable area per office worker. This relationship is also maintained for each of the four scenarios, with the correlation between emissions and area per office worker highlighted for each scenario in figure 2.

Figure 2. Levels of emissions vs. amount of space per office worker for each scenario



The recommendation is that the density of office workers in each building should be increased on a 'office worker per building' basis. This can be achieved by undertaking one or more of the following steps:

a) Ensuring that office buildings are fully let and vacancies are minimised at all times;
b) Decreasing the amount of office space that is leased although actually unused or empty;
c) Increasing the ratio of office worker to floor space; and/or
d) Modifying the approach to using office space to increase efficiency.

Key finding 3
Higher energy use and CO_2 emissions are positively associated with smaller buildings but negatively associated with medium sized buildings.

Buildings with a gross lettable area under 5,000m^2 are the highest aggregate consumers of energy by gross floor area and on a 'per person' basis, and produce the highest level of emissions per person. However, buildings with a gross floor area between 5,000 and 10,000m^2 use the least energy and have the lowest emission levels. Reasons for these results for each group are as follows:

a) smaller building are usually associated with a high proportion of older stock that exhibit typically higher than average vacancy rates. This is partly due to the higher levels of obsolescence in this group, especially with regards to physical and functional use.
b) in contrast to smaller buildings, increasing the building floor area will raise the level of efficiency due to the enhanced economies of scale.

The recommendation is for the focus to be placed on encouraging the development of medium sized office buildings in global cities. In respect of energy consumption and efficiency, this group is the highest and best use of the land. This may be achieved by closely monitoring the supply of smaller and larger buildings and the effect on the aggregate amount of office space would be negligible.

Key finding 4
As office buildings increase in age, energy use and CO2 emissions also increases.

The age of a building is directly related to obsolescence levels, which is turn has an effect on energy efficiency and CO_2 emissions. New buildings incorporate the latest advances in technology and building design, as well as minimal physical and functional deterioration this results in lower aggregate emissions and energy consumption. The focus should be placed on a 'per person' basis, where there is a direct relationship between age and energy consumption.

The recommendation is that the focus should be placed on reducing the proportion of older buildings in the CBD. This group are the highest energy users and produce the most CO_2 emissions. Policy makers should consider using incentives (or disincentives not to redevelop) which would ensure the highest and best use of the CBD office stock is maintained at all times. However it should be noted that this research did not consider the embodied energy within buildings and it is possible that consideration of embodied energy would have some influence on this data.

Key finding 5
Increase the occupancy levels of CBD office buildings which is linked to lower energy use and lower CO_2 emissions.

The number of employees in a building is positively correlated with energy use and energy efficiency, where buildings with more employees (but not necessarily floor area) have enhanced energy use and produce less CO_2 emissions. However, buildings containing fewer office workers have higher costs and emit more CO_2. This relationship is adversely affected by buildings with 50 or less office workers and exhibits poor use of resources. This finding does not conclude that buildings should contain more office workers on sliding scale, but rather that buildings containing a relatively small number of employees should be monitored.

The recommendation is that monitoring of buildings with low occupancy (not vacancy) levels based on the number of office workers should be undertaken. Since energy consumption and CO_2 emissions are closely linked to this group, a scheme based on either incentives or disincentives (e.g. property rating or property taxation) to maintain low occupancy rates should be introduced as soon as possible.

Barriers to a low carbon built environment

Based on the research, the barriers can be divided into the following categories: social (or professional), economic (market driven), and political.

The social barriers are related to the professions who are able to implement and deliver reductions in CO_2 emissions. There is a lack of knowledge about energy efficiency and sustainability amongst the property profession in Australia, which is understandable to a degree. Partly this has been attributed to professional conservatism (Scrase, 2001). There was also a perceived lack of expertise with this newly emerging area of professional services. This knowledge and expertise gap reflects a lack of education and continuing professional development (CPD) training. These gaps are being addressed with a variety of CPD events relating to energy and sustainability being offered and within built environment University courses sustainability and energy efficiency subjects are being offered to students. Furthermore understanding and knowledge of energy efficiency can be improved through more web-based information and access. CPD, training and short courses, regular professional body newsletters and web-based bulletin board are ways to improve knowledge and expertise. Though the choice of CPD events professionals attend is voluntary and member smay chose alternate events.Profession bodies need to consider some element of mandatory attendance for existing members to sustainability related CPD. In addition it takes time for the knowledge gap to close and for a majority of practitioners to become fully conversant with best practice approaches.

The economic barriers are that the overall market is still yet to be fully convinced of the value of energy efficient buildings. Until valuers assign additional value (if any) to buildings with energy efficient features, then the market will not demand more buildings with such features. Clearly this is partly related to knowledge levels but also it requires different methods of evaluating value. Work is being undertaken by others (Grissom, 2006; Myers, Reed & Robinson, 2007) in valuing sustainability in the buildings although certainty about the relationship between value and sustainability is yet to be fully understood by all stakeholders in the market. Increasing the uptake of corporate social responsibility (CSR) in organisations will send a clear signal to practitioners and valuers about the need for buildings with low carbon emissions. In addition, explicit statements regarding sustainability in company annual reports and policy and strategy documents will advertise the importance of sustainability to the market. Another argument against implementing energy efficiency is the perceived prohibitive cost of the measures, with a greater uptake across the sector economies of scale will result – since this is based on perception it seems the use of reliable case studies and their respective costs will confirm the actual implementation costs are not necessarily excessive.

When political barriers are considered, in this type of research there are several issues which arise and need further attention. Firstly there needs to be a high profile support and lead from government. Arguably in Australia this is beginning to emerge at a state level – for example, the State Government of Victoria will only lease office space with a 4.5 Greenstar rating in Victoria. This is not yet the case for federal government although John Howards government has softened in its views towards cliamte change and global warming since mid-2006. Clearly further innovative initatives are also required from local authorities to support this momentum. Melbourne is taking a proactive stance here, in 2006 the Melbourne City Council occupied it's new 6 GreenStar rated office building CH2, while the old council building is currently being extensively refurbished to high environmental standards. However it takes time for exemplar buildings to come on line and sceptics comment that local authorities can afford to spend on expensive features because of the long term tenure arrangements they have. At a micro-political level there is also resistance between professional groups themselves, whereby suggestions to implements energy efficient measures in a project may be rejected by others in the professional team. It is a dynamic that has not been explored to-date and would involve a candid insight into professional activities.

Conclusions

This research identified clear links between characteristics of office buildings located in a CBD *and* their respective consumption of energy plus CO_2 emissions. To undertake this task a comprehensive examination was undertaken of characteristics relating to all office buildings in the Melbourne CBD including age, quality, floor area, energy use, number of employees and prevailing market conditions. Importantly a longitudinal analysis was used to profile the entire office stock and CO_2 emissions during 2005, 2010, 2015 and 2020. In order to understand the full implications of change, there were four alternative scenarios introduced over this time period based on 'no change', 'minor change', 'intermediate change' or 'major change'. This process produced results that were both reliable and accurate in respect of the energy consumption and CO_2 emissions for a global city.

The research produced five major findings with accompanying recommendations for addressing the contribution of office buildings towards climate change In the process of conducting this research there was evidence that hurdles still existed that would severely inhibit any attempts to fully embrace climate change. Part of the problem appears to be related to the nature of the real estate market and its highly competitive and complex nature. For example, the rate of response for the survey returns was unexpectedly slower than anticipated even though the respondents were fully conversant with the information required. The researchers argue this is indicative of the prevailing attitudes towards energy efficiency in a portion of the sector where serious concerns abound in the property market about the level of confidentiality with this information. It should be noted that, in a similar manner to the broader real estate market, office markets are influenced by an extremely large number of factors including prevailing market conditions, government policy, investor sentiment and overall market perception. Consideration should be given to these external influences, some of which drive change others are barriers to change. To embrace change requires commitment from all property stakeholders – anything less will result in a lack of understanding, disillusion and the type of fragmented approach that arguably exists today.

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BIOGRAPHICAL NOTES

Sara joined the University of Melbourne in January 2005 from Sheffield Hallam University in the UK. She is a Chartered Building Surveyor and a Fellow of the Royal Institution of Chartered Surveyors (RICS). Sara completed an MPhil at the University of Salford in 1995 examining conceptual understanding of green buildings within the UK construction industry and in 2002 she was awarded an MA in Social Science Research Methods. She has published over 80 conference and journal papers and co-edited an RICS/Blackwell Science book on Best Value in Construction. Her research interests include energy efficiency and environmental issues and sustainability in the built environment. Sara is a member of the editorial board of Structural Survey journal and Vice Chair Commission 10 Construction Management Construction Economics of FIG (International Federation of Surveyors).

Richard Reed has conducted research in a diverse range of property-related topics including fast food businesses, intellectual property, retirement villages, national parks, auctions and demographic influences. His research interests are focussed upon three main areas: sustainability (depreciation and obsolescence) in the built environment, the housing market including reverse mortgages and demography, and the application of valuation in the property industry. After completing his first two Property Studies degrees at the University of Queensland he was employed as a property valuer in both the private and public sectors, gaining a wealth of 'hands-on' experience during this period. His PhD focussed upon the relationship between demographic influences and property values. He has published in numerous Australian and overseas journals, and presents regularly at local and overseas property conferences. In addition, he is an active member of property organisations such as the Australian Property Institute, the Pacific Rim Real Estate Society, the International Real Estate Society and RICS.

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