Are sustainable building retrofits delivering sustainable outcomes?

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Abstract:

Retrofit is driven by numerous drivers such as building obsolescence and the need to attract new tenants, another driver over recent years is the goal of sustainability. Pointedly, most existing stock was built without consideration of sustainability. Sustainability was legislated in 2006 in the Building Code of Australia, with minimum standards established for energy efficiency. In 2008, Melbourne launched the 1200 Buildings Program to deliver carbon neutrality by 2020 on the premise that retrofitting two thirds of the office stock would deliver a 38% reduction in greenhouse gas emissions. Further Australian legislation followed in respect of energy and buildings in 2010, the *Building Energy Efficiency Disclosure Act,* which focused attention on minimum energy standards when leasing or selling office space.

In this research a series of illustrative case studies are used to examine two research aims which were; *to gain a deeper understanding of the improvements made to offices retrofitted within the 1200 Buildings Program* and secondly, *to evaluate the outcomes against the project objectives.* The case studies cover the Melbourne CBD area in Victoria Australia.

The results show that the measures taken by owners were mostly focussed on building services and energy efficiency. Overall, far less work was undertaken to thermally upgrade the building fabric, to address issues such as water economy or related to social sustainability. This was acceptable to some extent as the program within which the works were taken; the 1200 Buildings Program is primarily focussed on reducing building related carbon emissions. However the results reveal that even when opportunities are there for other sustainability measures to be adopted, owners do not always take those opportunities and that wider sustainability issues are not necessarily that important in this market.

Article classification: Research

Keywords: Sustainable retrofit, building adaptation, refurbishment, commercial buildings.

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Introduction

Retrofit is driven by numerous drivers such as building obsolescence and the need to attract new tenants, another driver over recent years is the goal of sustainability. Significantly most global stock was constructed without consideration of sustainability. Environmental sustainability for commercial buildings was legislated in the Building Code of Australia in 2006, with minimum standards for energy efficiency applied to new build and some retrofits. As commercial buildings were responsible for 53% of all greenhouse gas (GHG) emissions in the Melbourne CBD in 2005-6 (City of Melbourne 2008), they represent good potential for reducing emissions through sustainable retrofit.

This paper starts with a review of the key literature in respect of the legislative framework and policy prevailing during the period in Melbourne. The literature review then moves on to examine broadly the issues pertaining to office buildings generally in respect of sustainability. There is a discussion of the responsibilities for energy within building which typically creates a split incentive in that owners pay for the energy efficiency measures that tenants benefit from through lower energy bills. This has been a stumbling block for increased energy efficiency in this market for some time. The literature review concludes by reviewing the main issues taken into account when determining whether to retrofit or not.

The research aims for the study are outlined as the paper moves into to describe the case study methodology which was utilised for the research. Issues such as reliability and internal and external validity are discussed in the methodology section. The results of ten case studies are then presented followed by a discussion of the results. The paper concludes with the conclusions which may be drawn from this research.

The policy and legislative framework for sustainability in Melbourne

In 2008 the City of Melbourne launched the 1200 Buildings Program as a strategy to deliver carbon neutrality by 2020. The Program encourages sustainable retrofit and provides financial support through a partnership between the City of Melbourne and the Sustainable Melbourne Fund (SMF). The SMF manages and administers the program's environmental upgrade finance mechanism, whilst the City of Melbourne implements the 1200 Buildings program.

With 7.7 million square metres of office space and approximately 1800 commercial office buildings in Melbourne, a target of retrofit to 5.2 million square metres was set. It is estimated that an average performance improvement of around 38% is required (City of Melbourne, 2008). Current targets are based on the Australian Building Greenhouse Rating (ABGR) standard of 4.5 stars out of a possible 6 stars, though in 2012, the City of Melbourne stated that it intended to raise the target to 5 stars ABGR. The National Australian Built Environment Rating System (NABERS) rating is a base building or whole building energy rating (NABERS, 2013). A base building rating covers the performance of central services and common areas, which are usually managed by the owner whereas a whole building rating covers tenanted space. In the Australian property market the NABERS rating is the rating most frequently referred to.

NABERS Energy rates the energy efficiency of commercial buildings by comparing them against a set of benchmarks developed using building performance data. NABERS rates performance on a scale of 0 to 6 stars. A 6 star rating is awarded for market leading performance, and represents a 50% reduction in greenhouse gas emissions or water use from a 5 star rating (NABERS, 2013). A zero star rating means the building is performing well below average and has considerable scope for improvement (NABERS, 2013).

Under the *Building Energy Efficiency Disclosure Act 2010*, there are mandatory obligations applicable to many commercial buildings. The Act, implemented through the Commercial Building Disclosure program, forms part of a package of measures to encourage building energy efficiency developed by the Australian government. The Commercial Building Disclosure is a national program to improve the energy efficiency of office buildings and is managed by the Department of Climate Change and Energy Efficiency. The scheme shares similarities with the EU Energy Performance Certificates (Warren, 2011). Sellers or lessors of office space of 2,000 square metres or more are required to obtain and disclose a Building Energy Efficiency Certificate (BEEC). A BEEC comprises a NABERS Energy star rating for the building, an assessment of tenancy lighting in the area of the building that is being sold or leased and general energy efficiency guidance. BEECs are valid for 12 months and must be publicly accessible on the online Building Energy Efficiency Register. The requirement to disclose a BEEC commenced on 1 November 2011. Mandatory Disclosure requires minimum standards of energy efficiency and the aim is to encourage the market to take up greater energy efficiency (Warren, 2011). Analysis of the Melbourne commercial building adaptation market from 2009 to 2011showed greater levels of energy efficiency and that the CBD program appears to be delivering on its aims (Wilkinson, 2012). Building Energy Efficiency Disclosure, NABERS and the 1200 Buildings Program together provide an environment in which sustainable retrofit is incentivised, encouraged and supported. This research sought to evaluate project outcomes to retrofits within the 1200 Buildings Program.

Existing office buildings and sustainability

Various office building typologies and energy profiles have been established (see table 1). Buildings are evaluated in terms of likely energy consumption patterns on the basis of size, configuration, methods of ventilation and the presence of air-conditioning. It is the case that Premium grade buildings, the best quality, in Australia (type 4 in Table 1) have the largest energy consumption and emissions however on a per metre squared basis lower grade offices, B grade, have higher emissions (PCA, 2008).

Table 1: Office typologies and energy profiles

Office typology	Size	Configuration	Ventilation	Energy consumption
1 – Naturally ventilated	100-3000m^2	Cellular	Natural	Lowest
2 – Naturally ventilated	500-4000m^2	Open plan	Natural	
3 – Air conditioned (standard)	2000-8000m^2		Air conditioned	
4 – Air conditioned (prestige)	4000-20000m^2		Air conditioned	Highest (3x lowest)

(Source: City of Melbourne, 200

When considering energy use within buildings heating, hot water and cooling are the largest consumers of energy across all typologies and the focus of efforts to reduce emissions. Energy use varies for tenants and managers depending on the lease arrangements which are termed 'gross' or 'net', and this creates issues in respect of the motivations for sustainable retrofit. The terms of net leases typically require the tenant to pay substantially all of the operating costs associated with the leased property. In other lease arrangements tenants may have an interest in, or even responsibility for, base building energy consumption and costs. Typical responsibilities for energy are outlined in Table 2.

Table 2: Responsibilities for energy in office buildings

Energy use for Buildings Managers	Energy use for Tenants
Heating and hot water (gas or heating oil) Cooling (chillers, air-conditioning plant, condensers and cooling towers) Fans, pumps and controls Humidification Lighting	Office equipment Catering Other electricity (print rooms) Computer communication rooms

(Source: Author)

Clearly managers have an opportunity to make significant energy savings. The savings which may be achieved can be as high as 70%, but are typically 30-50% (City of Melbourne, 2008). A retrofit which takes building performance from average (i.e. 3 stars NABERS) to best practice (5 star NABERS) represents a 38% improvement in performance (City of Melbourne, 2008). Typical measures are shown in table 3.

Table 3: Typical retrofit measures for office buildings.

Measure	Improvements
Air conditioning	Attend to running times, volumetric capacity and operating pressure.
Office appliances	Use more efficient equipment and reduce standby losses.
Insulation	Improve thermal performance
Heating and ventilation	Use building energy management system (BMS), use heat recovery and perimeter heating for preheating
Lighting	Use energy efficient fittings, timers, linear fluorescent lights for interior, exterior and parking lighting
Water heating	Use efficient systems and technologies such as solar

(Source: Author)

Retrofit issues

In retrofit multiple attributes are important and classified as economic, location and land use, physical, legal, social and environmental (Langston, 2007). Although costs can be traded against social and environmental gains, retrofit has to be economically sustainable (Bullen 2007). Furthermore based on whether the intention is to occupy or lease, different features become more or less important. Owner occupied stock has higher levels of retrofit attributes compared to speculative designs and a greater return on investment (ROI) over the whole lifecycle. Pre and post retrofit value is another success indicator, with a Hong Kong study finding a positive relationship between retrofit and value (Chau et al, 2003). Another economic indicator is the level of vacancy rates pre and post retrofit (Swallow, 1997). Depending on building condition, quality can be increased when measured as amenity features, services, fixtures and fittings (Bullen, 2007). Although quality, rental and capital value can be increased by retrofit, the extent and nature upgrade depends on building condition and location and the level of return on investment. To illustrate this point, a building in very poor condition will be more expensive to retrofit per metre squared than one in relatively good condition. If the building location is poor it may be the case that, although the building may be physically capable of retrofit, the costs make it unviable economically (Douglas 2006, Kincaid 2002).

Physical characteristics determine whether retrofit is possible and desirable, with some buildings having construction forms and materials making retrofit more expensive or challenging. Height, construction type and frame condition was important, with steel frames being more adaptable due to the ease of cutting into beams. Floor size was significant in London retrofits, where buildings with unusual floor plates or sizes were more difficult to retrofit and suited a fewer users (Kincaid 2002). Furthermore location of the services core affected the ability to sub-divide space, where a central location gives greater scope for sub-division minimising corridor and circulation space. A buildings degree of attachment to other buildings affects the ease or desirability for retrofit; with less attachment contractors work faster and cause less disruption to users. Access, or the number of entry and exit points, affected retrofit potential.

Location, considered in terms of proximity to public transport, is an environmental positive. Where little or no public transport is available the amount of on-site parking is significant (Douglas, 2006). Swallow (1997) concluded that retrofit is affected by tenure as it affected the funds a party is willing to invest. For example, an owner has an interest in perpetuity, whereas a lessee's interest lasts for the lease term. Institutional owners invest to maximise the ROI and probably use professional consultants for advice (Swallow 1997). Private owners may or may not use professional consultants, may reside overseas and may hold property for reasons, such as future development, or for rental income or capital growth and may engage in less retrofit; although this is unknown.

Retrofit is affected by occupation, with single tenants when leases expire there is opportunity to retrofit, however, with multiple tenants, it is unlikely all leases expire simultaneously and the building may be partly empty (and not income earning) before retrofit can occur. Alternatively, retrofit occurs with tenants in situ and requires careful management. Historic listing protects architecturally or socially significant buildings for society (Ball 2002) though retrofit can be more costly due to the expense of using traditional materials, techniques and craftspeople. Snyder (2005) found benefit in proactive policies and legislation in building retrofit while Bromley et al. (2005) found proactive policy and legislation enhanced retention of existing stock. Hostile factors included noise and asbestos, creating social and economic barriers driving up costs (Bullen, 2007).

The scope and extent of sustainable retrofit has increased and there is overlap with social, economic and location aspects. For example proximity to public transport provides environmental, locational, economic and social benefits. The most significant environmental impact of buildings is the GHG emissions associated with energy use (Douglas 2006). Building Energy Efficiency Disclosure legislation and NABERS are described above. Green Star is the voluntary Australian environmental rating tool similar to BREEAM in the UK and LEED in the USA. Retrofit offers a chance to reduce energy and water use and to recycle, to harvest and re-use water.

Research methodology

The aims of the research were; *to gain a deeper understanding of the sustainability improvements made to existing office buildings in the 1200 Buildings Program in Melbourne; and to evaluate outcomes to ascertain whether objectives were met.* This research embodies the characteristics associated with qualitative research (Silverman, 2000). The main features being a preference for qualitative data, analysing words and images rather than numbers, featuring observation rather than experiment. This type of research has a preference for meaning rather than behaviour, a rejection of natural science as a model and, a preference for inductive, hypothesis generating research (Silverman, 2000). This study involved the analysis of words and examined the research population's current practice regarding sustainable commercial retrofit as practised by participants of the 1200 Buildings Program. The aim was to gain a deeper understanding of practices with regards to sustainable retrofit. Given the low number of retrofits within the program, a quantitative approach was unsuitable as there were too few events for a statistically meaningful analysis (Silverman, 2000).

Research aim two was to evaluate project outcomes. This research is exploratory and best achieved through a content analysis of the published case studies of completed 1200 Buildings Program projects. The City of Melbourne provides case study exemplars of buildings in the program on its website. The results were interpreted through triangulation with the literature and previous Melbourne CBD research into retrofit practices undertaken by the researcher. All ten cases posted on the official 1200 Buildings Programme website in September 2012 were used in the analysis. This paper does not evaluate the 1200 Buildings Program per se; it evaluates the projects aims and outcomes of completed projects listed on the Program website.

Whilst interviews would have provided deeper and richer data, it was not possible to track down all those involved as some had moved practices or had left Melbourne. Retrofit involves an extensive team including financiers, investors, regulators, owners, project managers, designers, engineers and occupiers and the time required to interview all stakeholders was prohibitive. Furthermore accuracy of memory declines over time and recollections may be partial or incomplete at best, and inaccurate at worst (Robson, 2003). The documentary and textual analysis provided a useful source of material documenting the measures which were undertaken. This hermeneutic approach contends that the most basic fact of social life is the meaning of actions. Social life is founded by social actions, and actions are meaningful to the actors and to the other social participants. In the social sciences researchers need to attend to the interpretation of the meanings of social actions (Webber, 1947, Dilthey 1989). Sherratt (2006) affords a comprehensive debate of hermeneutic philosophy of social science. Finally, it was the intention to gain a deeper understanding of what had happened rather than what individuals thought about what had happened and the case study approach analysing publicly available textual data was best suited.

Case study research is exploratory or explanatory (Robson, 2003). The data relates to the retrofit measures undertaken with regards to sustainability and the property attributes of the buildings. The analytical strategy adopted here is partly explanation building and partly pattern matching with previous patterns of building retrofit practices in the Melbourne CBD. Internal and external validity are addressed as follows; given the primary purpose of the case studies was to observe and describe what measures and outcomes internal validity was not relevant (Robson, 2003). External validity centres on the representativeness of the cases and how they can be extrapolated to the wider population. Here, all cases posted on the 1200 Buildings Programme website on 28th September 2012 were analysed. In this way the research has external validity because all cases are considered; it is a census of all projects completed at the time within the program for which data was available. Sampling was not an issue and the findings are representative of the projects completed to date. Clearly all research has limitations and in this case, reliance on publicly available data allows the researcher to determine what has occurred but not to understand at a deeper level why a measure has been selected or omitted from decision making.

Results

Case study properties ranged from 24 to 116 years, (see figure 1) with an even distribution in age, which shows that the 1200 Buildings Program met the needs of retrofitting stock across all age ranges. Properties were mainly sited in the low prime areas, though fringe locations also featured. They ranged from Premium to ungraded and show the 1200 Buildings Program caters for all quality scales in the Property Council of Australia building quality matrix. The typologies of the buildings as identified in Table 1 above, included three type 4 properties (air conditioned prestige buildings) and seven type 3 properties (air conditioned standard).

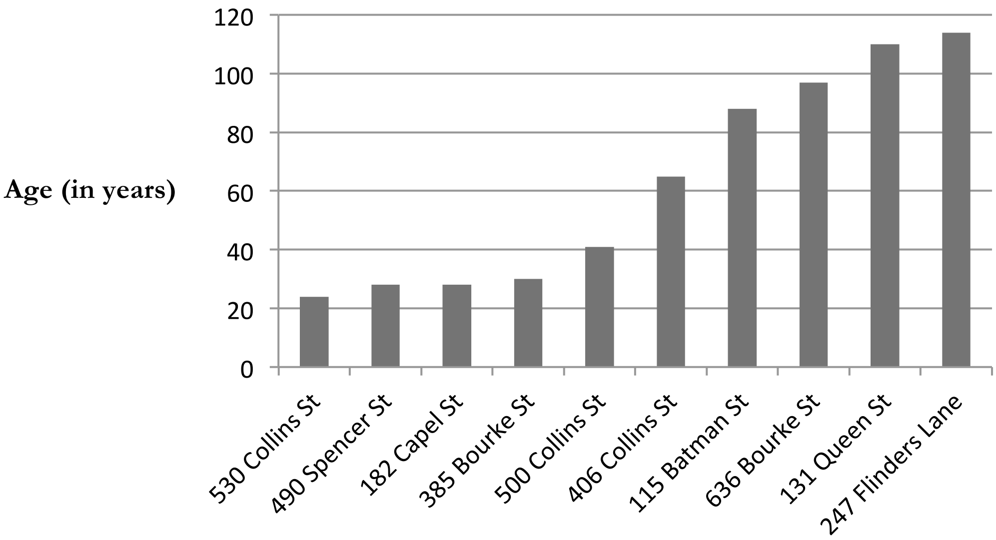

Figure 1: Case study building by age and address.

The PCA grade and location the case study buildings is shown in Table 4 below. It is apparent that the case buildings were located in the less desired fringe areas featured in four cases and; conversely, in the more desirable low prime locations in fives cases. Overall this indicates that the quality of the location had neither a postive or negative effect on whether a property was retrofitted.

Table 4: PCA grade and location of case study retrofit projects.

Case study building	Property Council of Australia (PCA) Grade (Premium, A, B, C, D, Ungraded, Not applicable)	Location (Prime, Low Prime, High Secondary, Low Secondary and Fringe).
530 Collins St	Premium	Low Prime
490 Spencer St	NA	Fringe
182 Capel St	U	Fringe
385 Bourke St	A	Low Prime
500 Collins St	B	Low Prime
406 Collins St	NA	Low Prime
115 Batman St	U	Fringe
636 Bourke St	NA	Low Prime
131 Queen St	B	Fringe
247 Flinders St	NA	Low Secondary

(Source: Author).

Table 5 summarises the retrofit objectives and the retrofit project outcomes. Though the scale and age of the buildings varied many objectives were similar, for example, in seven of the ten cases it was important to attain a recognised market environmental rating. The economic objectives were lower running costs and attaining ROI which shows that owners were focussed on financial considerations. Two projects were heavily dependent on Green Building funding and would otherwise have been reduced in scale or abandoned.

Table 5: Summary of objectives and outcomes of case study retrofit projects.

Case	Objectives	Outcomes
530 Collins St	Achieve a 4.5 star NABERS Energy rating.	None listed
490 Spencer St	Create a zero GHG building	On sunny days building is zero carbon. Water consumption is being tracked to compare to similar stock. Financial savings from better maintenance are considerable. Higher rents achieved post retrofit and lower running costs
182 Capel St	Reduce carbon footprint. Reduce carbon emissions by at least 50%. Attain a 4.5 star NABERS Energy	A NABERS rating was to be conducted at the end of 2011 with target of 4.5-5 star NABERS Energy. Water reductions saving 900 litres/day. Tenants are happy and have decided to stay. Mechanical maintenance costs reduced from $3,200 pa to <$1,000 pa. Lighting maintenance reduced from $1,200 pa to $500 pa. Project needed an 8% yield on investment which has been achieved to date.
385 Bourke St	Achieve 2.5 NABERS Energy rating.	41% reduction in CO_2 and a NABERS energy of 3.5 stars. 3.5 Star NABERS Water achieved. Works brought up maintenance issues which are being addressed. Increase in NABERS Energy rating opens up the building to a larger market of tenants.
500	Achieve A-grade	Energy was modelled to achieve a 30% reduction in AC, 50%

Collins St	building. Attain high environmental efficiency. Maximise tenant retention during upgrade to maintain optimum cash flow and provide pool of long-term tenants. Elevate tenancy profile by increasing the average size of tenancy, length of tenure and quality of tenant achieve a justifiable ROI.	reduction in lighting and 15% reduction in HW usage. Water modelled to achieve 40–50% savings. Sustainability Victoria productivity study in 2007-08 found a 39% reduction in sick days and 9% improvement on typing speeds. Reduced maintenance costs Rental value of the refurbished space has increased. Occupancy rate did not fall below 70%, and building has fewer tenants now. Gained a 5 Star Green Star rating. Important to communicate with tenants. Need strong project management leadership. Manage and control noise and temporary service shut downs. Engage an ESD consultant to advocate. Engage independent commissioning agent.
406 Collins St	Improve energy efficiency. Achieve a 4 star NABERS energy rating. Reduce carbon footprint and use green power sources.	Energy performance should be halved or as low as 25%. Achieved 5.0 NABERS Water rating. Educate tenants to accept warmer ambient temperatures in summer and cooler in winter for savings. With HVAC improvements and installation of BMCS maintenance will be faster and less costly. There will be significant energy savings, but the owner is unsure of direct financial ROI. Viability of the project hinged on the Green Building Fund grant.
115 Batman St	Introduce state of the art engineering services with very low levels of energy consumption. Provide comfortable working environment to enhance productivity Achieve 5 Star Green Star and 5.0 star NABERS Energy ratings.	Chilled beams work well and are superior to the third floor VAV system. Base building lighting consumes less than 2 watts per m^2 per 100 Lux. Building performs better than 5.0 stars NABERS energy. Very positive feedback from staff about the work environment. Maintenance straight forward.
636 Bourke St	Develop an environmentally efficient building in the use of energy and water. Minimise noise transfer in and around the building.	Energy consumption reduced to 36 Mj/day. Water consumption is 123 litres/day. Savings from reduced water use and water heating costs is significant. Green attributes make it attractive to guests. Maintenance costs may be higher than previously. Energy efficiency of fabric is paramount and should be addressed before services are changed.
131 Queen St	Make safety and essential services code compliant. Achieve to a 4/ 4.5 NABERS rating. Reduce running costs.	40% reduction in energy costs predicted. Green roof top valued by users. Savings of A$50,000 p.a. anticipated. Key issue was the complex ownership structure.
247 Flinders Lane	Achieve a minimum NABERS 4 star.	None listed

Discussion

Overall, seventy measures or building improvements were implemented to all ten case study properties (Wilkinson, 2013) and these measures can be categorised as environmental and social. For a complete evaluation of all measures undertaken readers are referred to the full research report (Wilkinson 2013). Many environmental measures were implemented due to potential economic benefits confirming Swallow's study (1997) of the importance of financial imperatives. Sixty one percent of measures related to the services, whilst 73% related to energy efficiency; reflecting the importance of energy efficiency in NABERS and Green Star ratings as well as the aims of the 1200 Buildings Program. The extent of energy efficiency confirmed Douglas' (2006) observation that energy is the most significant sustainability issue as well as indicating poor performance of existing stock.

Water economy featured less and accounted for 11% of all measures. Measures to the fabric were associated with energy efficiency. Building fabric measures occurred 17% of the time and involved access challenges and disruption to occupants, as well as being expensive confirming Bullen's study (2007). However these measures offer a more long term solution than upgraded services which require maintenance and will be replaced within 20 years.

Social sustainability featured in four cases (6% of all measures) in terms of amenities provided to users related to improved internal environmental quality (IEQ). One project featured a roof-top garden which provided a pleasant social space, however the rationale for inclusion included environmental benefits of reducing the heat island effect, insulating the roof and reducing energy use (an economic benefit). Finally one project featured a building which housed small businesses which were driven by social justice and equity issues; thereby having a positive social sustainability contribution. Overall social sustainability had a lower profile within the retrofits.

> Overall owners were motivated by different drivers, and the predominant initiating party was built environment consultants seeking to develop knowledge and experience in sustainable retrofit whilst upgrading their offices. Fringe locations featured more prominently in the cases compared to Wilkinson's 2012 study of 1422 Melbourne office retrofits undertaken between January 2009 to July 2011). The 'low prime' location is where most retrofits occur and this compliments earlier study (Wilkinson 2012). In the projects examined and completed within the 1200 Building Program there was a preference for non-heritage buildings confirming the additional requirements for adaptation noted by Ball (2002) may deter owners from adapting until absolutely necessary. Ungraded buildings were most likely to be worked on (50%), followed by B grade stock (20%) and overall the 1200 Buildings Program is reaching all grades of stock which is vital if the whole stock is to be adapted over time.

Conclusions

The aims of the research were; *to gain a deeper understanding of the sustainability improvements made to existing office buildings in the 1200 Buildings Program in Melbourne; and to evaluate outcomes to ascertain whether objectives were met.* In respect of the first aim; the understanding gleaned was the focus on energy efficiency driven by economic and environmental drivers. Water economy was less important, followed by social sustainability. Energy efficiency measures focussed on services rather than fabric which one case study noted was of paramount importance, though more expensive.

With regards to the second aim; the evaluation of projects outcomes concludes that;

i. Economic objectives were met in many cases with energy and water costs reduced, maintenance costs reduced in all but one case, higher rents recorded and yields achieved. In two cases there were concerns regarding returns on investment and these projects also relied on receipt of the Green Building Grant for viability. Economic issues such as yields and returns on investments were important critical success factors in some of the projects.

ii. Environmental outcomes were achieved and exceeded in some cases NABERS ratings exceeding targets. Energy and water use was reduced in all cases and one building is zero carbon on sunny days.
iii. Social outcomes are positive with higher productivity and improved IEQ measured in one post occupancy evaluation. Staffs were also noted to be 'happier' in the retrofitted buildings. The green roof had worked well and the hotel building attracted some visitors on the basis of its 'green' credentials.
iv. Physical issues were not related to fabric performance though it was acknowledged as important the costs of retrofitting fabric are higher. This reflects the current economic climate and timeframe for returns on investment. Other physical factors of note were hostile factors such as noise generated by the construction works disrupting tenants in situ. Noise issues identified as hostile were challenges in some projects.
v. Management issues which arose during the retrofits were the difficulties of getting multiple owners to agree on retrofit measures, the need to communicate effectively with and educate tenants about the process and projects, the need for strong project management, the need for advocates to promote ESD, the need for independent commissioning agents to verify data. Retention of tenants was also positive in the cases. In some projects the aim to increase occupancy was achieved the level of vacancy rates changed pre and post retrofit.

Substantial improvements have been afforded to buildings within the program in terms of energy efficiency. Finally Snyder's (2005) finding that there is a relationship between proactive legislation and change in the adaptation market is supported in this study; here the realisation is buildings with enhanced sustainability. The rate of retrofit within the program however, is not as high as originally anticipated and further changes to the program may be required to increase the numbers of buildings retrofitted in order to meet the policy target.

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