Transforming the commercial property market in Australians cities: Contemporary practices and the future potential in green roof retrofit

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Overview

Australia needs to increase the adaptation of the existing commercial property stock to reduce building related greenhouse gas emissions (CSIRO, 2002). Some of these emission reductions could be achieved by retrofitting green roofs. Given that Germany had over 10 million square metres of green roofs by 1996: have we been missing an opportunity in Australia?

Green roofs offer many benefits such as; storm-water management, improve water run-off quality (Mentens, 2006; Hilten, 2008), reduce the urban heat island effect (Susca et al, 2011), extend the lifecycle of the roof membrane (Kohler, 2008:91), and improve thermal performance (Castleton, 2010:62). There are social sustainability benefits through the provision of spaces for people to enjoy. Roofs can account for 40-50% of impermeable surfaces according to Stovin (2010) and typically around 15% of office stock in Australian city centres has the potential for green roof retrofit (Wilkinson & Reed, 2009).

This chapter defines green roofs and examines issues facing Australia in respect of retrofit, climate adaptation and sustainability. The transformation of the commercial property stock is examined in respect of the barriers, incentives, legislation and opportunities, which exist currently. A series of illustrative case studies demonstrate how roofs have been retrofitted for bio-diversity, urban food production, stormwater attenuation and thermal performance. Penultimately, an examination of policy and incentives at city and building scale reveals the future potential for green roof retrofit in Australian cities. The conclusions summarise where we are and posit an agenda for the future.

1. Introduction

Australia, like many other developed countries, needs to increase the adaptation of the existing commercial property stock to reduce building related greenhouse gas emissions (CSIRO, 2002). For example Melbourne aims to be carbon neutral by 2020 (ARUP, 2008) with a target of 1,200 building adaptations to deliver 24% greenhouse gas (GHG) emissions reductions through sustainability measures retrofitted to the existing stock. Some of these emission reductions could be achieved by retrofitting green roofs. Given that by 1996 Germany had over 10 million square metres of green roofs: have we been missing an increasingly important opportunity in Australia?

A green roof offers a building and its surrounding environment many potential benefits. These include: storm-water management; improved water run-off quality (Mentens et al, 2006; Hilten et al, 2008) improved air quality in the urban canyon (Yang, 2008:88); a reduction of the urban heat island (UHI) effect (Takebayashi & Moriyama, 2007; Susca et al, 2011); longer durability of a roof membrane (Kohler, 2008:91); and improved thermal performance (Castleton, 2010:62). Other benefits also include enhanced architectural interest and biodiversity (Castleton, 2010:62), re-introducing the natural world into the anthropogenic environment and the associated social sustainability benefits through the provision of spaces for people to enjoy.

Roofs can account for up to 32% of horizontal surfaces in built-up areas (Frazer, 2005), or 40-50% of impermeable surfaces according to Stovin (2010), and typically around 15% of office stock in Australian city centres have the potential to be retrofitted with as green roofs (Wilkinson & Reed, 2009). That is, the roof slope is below thirty two degrees and also meets other criteria in respect of access, safety, structural capacity, orientation and overshadowing.

This chapter defines green roofs and examines the specific issues facing Australia in respect of retrofit, climate issues and sustainability. The next section, explores the barriers, incentives, legislation and opportunities which exist in this market currently. A series of illustrative case studies from major Australia cities then demonstrate how roofs have been retrofitted for bio-diversity, urban food production, stormwater attenuation and thermal performance. The penultimate section describes the future potential for green roof retrofit in Australian cities, through the examination of policy and incentives at city and building scale, as well as through best practice guidance for practitioners. The conclusions summarise where we are and where we need to go forward.

2. Green roofs defined

A green roof is defined as a roof that uses plants which range from moss, lichen, sedum, trees, shrubs, flowers and bushes. Green roofs are referred to by a number of different labels, such as eco-roofs, nature roofs or roof greening systems. In short, green roofs are a living vegetated roofing alternative to traditional impervious roofing materials. A green roof is comprised of:

- a roof structure;
- a waterproof membrane or vapour control layer;
- insulation (if the building is heated or cooled);
- a root barrier to protect the membrane (i.e. made of gravel, impervious concrete, polyvinylchloride (PVC), thermoplastic polyolefin (TPO), high-density polyethylene (HDPE), or copper);
- a drainage system;
- a filter cloth (non-biodegradable fabric);
- a growing medium (soil) consisting of inorganic matter, organic material (straw, peat, wood, grass, sawdust), air; and
- plants.

Figure 1 illustrates a typical green roof section.

Figure 1: Typical green roof section

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(Source: Wilkinson, forthcoming)

Green roofs can be extensive or intensive. Table 1 summarises the characteristics of extensive and intensive green roofs. Extensive green roofs are essentially roof gardens, which typically provide space for people, and the depth of soil or substrate layer provided varies between 50 to 200mm and requires artificial irrigation. Intensive roofs, on the other hand, often require a deeper planting medium greater than 150mm. There is a third type, a semi intensive green roof that is a hybrid of the intensive and extensive roofs. It is vital to keep the plants alive in the long term, and this is a challenge because it requires an active and ongoing commitment to a maintenance and irrigation regime (Skyring, 2007). Standard soils are not used because they are too heavy for roof structures and a calculated ratio of aggregate (e.g. shale, vermiculite, etc.), organic materials, air and water is used. The correct growing medium is critical and may be challenging in some Australian cities due to climatic conditions particularly excessive seasonal rainfall (e.g. as in the Northern Territory) or minimal rainfall (e.g. as in Victoria).

Table 1: Characteristics of extensive and intensive green roofs

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(Source: Wilkinson and Reed, 2009).

3. Retrofit issues in commercial stock in Australian cities

Suitability for a green roof retrofit is dependent on factors such as the roof type, size and slope. Extensive and intensive roofs require a minimum slope of 2% and roofs with less than 2% slope require additional drainage measures to avoid water logging (University of Florida, 2008). Additional requirements are good drainage, lightweight growth media, waterproofing, additional structural support, rainwater harvesting and the use of drought or heat tolerant plants. Longevity of the structure, drainage and waterproofing system is essential because replacement costs are high. Green roofs are designed to last a minimum of 50 years which is approximately twice the life cycle of a roof covering such as bituminous felt. Overall the following criteria are taken into account when determining whether a roof is suitable for retrofitting: position of the building, location, orientation of the roof, height above ground, pitch, weight limitations or load bearing capacity of the building, preferred planting, sustainability of components and levels of maintenance. The first six criteria are purely physical attributes of buildings and the last three are related to building owner / client desires and the ability to maintain (Wilkinson and Reed, 2009).

Other factors such as climate influence the potential to retrofit a green roof, and the type of green roof it is possible to provide. Australia has eight climate zones and is one of the most climatically diverse nations. For Australia, major flooding occurred over the densely populated East Coast area for two consecutive years from 2010. On the west coast, the State Emergency Service responded to over 100 requests for flood-related damage when 29 mm of rain fell in half an hour at Perth Airport (Bureau of Meteorology, 2012). In March 2012 the Bureau of Meteorology issued Flood Warnings and broad-scale Severe Weather Warnings for heavy rain and flash flooding over much of northern and eastern Queensland. The estimated costs of remediating flood damaged buildings was A$ 20 billion (Companies and Markets, 2011). Another example, excessive heat can cause heat to become trapped under the tree canopy in urban canyons formed between high-rise commercial property; and a consequence is increased mortality in Australian cities caused by heat stress (ABC, 2014). Thus some cities benefit more from green roof retrofit to reduce UHI whereas others would benefit more from stormwater attenuation retrofit.

Commercial stock in the city centres is varied, dating from the early to mid 1800s onwards. Institutionally owned stock tends to be more contemporary, medium to high-rise, detached and concrete framed. This stock also is more likely to have environmental ratings either for energy and water use (NABERS), a requirement of the 2010 Commercial Building Energy Efficiency Disclosure legislation (Warren and Huston, 2011) or the voluntary Green Star rating. This stock has the most potential, physically and financially to be retrofitted (Wilkinson, 2012). Privately owned commercial stock tends to be smaller in scale and is more likely to have pitched roof structures. In commercial stock, owners and/or property / facility managers need to consider maintenance requirements. With green roofs long-term maintenance is essential, and the building owner is recommended to enter into a minimum five-year maintenance contract, to ensure the correct processes are undertaken and that planting is properly established. Finally there are budget considerations, which include how much the owner is willing to pay for a green roof. And here, a whole life cycle costing approach may be useful to determine the overall costs and may offset the higher initial construction and installation costs.

4. Drivers for green roofs

There are many benefits of green roofs, one of which is the reduction of external noise for occupants, as the substrates and vegetation absorb airborne noise. In addition, water harvesting is possible from green roof systems. It is possible to design the system to collect rainwater, which can irrigate the planting systems or, in some climates, can be used within the building to reduce overall water usage from the mains systems. With regards to stormwater management it may be possible to reduce the volume of stormwater between 50-85% (Lamond et al, 2014a). In addition, the percolation and filtering of stormwater improves the quality of stormwater entering the main drainage systems (Wilkinson and Reed, 2009).

Energy conservation of between 15 to 30% has been recorded in buildings with green roofs (Niachou et al 2001). As a result of less energy use, greenhouse gas emissions are reduced. The amount of energy conserved varies due to variations in climates, variation in the depth of green roof substrates and also differences in base building construction and performance (Niachou et al. 2001). Green roofs can lower surface roof temperatures by 10 – 15.5^{o} C, which means less heat gain occurs inside the building and less cooling is required as a result. Lower temperatures are recorded where darker vegetation is used (Niachou et al. 2001). On a larger scale, the reductions in energy usage and external surface temperatures of roofs can lessen the UHI effect of city centres. The city of Toronto in Canada estimated that a city wide application of green roof technology could reduce the UHI by 0.5 to 2.0 ^{o}C (City of Melbourne, 2014). UHI is caused when the heat from the sun is absorbed into buildings by the roof and then released back into the air leaving city centres up to five degrees hotter than outer suburbs and rural areas. The UHI is exacerbated in high density high rise city centres where hot air is trapped at lower levels under tree canopies creating even hotter temperatures; this phenomenon is known as the urban heat canyon. Pollution abatement is another benefit, where airborne particulates are caught within the vegetation and pollutants are filtered naturally through the planting systems. Furthermore air quality is improved as the plants reduce the levels of nitrous oxides and volatile organic compounds (Peck & Callaghan, 1999). A London study of green walls found a reduction of 15-40% in Nitrogen Dioxide and 23-60% reduction in particulate matter (Pugh et al, 2012). A final environmental advantage is the contribution to bio-diversity within the city with the creation of habitats for birds and invertebrates.

For owners seeking to promote sustainability, and to offset the impact of environmental obsolescence as well as gaining accreditation through the green rating tools, some ratings like Green Star award innovation points for green roofs (GBCA, 2015).

Advocates of green roofs posit that green roofs have high aesthetic values, and add colour and vibrancy to colourless rooflines. Humans derive enjoyment from being able to view natural environments and the provision of green roofs allows occupants in dense urban centres the chance to enjoy the visual amenity of green roofs and gardens. This phenomena is known as the biophilia effect (Kellert and Wilson, 1993). Other social and community benefits are increased worker health, productivity and creativity (Peck & Callaghan 1999).

On a practical level, green roofs extend the useful life of the base roofing material because it is covered and protected from the aging effects of exposure to the atmosphere, weather and pollutants (Wilkinson et al, 2015). Furthermore financial savings are made because less maintenance of roof coverings is required. Other economic benefits are employment opportunities created for a wide range of professionals including suppliers and manufacturers of green roofing materials as well as engineering professionals.

Costs were noted as a barrier above, however some incentives now exist to encourage owners to retrofit sustainability. In Melbourne and Sydney, these are known as Environmental Upgrade Agreements or EUAs (City of Sydney, 2015). In an EUA building owners can access capital for commercial building improvement projects, allowing owners and tenants to benefit from a more sustainable and efficient building. EUA loans are provided by a lender at favourable rates of interest to fund works that improve the environmental performance of an existing building. The repayments are collected through rates paid by tenants. To date there has been a disappointing uptake of EUAs within the sector, however it has coincided with the global financial crisis and activity across the sector as a whole is much weaker (Van der Heijden, 2014). A Green Roof Policy was published in Sydney in 2012, a first in an Australian city, and a Green Roof Technical Officer was employed to document, promote and encourage the uptake of green roofs in the city. The officer was supported by a Technical Advisory Panel (TAP), which was of comprised of State and Local Government officials, professional consultants and academics. The officer and TAP were supported for a two year period only, and a longer period would have enabled green roofs to become more embedded within the Sydney practice. Similarly a green roof policy exists in Melbourne. However no other Australian city has yet to formally adopt any policy or appoint a dedicated officer for the technology. As noted some cities such as Toronto in Canada and Basel in Switzerland have mandated green roofs in certain circumstances and this may be a viable solution elsewhere and for retrofit (City of Melbourne, 2014).

One barrier, a lack of legislation around sustainability, is gradually being overcome although it is quite possible that legislation will be repealed. The innovative and world leading Carbon Tax is one such victim of the current Australian government's attitude towards sustainability legislation: it was repealed shortly after their election victory in 2012.

A question that frequently arises is: do mandatory or voluntary approaches work best with regards to sustainability measures in buildings? In 2010 a Commercial Building Energy Efficiency (CBEED) Mandatory Disclosure Act (Commonwealth) was passed, requiring all owners of premises over 2000 m^2 to disclose in public a certificate relating to the buildings energy rating under the NABERS rating tool. The certificates are known as Building Energy Efficiency Certificates or BEECs and are very similar to the European Energy Performance Certificates (EPCs) (Warren and Huston, 2012). A 2012 study of commercial office building adaptation in Melbourne from 2009 to 2012 showed that NABERS was more important than Green Star when it came to drivers to adaptation (Wilkinson, 2014a). This shows that mandatory approaches appear to work more effectively than voluntary ones in Australian commercial building adaptation or retrofit. On this basis, it is posited that a mandatory approach to green roof retrofit could work.

Opportunities for greater take up of green roof retrofit include the increasing importance of Corporate Social Responsibility (CSR), which encourages private companies to adopt measures that enhance social and environmental sustainability. Green roofs have environmental and social benefits and tick two boxes at once. In summary the drivers and barriers to green roof retrofit are environmental, economic, social and physical and are illustrated in Table 2, where drivers and benefits outweigh the barriers.

Table 2: Barriers and drivers to green roof retrofit

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(Source Adapted Wilkinson and Reed, 2009).

5. Transformation of the commercial property stock

How can we transform the commercial property stock? A series of barriers and drivers to the adoption of green roof retrofit are explored in this section of the chapter. The barriers to green roof uptake rest with a number of stakeholders. For example, there is a perceived lack of awareness within the development industry and built environment professionals, as well as a poor appreciation by government officials in some cities and the general public regarding the benefits of green roofs. Furthermore there have been few Australian incentives supporting green roof diffusion and little debate as to whether mandatory or voluntary approaches work best (Wilkinson, 2014. Skyring, 2007). In Basel and Toronto, planning policy requires that all new flat roofs meeting certain criteria, above 350m^2 in Toronto, are green roofs and thereby presents a pro-active approach to encouraging green roof technology (Banting et al, 2005).

Another perceived barrier is that green roofs have higher construction costs. Skyring (2007) estimated that costs are double those of a standard roof. For new construction on a small green roof, costs are estimated to be \$150-450/m^2 plus costs of building and planning permits, lifts and cranes and consultants fees (City of Melbourne, 2014). The costs of strengthening works to concrete roofs vary between \$450-650/m^2 and for steel roofs around \$250/m^2, with additional columns to support roofs being \$2500-6500 each (City of Melbourne, 2014). Historically the market does not recognise or appropriately account for the benefits of green roofs, and rather than adopting a life cycle assessment which includes accounting for the environmental and social benefits, typically the economic case is the only one considered (Peck & Callaghan 1999).

One of the biggest barriers to adopting new methods and techniques in property and construction is a risk aversion to, or a fear of, the unknown. There are no long-term documented examples of green roof technology for stakeholders to use as evidence (Wilkinson and Reed, 2009). For example, whilst claims of lower maintenance costs appear reasonable and sound, there is no historic evidence to conclusively support this claim and the notion that green roofs are a maintenance liability prevails. When green roof technologies are adopted within building codes and technical standards are produced, it is envisaged that confidence will be enhanced in the sector. Another issue is related to the technical data limitations for calculating the benefits associated with green roofs. The benefits noted above achieved through the installation of green roofs vary according to a building's location, climate and construction type. However the anticipated savings may not be fully realised in practice and concern over this factor may deter some from adopting the measure.

6. Valuation Issues

A further perceived barrier is the issue of value in respect of green roofs. The commercial property market is primarily motivated to act by economic factors. When evidence exists that measures add rental and so capital value to a property, there is a greater incentive for uptake and adoption. Rooftop space is generally considered to add value to a building when there is an associated income stream such as rental income for telecommunications installations, signage rights or perhaps as a childcare playground (Williers, Personal Communication 2015). The relationship between any such income and additional capital value is dependent upon the certainty and stability of the income stream. Naturally, the rental level that can be economically paid by the tenant is a reflection of the underlying profitability in the relevant "rooftop" enterprise.

On this basis, attributing value to a "green roof" would require a third party to take a lease or licence agreement over the space and then, at their own costs, fit the roof for their intended use. The underlying rental would be a reflection of the economics relative to the agricultural / horticultural enterprise and the supply and demand of rooftop space fit for purpose. At face value, it seems unlikely that this would be a viable proposition in terms of food production, particularly given the likely maximum scale of any proposed enterprise, the direct set up costs involved and overlaid with other complexities such as the legal issues involved with sharing roof space with existing users, access restrictions and building security.

Possibly, uses such as for resting / circulating indoor plants may be viable at a low rental level. In the future, medical marihuana may be suitable given inherent access, location and security related benefits present in commercial buildings. Based on retail product pricing across the USA, medical marihuana would seem a highly viable proposition.

A second, and less directly quantifiable, approach to assessing any rental or capital value increase is the positive impact green roofs may have on the overall appeal of a building within the tenancy market: the so-called 'non-tangible' benefits. This could be simply from the additional aesthetic appeal or by incorporating associated recreational / entertainment facilities, or perhaps by allowing building occupants to take a more active role. Green roofs positively impact sustainability ratings available to tenants and owners in the Green Star rating system as an innovation point (GBCA, 2015).

Financial benefits under this approach are difficult to measure in terms of any additional rental income or capital value attributable specifically to green roofs. Nevertheless, within a basket of sustainable or other building attributes, they may make a building more desirable to tenants, leading to reduced vacancy periods and energy costs in comparison with competing buildings. The difficulty in measuring the rental and capital value impact of a single building attribute reflects the multiple attribute differences that generally exist between comparable buildings and the fact that rental negotiations do not apportion the rental agreed against individual building attributes. As such, identifying the rental value of one attribute from the basket of attributes provided by reasonably comparable buildings is often an impossible task. Some attributes, such as a panoramic view, are more identifiable, however others, for example the nature of the building foyer, are more difficult.

A large data set is required, wherein the particular attribute being tested can be distinguished from buildings without that attribute. This approach is reflected in research, which originally identified the value benefit of incorporating energy efficiency measures within commercial buildings (Eichholtz, et al., 2013; and Newell et al, 2011). These studies were undertaken in the US and Australia and contributed towards the establishment of the Investment Property Databank (IPD)'s "Green Property Investment Index" in 2011 which now informs owners and investors in the commercial property sector. Traditional valuation approaches involve using historical transactions as an evidence base and experience has shown that this makes it harder to initially establish value in innovative building technologies (Warren-Myers, 2013).

A factor presently attracting industry and academic attention is attempting to quantify productivity benefits attributed to high Indoor Environmental Quality (IEQ) performance in commercial buildings (Bordass et al, 2001). Productivity can be measured in dimensions such as staff turnover, absenteeism, and how occupants physically and mentally feel at various times of the day relative to local environmental conditions prevailing within the building at those times. Logically, an improvement in the physical environment such as access to, or views over, green roofs may add something towards the same agenda. The underpinning rental / capital value argument is based on taking a more holistic view of how IEQ related building performance impacts on operational costs of building users and attempts to attribute measurable business cost savings to the same. This approach may possibly be a more accurate way of measuring the true benefits of physical building attributes and involves factors such as IEQ, building responsiveness to external climatic conditions and user comfort.

Demonstrable productivity benefits attributed to a specific building attributes are likely to have a far greater impact on tenancy decisions and rental / capital values in the long term as labour costs are much higher than rental costs in the productive use of a commercial premises. To illustrate the point, typical labour costs are likely to be upwards of AU$5000 per m^2 in a commercial building where gross rental costs for the same may be $500m^2 (say 10% of labour costs). Accordingly a ten per cent increase in productivity attributed to a high IEQ may equate with a 100% increase in arguing the underlying rental value. On the basis that high IEQ performance is shown to lead to increases in user productivity, the financial case for using this performance as a dimension of rental value and so capital value will be established. Nevertheless isolating IEQ performance (and building attributes such as a green roof) from other variables in measuring employee performance is a complex task.

Some pioneering work exists in Canada with regards to ascribing a monetary value to green roofs (Tomsky and Koromowski, 2010), which sets out techniques for valuing sound attenuation, stormwater attenuation, air quality and associated health improvements, as well as greenhouse gas sequestration. Tomsky and Koromowski (2010) take the view that non-market or indirect valuation techniques must be adopted. Whilst a non-market approach may be useful in informing policy makers, it is unlikely to form part of developer / investor / tenant decision making processes or stimulate voluntary investment in green roofs in the sector. The value in this work lies in establishing costs and benefits of potential policy measures.

7. Retrofitting Investment To Date

Commercial property market practices are primarily motivated by relatively short-term market economics. A parallel may be drawn with market experience in regards the uptake of energy & water efficiency retrofitting in Australia. Recent experience points to the following factors as the likely drivers for sustainable retrofitting of commercial buildings:

1) Nature of building owner (e.g. institutional investor versus private investor).
2) Tenancy profile / likely tenant profile for a specific building.
3) CSR branding by fund managers, listed ownership entities & tenants.
4) Introduction of mandatory disclosure legislation & BEECs.
5) Physical attributes of a specific building and likely economic life.
6) Length of tenure under existing leases (how long until vacancy becomes a risk).

In reality, adoption of energy efficiency and other sustainability measures in the Australian commercial sector has been largely limited to buildings which are likely to remain desirable to publically listed and government tenants and fall within the Premium, A and B grade sectors of the office market (Wilkinson, 2014a). These buildings tend to have floor plates in excess of 1000m^2, be located in Central Business District locations and date from the 1980s onwards (Wilkinson, 2014a). Whilst energy and water efficient retrofitting of commercial buildings in this sector has now been widely adopted, the economic case in regards to energy and water cost savings, even here, is marginal. The primary motivation appears to stem from:

1) Corporate branding benefits for owners and tenants;
2) Mitigation of vacancy risk by owners (where sustainability ratings are a ‘must have” part of tenancy market location decisions);
3) Risk management by owners and tenants against rapidly escalating energy costs (particularly under a carbon tax regime);
4) Energy / water efficiency upgrade forming part of an overall building upgrade and re-positioning of the property or portfolio within the investment market; and more recently;
5) Impacts on investment decisions resulting from the establishment of Green Building Index in 2011 which has favourably reported the comparative financial performance

of NABERS rated commercial buildings held by listed investment funds /property trusts in comparison to the overall sector performance.

On the other hand, with C grade stock and below, the structure of ownership and tenancy markets are very different and motivation for the uptake of other than minimal energy efficiency retro-fitting (lighting) is not a serious economic consideration or perhaps a viable option (Wilkinson, 2014a. Wilkinson, 2014b). The physical building assets are typically inferior in terms of structural capacity, floor plate size and existing building technology. Additionally the inferior physical building attributes predominating in this sector are likely to substantially impact costs to retro-fit green roofs and the economic viability of any environmental benefit despite various incentive schemes, EUA's and the like. Further, owners and tenants in this sub-sector are unlikely to have the human or financial resources to investigate or invest in sustainability options in a comprehensive manner.

Accordingly the uptake of green roof retrofit is likely to be largely limited to more contemporary and substantial buildings where financial, corporate branding, environmental and perhaps productivity benefits, if demonstrated, are considered within owner and tenant decision making processes. This dynamic appears to be reinforced by market evidence from Basel and other cities where green roof retrofitting activity has taken place for the longest time to date.

8. Taxation Considerations

Annexed to the uptake for green rooftop space providing added value to a building, there is also another aspect to consider for the commercial property market. In particular, this is the potential to introduce tax incentive benefits for green roofs. These tax incentives can be at both Federal level, where there is a benefit available for taxable income derived from the building; and also at state level with incentives for property developers to receive the opportunity for additional floor space ratio or similar. For instance, in America, the Energy Policy Act 2005 (Federal), provides Federal tax credits of US$1.80 per square feet if certain conditions and standards are met. Additionally, on a State level, there are varying bonuses such as in Texas USA, green roof density will provide the developers with the opportunity to acquire an additional eight square feet of floor space for each square foot of green roof space installed. Similarly Toronto (Canada), Tokyo (Japan) and Switzerland have developed and introduced tax incentive schemes for building owners and developers. In contrast, Australia is relatively inexperienced with embracing green rooftops for the commercial property market.

In part, this could be attributed to the complexity of the Australian taxation laws, with differing applications for the stakeholders, namely the building owner, the tenant, and the developer. Issues such as retrofitting compliance, ongoing maintenance and upkeep, and commercial leasing considerations would need to be measured and introduced into the relevant taxation aspects of the legal system. For instance the costs associated with the retrofit of a green roof are born either by the building owner or the tenant who has taken out a lease or licence agreement. Under the current taxation laws in Australia, either party is able to claim some portion of these costs against their relevant taxable income, however there are some technical restrictions; such as the intention of undertaking the green roof retrofit i.e. are either of the parties entering into a lease or licence agreement for "profit-making purposes"?

Other aspects of taxation law include the decline in value of selected assets, the building write off for parts of the structural requirements for the roof top space, and costs associated with the installation and drainage of the irrigation system necessary for the green rooftops. Therefore, clear policies and guidelines to maximise these deductions would be ideal for all stakeholders involved. Indeed, clarifying the tax application and the introduction of tax incentives within the green roof regime is a worthy theme for the future transformation of Australian cities.

9. Contemporary practices

Four illustrative case studies demonstrate the application of green roof technology in practice for bio-diversity, food production, stormwater and thermal performance. Unfortunately there are few examples of retrofitted green roofs in Australia currently, and where no retrofit examples exist new buildings are shown.

9.1 Green Roof Retrofit In Commercial Stock –Case Studies From Melbourne And Sydney

9.1.1 Bio-diversity green roof retrofit – University of Melbourne Burnley Campus Victoria

The building was originally constructed between 1946 and 1949 and is used for teaching purposes. It is listed on the Victorian Heritage register. The roof is concrete with a one-degree slope. The roof is accessible to staff and students who have a working at height certification, and is visible from the first floor hallway window. Horticulture is taught within the building and the roof is used in teaching and research. This bio-diversity roof comprises Victorian grassland plant species in a shallow scoria substrate, a range of landscaping materials and features to provide habitats for lizards, birds, insects and other small invertebrates (Figure 2). The retrofit was completed in February 2013 at a cost of $13,930 and covers 49m^2. The existing concrete roof has a load bearing capacity of 150kg/m^2.

The existing waterproofing was patch repaired saving $2,000. The green roof components include ZinCo SSM45 protection mat and high-density polyethylene (HDPE) root barrier, a ZinCo FD40 drainage layer and ZinCo Filter Sheet SF. A scoria-based growing substrate 100mm deep was installed. The roof receives run-off from two downpipes that drain a roof area above. One is directed into the pond and ephemeral stream, the other enters a buried drain pipe that travels along the long axis of the roof. This allows lateral seepage of water into the substrate, and supports plant species with higher water needs, such as Kangaroo Grass *(Themeda triandra)*. Drainage off the roof is achieved through two drains on the northern perimeter of the building. As there is no irrigation system, the roof is watered by hand-held hose during hot weather or prolonged dry periods. The design and preliminaries costs $3000, with patch repairs at $1500, green roof costs were $5150, labour costs were $1650, and the remaining $2630 was spent on plants and planting.

Figure 2: Bio-diversity roof retrofit – University of Melbourne

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University staff maintain the roof, which takes about an hour per month, and a photographic record of weed species is maintained to monitor those that germinate on the roof. Timely removal of these plants before they set seed prevents them from becoming more widespread. Plant nutrition is provided as eight to nine-month low phosphorus controlled-release fertiliser, applied at half the recommended rate.

Nine months after planting the vegetation was still sparse, although this is likely to fill in, as the grasses self-sow over time. Possums living in two Italian Cypress trees that grew adjacent to the building grazed on the plants, although the trees were removed in 2013 as possum nesting and grazing had caused irreparable damage to the trees' canopies. The rooftop plants recovered well in spring and Australian ravens and magpies visited the roof to use the pond and to bring food to consume on the roof. Spiders colonised the tree debris, and an ant colony has moved into the rocky substrate near the end of the stream. Building occupants have commented on their enjoyment of the colourful grassland species planted outside the first floor window.

9.1.2 Food producing green roof retrofit – University of Technology Sydney (UTS) Housing Ultimo, Sydney, NSW

This nine-storey student residence, called Gumul Ngurang, which means friendly place in the local indigenous language, was built in 2003 with a roof designed for public access. This accessibility made it relatively straightforward for adaptation to food production. Perimeter garden beds were part of the original design. In 2013, following the award of a City of Sydney environmental grant two large raised beds were designed and installed on the rooftop, following negotiation with the University building Property Manager. In order to address concerns about potential damage to the roof membrane and to accommodate the possible need to remove the beds at some future stage, raised beds were provided. These beds drained into water containers, which was reused on the beds. Herbs and vegetables are grown all year round (see Figure 3) and the garden beds are maintained by the UTS Staff Student Garden club. The raised beds provide no thermal benefit to the roof, a limited impact on stormwater attenuation but have attracted local biodiversity to the roof and there is considerable social engagement for staff and students.

Figure 3 – Food producing retrofitted roof UTS Housing, Sydney.

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(Source: Wilkinson, 2014).

9.1.3 Stormwater roof – UTS Alumni Green Roof, Ultimo, Sydney, NSW

This building was completed in October 2014 as part of a major redevelopment of the UTS campus. Alumni Green is a green roof 6500m^2 overall, with a sports hall and a library retrieval system located directly below. There is easy access to the green roof for staff, students and the public. Native and drought tolerant plants occupy the eastern part of the roof, and an open space covered with turf comprises the western part of the roof. Sydney Local Government Area has only 4% of the native flora and fauna left from the date of settlement in 1788 (Bradshaw, 2012), and sites that reintroduce native species are highly desirable as they also encourage native insects to return. Some deciduous trees provide much needed shade in summer months but allow sunlight to penetrate the space in winter periods. Stormwater is captured, stored in 60,000 litre tanks, treated and re-used to supply approximately 87% of the Alumni Green water requirements. A 32,000 litre tank provides on-site detention and is used to manage stormwater during excessive rainfall.

UTS Executive Project Manager, Marc Treble, and Sustainability Officer, Danielle McCartney, specified the green roof for a number of reasons including improvements to air quality and biodiversity, as the site is located in the city centre on the fringe of the Central Business District. Other environmental benefits are increased quality of stormwater run-off and mitigation of the urban heat island. Water economy is managed through a system of irrigation, which is controlled to ensure efficient watering of the plants and turf. A key driver was the opportunity to create a green space on campus for UTS staff and students in which to socialise and relax. Being a city centre campus, many students tend not to remain on site after classes. The Alumni Green roof is part of a policy to encourage students to remain on campus for longer periods. Figure 4 shows that the social space is well used and the area has been transformed by the green roof.

Figure 4 Alumni Green Roof UTS Sydney, Ultimo NSW

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(Source: Wilkinson, 2015).

9.1.4 Thermal roof and UHI - Minifie Park Melbourne Victoria

This one storey, early learning centre building has a green roof of 440m^2, is located in a city park, and was completed in December 2012 at a total building cost of $306,000. Of this sum, $180,000 went on design and preliminaries and $126,000 on the green roof installation and plants. The roof has a two to three degree slope. The roof was intended to provide thermal insulation primarily, but also to blend into the park location and to add to bio-diversity by using local flora and providing habitats for local fauna (Figures 5 and 6). The roof comprises an aluminium roof deck supported by a steel framed portal structure: a load bearing capacity of 170kg/m^2 was provided. The green roof is irrigated and water is collected and stored in six tanks with a total capacity of 24,000 litres. Monitoring of the energy and water consumption will reveal performance levels. Anecdotally the builders used the building during winter time as it was warmer than the site office.

Figure 5: Minifie Park Green Roof.

ABOUT HERE

Figure 6: Minifie Park Green Roof.

ABOUT HERE

10. Future potential in green roof retrofit

The chapter has shown that green roof retrofit for many commercial properties is technically possible and economically, environmentally and socially desirable, yet it remains the case in Australia that wide scale adoption has not occurred yet. This part of the chapter discusses the future potential for green roof retrofit at a city and building scale, and also at policy level. Finally the chapter examines the availability of best practice guidance to professional practitioners in the built environment, which aims to up-skill consultants with the latest advice and knowledge with regards to best practices regarding valuation, licenses and technical advice.

With predicted climate change, Australia is said to be facing areas where increased frequency and intensity of rainfall will be experienced and other areas which will become hotter and drier. On this basis some cities and regions will be looking at adaptation of the existing stock with stormwater green roofs whereas others will see green roofs as a means of reducing energy usage and cooling demand. With regards to stormwater management Lamond et al's (2014b) Melbourne study of office building green roof retrofit found it may be possible to reduce the volume of stormwater between 50-85%.

The City of Melbourne experiences intense heat in summer periods. In January 2014 a four-day period of temperature exceeding 42 degrees saw an extra 250 people die in Melbourne through heat related illness, some of which was experienced in the CBD (ABC, 2014). Heat was trapped in between high-rise CBD buildings and under tree canopies exacerbating the heat further. Toronto in Canada estimated that a city wide adoption of green technology would deliver reduction of 0.5 to 2 degrees Celsius to their UHI, and with 15% of roofs retrofitted the temperature of the CBD could be reduced by two degrees Celsius (City of Melbourne, 2014). If this were to happen, the heatwave conditions as experienced in Melbourne, during January 2014 may not have caused so many fatalities.

Furthermore the continuing expansion of our cities will require some to use green roofs to improve air quality and attract bio-diversity into the area. The City of Sydney has lost 96% of the original flora and species that existed when the city was settled in 1788, some 226 years ago – this loss is quite astonishing (Bradshaw, 2012). Such catastrophic loss demands action on a city-wide scale. The mandated approach adopted by Toronto could see a fair amount of re-introduction of native species into the city, on the basis that 15% of roofs can be retrofitted; an area of 168.75 hectares would be available to plant out (Ghosh and Wilkinson, 2015).

Although evidence exists that:

(a) native species could be protected and reintroduced on a scale never before seen in Sydney,

(b) the UHI of Melbourne could be reduced by two degrees Celcius and save lives during heatwaves, and
(c) that stormwater surges could be reduced by 50-85% in Melbourne

To date no mandatory legislation exists in Australia with respect of green roofs in new construction or retrofit works. This surely must be revisited if our cities are to adapt to predicted climate change conditions. A combination of mandatory measures and changes in practices in our commercial property market will be required to bring about the necessary transformation. Currently what we have are guides and policies to encourage the uptake of green roof technology in new build and retrofit (City of Sydney, 2015; City of Melbourne, 2014). Whilst there has been an increase in the specification of green roofs in Melbourne and Sydney over the last 3-5 year period, many more green roofs are required for the changes in temperatures, reductions in stormwater flows and increases in bio-diversity to be apparent.

This chapter has shown that private building owners can benefit from installing green roofs from enhanced values and from improved occupant and building user satisfaction. Initiatives where green roofs are used to grow food to be donated to charity can be featured in Corporate Social Responsibility reporting and enhance a company's reputation and standing in the community. Peck's work (Tomsky and Koromowski, 2010) shows us it is possible to ascertain the value add in green roof retrofit, though these are of most use to policy makers. With greater uptake of green roofs in commercial property, valuers will be able to discern added value, though isolating the green roof contribution is challenging. As with sustainability and value more broadly, there is a need to educate the valuation profession. Other opportunities could exist in exploring the potential to write off leasing or licensing of roof space used for food production and donation as a tax write-off.

Whilst best practice guides have been produced by the City of Melbourne and Sydney respectively, professional practice guides are required to communicate to practitioners how green roof retrofit can enhance building value, improve occupant comfort, reduce operating costs, extend roof covering lifecycles as well as mitigate the UHI, improve air quality and water run-off quality through filtration and reduce building related greenhouse gas emissions. With regards to enhancing building value, it would be necessary to tie into income or risk if the building is an investment property. Good quality information on design, costings and management and maintenance of the roof is also needed. At the time of writing one of the authors is engaged in co-authoring a Best Practice Guide for Chartered Surveyors to evaluate the potential for green roof retrofit. This is a good step forward, however guides on valuation are also needed if the case for green roof retrofit is to become stronger.

11. Conclusions

The benefits of green roof retrofit are manifold and evident to many, however key stakeholders remain largely unconvinced on a wide enough scale to make them a common specification in any adaptation. The reasons for this reticence to adopt green roof retrofit have been outlined and range from technical to social judgements, to knowledge and to awareness levels. In particular, valuers do not know how to value a green roof and to date, no widely accepted license or lease document has been accepted to formalise arrangements between parties. This is changing however and should provide reassurance to all parties in respect of responsibilities and liabilities. Research shows the potential impact of green roof retrofit is significant – the temperature of city centres can be reduced by two degrees if 15% of roofs were retrofitted (City of Melbourne, 2014). This is likely to increase in importance as time goes by. The transformation of the commercial property market comes in a number of forms, for example one would be the added value in buildings which have green roofs. Eventually it will be possible to distinguish more accurately the value of the aesthetic social green roof space from the bio-diverse, or stormwater or thermal green roof. More importantly, green roofs provide that link to nature and to the seasons; they remind us when it's too wet or too hot, too dry or too cold. Food producing green roofs remind us where our food comes from and what we can grow locally, connecting us again to the seasons. This relationship should be revived for all our sakes. There is a strong correlation between observing, knowing and caring – we should encourage this relationship wherever possible from our built environment to the natural environment.

12. Acknowledgements

The authors would like to acknowledge the input from the following professional practitioners;

Mark Willers AAPI FRICS, Director, Certified Practising Valuer, Land Mark White (LMW), Sydney.

Martin Fisher, Director Property Management, Burgess Rawson Commercial Property Consultants.

13. References

ABC, (2014). *Heatwave blamed for large spike in the number of deaths in Victoria last week* [Online]. Available: http://www.abc.net.au/news/2014-01-23/heatwave-death-toll-expected-to-top-almost-400/5214496 [21st March 2015].

Arup Pty Ltd (2008) Zero Net Emissions by 2020 – update 2008 (Consultation Draft) City of Melbourne.

Banting, D., Dashin, H., Li, L., & Missios, P. (2005). *Report on the environmental benefits and costs of green roof technology for the City of Toronto. Prepared for the City of Toronto and Ontario Centres of Excellence – Earth and Environment technologies.* [Online]. Ryerson University. Available: http://www.torontocalgreenroofs/pdf/executivesummarypdf. [13th May 2015].

Bordass, W., Leaman, A., & Ruyssevelt, P. (2001) Assessing building performance in use 5: conclusions and implications. *Building Research and Information.* 29(2), 144-157.

Bloomberg (2012) *Insurers count cost in Queensland as floods peak*. [Online]. Avaiable: http://www.bloomberg.com/news/articles/2012-02-07/insurers-count-cost-in-queensland-as-floods-peak-correct- [13th May 2015].

Bradshaw, C.J.A. (2012). Little left to lose: deforestation and forest degradation in Australia since European colonization. *Journal of Plant Ecology*. Vol 5, Issue 1, Pp 109–120.

Brown, F. & Smith, J. (1989) Chapter title. In: *Book Title in Italics.* (eds A.B. Editor & C.D. Editor), 2nd edn, pp. 00–00. Publisher, Place.

Brown, F. & Smith, J. (eds) (1991) *Book Title in Italics* Publisher, Place.

Castleton, H. (2010). Green roofs; building energy savings and the potential for retrofit. *Energy and Buildings, 42*, 1582-1591.

Bureau of Meteorology. (2012) *Heavy rain and Flooding*. [Online]. Available: http://www.bom.gov.au/wa/sevwx/perth/floods.shtml. [9th July 2012].

Companies and Markets (2011) *Australian Flood Damage Reconstruction Likely to Cost Billions*. [Online]. Available: http://www.companiesandmarkets.com/News/Construction/Australian- Flood-Damage-Reconstruction-Likely-to-Cost-Billions/NI1713 [12th July 2012].

City of Melbourne, 2014. *Growing Green Guide*. [Online]. Available: http://www.growinggreenguide.org/wp-content/uploads/2014/02/growing_green_guide_ebook_130214.pdf [4th January 2015].

City of Sydney. 2015. *Environmental upgrade finance* [Online]. Available: http://www.cityofsydney.nsw.gov.au/business/business-support/greening-your-business/environmental-upgrade-finance [4th January 2015].

CSIRO, 2002 *Annual Report 2002-2003.* [Online]. Available; http://www.csiro.au/Portals/About-CSIRO/How-we-work/Budget--Performance/Annual-Report/Past-Annual-Reports/CSIRO-Annual-Report-2002-2003.aspx [27th January 2015].

Eichholtz, P., Kok, N., & Quigley, J. M. (2013). The economics of green building. *Review of Economics and Statistics*, *95*(1), 50-63.

Energy Policy Act 2005 (USA Federal),

Frazer, L. (2005). *Environmental Health Perspectives* . (113), 457-462.

GBCA, (2015). *Green Roofs and Green Star innovation points*. [Online] Available: https://www.gbca.org.au/search.asp?search=green+roofs+and+innovation+points [13th May 2015]

Ghosh, S. & Wilkinson, S (2015). *Roles Of a Roof Top Garden in Enhancing Social Participation and Urban Regeneration in Sydney CBD*. RICS COBRA Conference 8-10th July 2015 Sydney Australia.

Hilten, R. N., Lawrence, T. M. & Tollner, E. W. (2008). Modeling stormwater runoff from green roofs with HYDRUS-1D. *Journal of Hydrology,* 358**,** 288-293.

Kellert, S.R. and Wilson, E.O. (1993) *The Biophilia Hypothesis.* Washington D.C., U.S.A: Island Press.

Kohler, M. (2008). Green facades—a view back and some visions. *Urban Ecosystems,* 11, 23-436.

Lamond, J., Wilkinson, S. J., Rose, C, & Proverbs, D G. (2014a). *Retrofit of Sustainable Urban Drainage (SUDS) in CBD for improved flood mitigation.* RICS Research Trust Report December 2014.
http://www.rics.org/uk/knowledge/research/research-reports/sustainable-urban-drainage/

Lamond, J., Wilkinson, S., & Rose, C. (2014b). *Conceptualising the benefits of green roof technology for commercial real estate owners and occupiers.* Pacific Rim Real Estate Conference, Jan 19th – 22nd 2014. Christchurch NZ.

Mentens, J., Raes, D. and Hermy, M. (2006) Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century? *Landscape and Urban Planning*, 77(3), pp.217-226.

Newell, G., MacFarlane, J. & Kok, N., (2011). *Building Better Returns: A Study of the Financial Performance of Green Office Buildings in Australia.* [Online]. Available;
http://www.api.org.au/assets/media_library/000/000/219/original.pdf [13th May 2015].

Niachou, A. et al., (2001) Analysis of the green roof thermal properties and investigation of its energy performance, *Energy and Buildings* 33 (7) 719–729.

Pugh, T.A.M., Mackenzie, A.R., Whyatt, J.D., & Hewitt, C.N. (2012). Effectiveness of green infrastructure for improvement of air quality in urban street canyons. *Environmental Science and Technology.* 46:7692-7699.

Peck, S. W. and Callaghan, C., (1999). *Greenbacks from Green Roofs: Forging a New Industry in Canada*, CMHC / SCHL.

Skyring, S. (2007) *Green Roofs for Australia. Australia Green Development Forum*. Brisbane 22nd - 23rd February 2007.

Stovin, V. (2010) The potential of green roofs to manage Urban Stormwater. *Water and Environment Journal,* 24(3), pp.192-199.

Susca, T., Gaffin, S. R. & Dell'Osso, G. R. (2011). Positive effects of vegetation: urban heat island and green roofs. *Environmental Pollution,* 159**,** 2119-2126.

Takebayashi, H., & Moriyama, M., (2007). Surface heat budget on green roof and high reflection roof for mitigation of urban heat island. *Building and Environment* 42(8), 2971e2979.

Tomsky, R. and Koromowski, B. (2010). *The Monetary Values of the Soft Benefits of Green Roofs.* Smart Cities Research Services, Montreal. Canada Mortgage and Housing Corporation (CMHC). August 2010.

University of Florida. (2008). Green Roof/Eco Roof. [Online] Available: http://buildgreen.ufl.edu/Fact_sheet_Green_Roofs_Eco_roofs.pdf. [13th May 2015].

Van der Heijden, J. (2014). Governance for Urban Sustainability and Resilience: Responding to Climate Change and the Relevance of the Built Environment. Cheltenham, Edward Elgar.

Warren, C.M.J. & Huston, S. (2011). *Promoting Energy Efficiency in Public Sector Commercial Buildings in Australia.* RICS COBRA Conference 12th-13th September, 2011. School of the Built Environment, University of Salford, UK.

Warren-Myers, G. (2013). Is the valuer the barrier to identifying the value of sustainability? *Journal of Property Investment & Finance,* Vol. 31(4), p.345-359. ISSN: 1463-578X.

Wilkinson, S. J. (2012). Analysing sustainable retrofit potential in premium office buildings. *Structural Survey* January 2012. July 2012. Vol. 30 Issue 5. ISSN 0263-080X

Wilkinson, S. J., (2014a). Office building adaptations and the growing significance of environmental attributes. Submitted to *Journal of Corporate Real Estate.* ISSN 1463-001X Volume: 16 Issue: 4

Wilkinson, S. J., (2014b). How buildings learn: Profiling the adaptation of low grade office buildings. *Facilities.* Volume 32 Issue 7/8, pp. ISSN 0263 2772.

Wilkinson, S. J., Lamond, J., Proverbs, D., Sharman, L., and Manion J. (2015). Technical considerations and stakeholder awareness in green roof retrofit for stormwater attenuation. *Structural Survey* vol 33, issue 1. ISBN 0263-080X.

Wilkinson S. J. and Reed R. (2009). Green Roof Retrofit Potential in the Central Business District. *Journal of Property Management.* ISSN 0263-7472. Vol. 27. Issue 5.

Yang, J. (2008). Quantifying air pollution removal by green roofs in Chicago. *Atmospheric Environment, 42*

Young, C. (2001) *English Heritage position statement on the Valletta Convention*, [Online], Available: http://www.archaeol.freeuk.com/EHPostionStatement.htm [24 Aug 2001].