POTENTIALS AND CHALLENGES FOR SUSTAINABLE RETROFITTING OF NON-DOMESTIC BUILDINGS: A UK PERSPECTIVE

Paula FEMENÍAS, Dr. Arch.[1, 2]
Colin FUDGE, Prof. [1]

1. Faculty of the Built Environment, University of the West of England, Bristol, U.K., paula.femenias@uwe.ac.uk, colin.fudge@uwe.ac.uk and colin.fudge@rmit.edu.au
2. Department of Architecture, Chalmers University of Technology, Sweden, femenias@chalmers.se

Keywords: sustainable development, retrofitting strategies, environmental, commercial buildings, urban regeneration, revaluing property, Bristol, UK

Summary

This paper presents tentative results from a study of retrofitting activities in the commercial property sector in Bristol, the UK. The study is part of on-going research on the theme 'Retrofitting the city' that explores the adaptation of existing built environments to deal with climate change and objectives for sustainable futures. From the Bristol study two concepts related to retrofitting becomes especially apparent: 'commercial' and 'community'. Results indicate that we might be experiencing a shift where the UK property sector is gaining conscience of the risk of having 'unsustainable' property as part of their portfolios. This change is induced by occupier demands, increased costs for energy and waste management etc., and a more complex process for planning permission. Environmental ambitions have to be balanced with commercial viability, but strengthened policies are to be expected. The study shows that retrofitting of single buildings often includes visions for regeneration of urban areas and the involvement of the local community. This agenda seems partly to be pushed by new planning permission procedures. The study points to a number of fields in which contributions are needed to facilitate future sustainable retrofitting activities including: the archaeology of site, rewiring of the city, and the socioeconomic and environmental benefits in a revaluation of existing property.

1. Introduction

The starting point for this research project is the increased pressure on the urban built environment related to growing urban populations, environmental protection and visions for sustainable development. In 2008, statistics show us that we have reached the tipping-point when half the world's population became city dwellers (www.un.org). From a European perspective where almost 80% of the population lives in urban areas, and cities are changing slowly there are important work to be done to existing, obsolescent and deteriorating urban structures. The UK building stock is renewed by no more than 2% per year through new construction and major renovation. As for the next 50 years the majority of the stock will be comprised of building that exists already today, it is generally perceived that initiatives to address goals for carbon reduction in new buildings will have relatively little impact on the stock as a whole.

1.1 Scope, Definitions and Limitations of the Study

The aim for this paper is to identify and understand the commercial framing of retrofitting activities of existing buildings and the mediation of these issues in current development and regeneration processes. Focus is on non-domestic buildings, an area that has been less studied than the dynamics of the domestic building sector (Bruhns *et al.*, 2000). In addition, the potential for carbon savings in the commercial building stock is seemingly large. The rate of growth of energy use in the commercial sector in the UK has since the 1970s been three times greater than in the domestic sector (Scrase, 2001). The study includes mixed use development (residential, work space and leisure) which is increasingly part of contemporary commercial property development.

As regards definitions, Flourentzou and Roulet (2002) state that the concept of 'renovation' can be divided in two sub-categories: retrofit and refurbishment. The concept of 'retrofit' identifies actions to upgrade a building to new requirements while 'refurbishment' refers to actions to bring back the building to its original state. We use the term retrofit as it conforms to a necessary environmental upgrading and it also highlights the act of revaluing property. Retrofitting actions will also include strategies in new design to facilitate adaptation to future demands for energy reduction etc.

1.2 Methodology

An extensive literature review has been carried out in order to understand the dynamics of the commercial property sector in a UK perspective regarding retrofitting strategies as well as its ability to respond to the sustainability agenda. This paper sums up the research field based on the literature review and tentative results from on-going empirical studies, setting out a range of issues to be examined and that might become hypotheses for the continued work. The paper has three main parts: a review of knowledge regarding environmental issues and non-domestic buildings; a review of knowledge regarding the dynamics of the British commercial property sectors; and a short presentation of the four case studies and their outcomes.

The empirical material consists on the one hand of interviews with senior representatives in the Bristol commercial property sector, and the other hand of four evolving cases of retrofitting of non-domestic buildings in Bristol city centre. At present 14 qualitative and open-ended interviews (length from 1 hour to 1 hour and a half) have been carried out with 16 actors including architects, developers, estate agents and planning officers. Additional interviews have been made for the case studies. The choice of the four cases reflects problems when addressing different categories of non-domestic buildings. This includes obsolescent 1960s and 1970s office buildings, industrial buildings and listed buildings. The choice of cases also shows varying approaches to address the sustainability agenda from basically 'green' projects to more commercially pragmatic approaches.

2. Addressing the Non-domestic Building Stock

During last years, major work has been done to develop a UK national database on non-domestic buildings (NDBS) (e.g. Environment and Planning B, 2000 vol. 26; Bruhns *et al*, 2000). Compared with the domestic stock, the non-domestic building stock is very diverse, complex and heterogeneous. If the housing stock can be effectively represented by 1000 dwelling types, the non-domestic stock would need maybe 100.000 building types (Pout, 2000). Many non-domestic buildings have mixed use and mixed construction, coming in a huge range of shapes, size and materials. In addition, the boundary between domestic and non-domestic is not always clear.

2.1 Age and Lifecycle

The majority of non-domestic buildings in the UK were built before the 1980s (Bruhns *et al*, 2000). Just over half of the stock is more than 30 years old. Old buildings (pre-1939) dominate in retail and offices while newer stock is found in factories and warehouses. Over 50% of all office space was built prior 1939 but only counts for 30% of the total floorspace. The old age of the UK office stock indicates a great potential for energy efficient retrofitting or refurbishment activities.

In general, non-domestic buildings have been found to have a higher replacement rate than domestic buildings, one important factor can be that they more often change ownership than domestic and in each ownership change the question of demolishing or recycling will appear (e.g. Bradley and Kohler, 2007). Non-domestic buildings are also to a higher degree exposed to changes in use and have a high rate of change of tenants/users. The service life of a building can be prolonged through regular maintenance and refurbishment and does not automatically mean the physical life of the building. The economic life is established by taxes, legal requirements and accounting standards and is not necessarily related to the likely service life or physical life. The 'effective life' of buildings, in general, seems to be much higher than different assumptions of service life and economic life. Some parts of buildings, like the foundation and structure, will probably have a technically longer life than other parts and longer than the assumed service life. Internal replacement cycles in for example office layout and leisure decoration, is higher than external or structural replacements (Ball, 2003). This indicates that subsystems should be

controllable and replaceable and that certain design criteria such as floor heights could be provided in the perspective of a possible 'second service life' (e.g. Bradley and Kohler, 2007).

2.2 Carbon Reduction

Non-domestic buildings in the UK are responsible for almost 20 % of the UK's energy consumption and carbon emissions (Communities and Local Governments, 2008). Even if less in total numbers than domestic buildings, several categories of non-domestic buildings have the highest energy use per square meter as for example office buildings. The repatriation of energy use in UK offices is: 58% for heating, 15% for lighting, 7% for IT equipment, and 5% for water heating (Mortimer *et a*l., 2000). The remaining 15% is used for cooling, fans, small power equipment etc. The Carbon Trust (2006) claim 15% of the office electricity use to IT services a figure that is expected to rise to 30% by 2020. In addition, HVAC – heating, ventilation and air conditioning (AC) – uses 20-30% of the total space in commercial buildings (Wagner *et al*, 2005).

Last years rapid growth in commercial energy use reflects expansion in floor space where offices occupy twice as much floor space in 1994 as in 1970 (Scarse, 2001). Between the mid-eighties and mid-nineties, the use of AC increased by a factor of three in the UK. This increase has various reasons (EOF, 1995): client demand, institutional requirement and market perception; deeper plan constructions; increasing external pollution and noise; high density of occupancy; higher internal gains principally from small power loads (poor efficiency of lighting and IT equipment); excessive solar gain due to poor design but also hotter summers. The heavy dependence on electricity for AC, lighting, IT equipment etc. is one major contribution to natural deterioration from the commercial property sector as in UK, electricity production emits twice as much carbon dioxide emissions than for example gas heating due to inefficiencies in power stations (Toke and Taylor, 2007). The situation will be different with new energy efficient lighting and IT equipment. For example, the use of energy-efficient lighting can reduce the overall energy use by 4 to 10% (McAllister and Sweett, 2007). Another problem is related to occupancy and the importance of energy efficient behaviour. One architect office in our study claim that 60% of their energy use is outside office hours (this energy is used for IT services, heating and some cooling).

2.3 An Inclusive Sustainability Perspective

Several studies point to the relative environmental advantage of retrofitting existing buildings compared to demolishment and new construction. In their comparative study, the British Research Establishment BRE (Andersson and Mills, 2002) suggests that the re-construction option (based on lifecycle of 60 years) has a higher environmental impact when using the same method of ventilation or cooling, even though the uniqueness of every site could influence results. The comparative evaluation is based on: embodied impacts (including transport, maintenance and disposal), cooling and ventilation energy, heating and lightning energy, capital costs, whole-life costs, rental values (lettability and manageability), buildability (speed of construction and disruption). The higher environmental impact of the re-construction option is attributed to the demolition and materials involved in the new construction (40-50% of the environmental impact).

The BRE study points to the necessity to expand the scope of environmental considerations beyond embodied energy and energy in use. However, few studies focus on the inclusive 'ecological footprint' and the sustainability agenda regarding socio-economic aspects of building activities (e.g. Building Research & Information, 3/36 2008). For example, location, e.g. accessibility by low carbon transport means will be of importance. A few models under development include other environmental measures in commercial property valuation such as water, waste, material and biological diversity (Ellison *et al*, 2007; McAllister and Sweett, 2007).

3. Addressing the commercial property sector

Generally the 'greening' of the commercial property sector is perceived as "tense and uncertain" and the "idea of 'development' appears anonymous with environmental degradation and unsustainable development" (Guy, 2000). Different actors in the commercial building sector have differing values and wishes concerning what they want to achieve from development of property. In a 'vicious circle of blaim' (Cadman, 2007) occupiers would like sustainable buildings but there are few available; constructors can build them but are never asked; developers would ask for

them but investors will not pay for them; and finally investors would found them but nobody asks for them. The circle is further reinforced by the agents that can not see any market demand. However, there are witnesses of an emerging awareness regarding the consequences on investment portfolios of neglecting social and environmental issues and a perceived risk for future or 'anticipatory' legislation (Pivo and McNamara, 2005; Lützkendorf and Lorenz, 2007; Scarse *et a*l, 2007; Cadman, 2007). This development is supported by new property rating systems capable of expressing the relative advantages of sustainable measures through the treatment of 'unsustainability' as additional risk (downside risks such as environmental hazard, increased rates of obsolescence and value depreciation) and the inclusion of sustainability for the calculation of credit and mortgage. In addition, sustainable building has been acclaimed to bring countless win-win situations as they are not necessarily more expensive to build and their ownership results in financial benefits including lower operating costs, improved marketability, longer life-spans, reduced exposure to increasingly stringent legislation, and increased occupant productivity and well-being.

Other internal market drivers are for example changed conditions for occupiers with shorter leases and opportunities to negotiate space based on functional demands, and more flexible and healthy workplaces (Guy, 2000; Sayce et al, 2007). However, the strongest pressure for sustainable and energy efficient commercial property does not seem to come from occupiers. Observations made by Cadman (2007) is that developers has led the way since the late 1990s and more recently, also investors have taken a shift and started to shape good practice.

External enablers to adapt more sustainable property management comes from strengthened legislation, taxes as for example The Climate Change Levy, The Aggregate Levy and land fill taxes, as well as raised energy costs. Several political documents addressing carbon reduction has been published last years, e.g. the Climate Change programme (2006), the Climate Change Bill (2007) and the Sustainable Energy Act (2006). The government has set out a progressive tightening of Building Regulations. The 2006s revision to Part L on Conservation on Fuel and Power of the Building Regulations is set to reduce carbon emissions for new built and refurbished non-domestic buildings. Another key measure is the Energy Performance of Buildings Directive, i.e. energy labelling of buildings. Furthermore, the government supports sustainable property management through VAT reduction on renewable energies; the English Partnerships, the regeneration agency, that focus on sustainable urban regeneration; and the Carbon Trust that supports private and public organisations in reducing energy use and carbon emissions. Launched in 2007, the UK Green Building Council sustains a new partnership between government, industry and other stakeholder groups that facilitates dialogue and sets up objectives on the road to more sustainable futures.

Except from cutting-edge buildings the raised awareness for sustainable property has not led to large market transformations. Despite rapidly increasing energy prices it is difficult to create a business case on cost reduction from environmental property even when adopting a whole-life approach (Sayce *et al.*, 2007). In the hand of the occupier, energy costs only represent a fraction of total business costs. Several authors state that a market-led shift to sustainable property is unlikely to happen within the time-frame set out by the current political agendas, proposing more fiscal measures if the market fails (Scarse, 2001; Toker and Taylor, 2007; Sayce *et al*., 2007).

4. Case studies of Retrofitting Projects in Bristol UK

In early 2007, Bristol council launched the action Bristol Green Capital. Together with Bristol Partnership they seek to establish joint public-private and voluntary actions to reach the Community Strategy target to cut carbon dioxide emissions in Bristol by 60% by 2050.

At present the local authority's possibilities to push the environmental agenda in planning permissions is weak, but strengthened policies are expected in the end of the year. Changes to planning permission procedures have through for example the introduction of the 'section 106 agreement' set restrictions on the developers for the benefit of the local communities.

4.1 Hamilton House – The Pioneering Environmental Retrofitting Project

Hamilton House project is the retrofitting of a 1970s office block in central Bristol for mixed use including residential, offices, retail and a café. New light-structure penthouse apartments are

added on the roof and a new residential building to the back of the block. Built in 1974, Hamilton House is currently only partly occupied as offices for the owner, a commercial developer. The owner approached the Bristol City Council with a proposal for a redevelop to housing which was refused. Instead, the city council proposed them resubmit an environmentally focused proposal.

Bristol based architects White Design work on the project now subject for planning permission. One of the challenges is the building being set back from the street with 5 metres, a space that quickly dilapidated. In the new scheme this space is turned it into an atrium, approaching the façade to the street, creating a place for a café and art exhibitions (the building has a Banksy mural), and providing a noise screen that will enable the building to be naturally ventilated. A new façade will be set up with super-insulated panels and floor to ceiling full height glazing. The whole block is heated with a biomass boiler and there will be solar heaters for domestic hot water. The architect has experienced problems as the original structural data of the building can not be retrieved. The structure will be reinforced for wind loads to comply with contemporary regulations.

The architect is convinced that the retrofitting project is the best sustainable solution and works on convincing the developer that this project would not only increase the market value of the property but also support the regeneration of the area, a great story in which they would take part. In their negotiations with the planners, they put forward that the project would add public value in terms of environmental quality, mixed use living, the attractive atrium space and a public garden.

4.2 Lake Shore – The Commercial Green Regeneration Project

In 2004 the award winning developer Urban Splash (South West) bought the 4,5 hectare site with the former Imperial Tobacco head quarter (HQ) building in Hartcliffe, an area that suffers from problems which characterise a socially excluded community. The HQ building from 1973 is a modernist structure of Cor-ten steel sitting on an artificial lake. In 1991, the factory was closed and HQ building was left derelict. In 1997 the building was listed by English heritage.

Urban Splash has a long record of approaching difficult and run down sites and successfully regenerating them in commercial terms. Their vision for the Lake Shore project is to retrofit the listed building and add a new building to create 406 apartments, live and work space, and some commercial space. They wish to attract people offering high quality architecture in an environmentally green area to comparably low prices. The success of Urban Splash can be linked to their niche market of approaching derelict and unwanted sites that they have been able to buy to low prices (and sometimes with additional grants from governments) leaving them resources to focus on their passion for architecture and design and now recently on the green agenda.

Initially Urban Splash aimed at an excellent level of BREAM rating Eco Homes (now Sustainable Homes). They are actually on level 4 (of 6) due to changes in the assessment model. Prerequisites of the site allowed them to use geothermal heating combined with a biomass boiler, local waste water management. They have plans for solar collectors and wind turbines and the lake has been decontaminated. Their work with the local community has brought together a job initiative where 10 trainees work on site. Furthermore, a social enterprise scheme matches local skills with enterprises. The architect is Acanthus Fergusson Mann (see 4.4).

4.3 Broad Quay and A Few More Cases – The Commercial Projects

This case presents a few retrofitting project by the commercial architects Atkins Walters Webster, AWW. The main case, Broad Quay comprises the partial demolition and regeneration of a 1970s office tower in Bristol city centre and the construction of new buildings on the site. The tower which is transformed into a hotel is re-clad and the original slab slightly extended outwards to suite the new use as a hotel. The 18 story hotel will be equipped with AC. The rest of the site will be developed for residential units, leisure and retail. Issues that the project has brought up are: the importance of an intelligent assessment of the existing structure and basement in order to support recycling instead of demolishing; and the commercial value of a good basement and piling that can be reused (for example car parking). This case shows that the reuse of the original foundation, not making changes to the infrastructure can be very commercially beneficial.

The architects own offices in a 1970s office building has undergone an interim recycling, a kind of refreshment to modern standards resulting in good presentable offices but with lower rent levels

than a state-of-the-art new built office. The lower floor levels have low density occupancy and are naturally ventilated. The top floor, a lightweight construction has high density occupancy and AC. The concrete slab has been left bare for thermal adjustment and purging of heat at night.

The former Dingles department store a listed 19th century building originally built as residential has undergone a major redevelopment to host shops on the ground floor and residential apartments in the upper floors. The project can be described as recycling a site as only the exterior facades are kept and all slabs are changed to fit new uses. The recycling of the listed façade has been an expensive venture resulting in some qualities but also compromises in use.

Figure 1 Case study images: Lake Shore, Broad Quay and Hamilton House.

4.4 The Greenbank Chocolate Factory – Sustainable retrofitting and the Community

After 100 years of chocolate production, Elizabeth Shaw closed the Bristol Greenbank factory in 2006, with the loss of 145 jobs. A volume house developer made a proposal to demolish the existing building and build a new residential block. The local community opposed to the development with the aim to save the historically important site. Bristol planners rejected the scheme and it was upheld that it was important to retain the site for local work space. The site was sold to Bristol based developer Squarepeg who develops a new scheme with the approval of the community to provide a mix of affordable work space, retail, leisure, and community space. The aim is to use state-of-the-art sustainable building practices to create a pioneering development. The architect George Fergusson from Acanthus Fergusson Mann has experience from similar projects. In 1995, he saved the Tobacco Factory in Bristol from demolition and redeveloped it into a successful cultural venue that is likely to have supported the regeneration of the local area.

5. Results and Discussion

The interviews with Bristol based commercial property sector actors as well as the presented case studies point to some broad issues that will be further discussed. First, the raised importance of the sustainability agenda will be discussed, and the commercial move from retrofitting towards regeneration. Second, mechanisms related to motivation, enablers but also problems in retrofitting and recycling activities will be further explored.

5.1 The Sustainability Agenda and Regeneration

The interviews reveal a shift as the sustainability agenda has gained in importance over the last 1,5 to 4 years. Including the commercial agents acclaim that sustainability is now part of their business agendas. However, barriers remain. A few respondents find that there are not yet enough reliable renewable energy technologies on the shelf. They think that this problem will be solved in the coming five years and prefer to wait before investing in these technologies.

The case studies show a bias for retrofitting in a regeneration perspective, with more or less involvement of the local community, while high ambitions for energy efficiency are less apparent. Compared to recent Swedish development with a strong single focus on energy efficient building and passive house concepts (Femenias *et al*, 2008), the UK cases seem to address a more socioeconomic then environmental agenda. From the perspective of developers and investors, regeneration is interesting as developments that address local concern easier receives planning consent and can be given subsidies (Pivo and McNamara, 2005). The 2007 IPD Regeneration Index states market advantage in investing in regeneration over the long-term. Their study shows that total returns for all property in regeneration areas has outperformed all UK property over the last five years. Regeneration is claimed to be no longer a niche market but mainstream.

5.2 Retrofitting Decision Making Mechanisms

How does the commercial property sector deal with decision making facing retrofitting and recycling of existing buildings and structures? There are a number of factors that will enable the recycling and retrofitting of existing buildings. From a commercial point of view the market is the starting point. Some of the case studies show expensive engineering and design solutions that can only be carried through when there is a strong demand. Urban Splash in their approach to commercial development shows a way to create market demand. If instead the market demand is low, it can be a business case to do only an interim refurbishment for lower costs. The application on the Part L in the building regulations on energy efficiency should be applied on all planning permissions why necessary refurbishment activities in low budget projects can be called off.

It is seldom that physical deterioration defines the timing and nature of retrofitting activities (e.g. Ball, 2003; Bradley and Kohler, 2007). Often triggered by ownership changes or in between lease contract it is generally functional or locational obsolescence that will determine if the building will be recycled or demolished. Functional obsolescence can originate from several aspects: changes in the market with new user demands, development of internal equipment technology or simply due to poor initial design. The study points to some key design criteria important in this decision process. The floor to ceiling height will determine the possibility to install raised floors and AC. Low floor to ceiling heights can be a determining factor for demolition or change of use to residential (not in need of raised floors/AC). The size and flexibility of floor space are other important factors. Modern offices often demand large open floor space for good communication and more productive working conditions. Functional obsolescent buildings in city centres are probably more often subject to demolition to reach higher density and better functionality in a new building, which is an economically more attractive solution (e.g. Bradley and Kohler, 2007).

In order to reduce energy and especially electricity use, natural ventilation and natural lighting are issues in current UK property development. The depth of the building plan will be determining for the use of natural ventilation with a maximum width about 15 metres. A shallow plan but a low floor to ceiling height can be compatible with natural ventilation depending on the location: noise and pollution levels, heat islands in city centres, occupancy rates and the height of the building (when over 14 stories windows can not normally be opened). Thermal mass is advantageous for naturally ventilated as well as air-conditioned (and night cooled/ventilated) offices.

Several respondents brings up the issues of spending 10% more initially to get better design quality, for example higher floor to ceiling heights, that will be of advantage in future retrofitting. This is often the case with head quarter buildings and buildings for other well-established institutions. It can also be argued that older buildings develop status and prestige that could justify higher rent levels and motivate recycling instead of demolishing (Ball, 2003). The intelligent assessment of the value of the existing structure is important. As expressed by one director of architect AWW: “A building that has a good frame and a good basement is a good asset”.

5.3 The Archaeology of Retrofitting and Rewiring the City

The empirical studies point to the importance of thorough initial analysis of the existing structures. One problem is that the records of the existing structure and the infrastructure are often missing. The cases show that even for rather recent buildings, from the 1970s, drawings can not always be found and not structural data. It can be very costly to analyse a structure and it can lead to just-in-case reinforcements or even demolition. The infrastructure issue is of great importance for future retrofitting of urban areas. The large costs that are related to under ground work, locating and relocating pipes and wires will be of additional commercial benefit for the recycling of structures and in particular valuable basements and piling.

6. Subjects for the Continued Research

Several broad areas for further studies can be drawn from the project at this stage. First, are the tendencies reflected in the empirical study signs of a long-term shift towards more sustainable property management? Are on-going activities the result of enlightened clients, one-off market events, or business cases: what are the real mechanisms that enable these projects? The study does indicate that once sustainability issues begin to bite there will be a switch to a market situation where failure to take this in account will lead to increased exposure to financial risk. Second, the study points to the need for further studies of the links between on the one hand

retrofitting of existing buildings, or parts of the structure, and environmental impact and commercial value, and on the other hand the link between commercial regeneration and local sustainable development. Will regeneration projects as those studied actually contribute and sustain the local economy and the quality of life for the actual local population? What are the long-term effects of the projects? Third, retrofitting of cities involves a broad field of areas from infrastructure and recycling of existing material capital to the relive of degenerated areas. There is a need for further reflection on the organisation and documentation of work in the retrofitting of cities.

Acknowledgement

We wish to thank all the actors in Bristol that has contributed with their experiences in this study.

References

Andersson, J. and Mills, K.. 2002 Refurbishment or redevelopment of office buildings? Sustainability Comparisons. Building Research Establishment Information Paper 9/02, part 1

Ball, M. 2003 Is there an Office Replacement Cycle? Building Research and Information, 20(2), 173-189

Bradley, P and Kohler, N. 2007. Methodology for the Survival Analysis of Urban Building Stocks. Building Research and Information, 35(5), 529-542

Bruhns, H. R., Steadman, P., Herring, H., Moss, S. and P.A. Rickaby 2000 Types, numbers, and floor areas of non-domestic premises England and Wales, classified by activity. 27 (5), 641-665

Building Research & Information 2008, vol. 36 (3).

Cadman, D. 2007 Centre for the Study of Sustainable Building: The Carbon Challenge. University of the West of Bristol. www.built-environment.uwe.ac.uk/research/cssb/docs/carbonchallenge_davidcadman.pdf

Ellison, L., Sayce, S. and Smith J. 2007 Socially Responsible Property Investment: Quantifying the Relationship between Sustainability and Investment Property Worth. Property Research 24(3) 191-219

Environment and Planning B: Planning and Design 2000, vol. 27 (5)

EOF – The Energy Efficient Office of the Future 1995 A performance specification for the energy efficient office of the future. Best Practice Programme. General Information. Report 30.

Femenías, P, M. Edén, and B. Rubino 2008 Supporting development towards more sustainable building: perspectives on the demonstration project as a strategy for change. Proceedings from SB08 Melbourne

Flourentzou F. J.L Genre and C. A. Roulet 2002 TOBUS software — an interactive decision aid tool for building retrofit studies. Energy and Buildings 34 (2), pp. 193-202

Guy, S. 2000 Framing environmental choices – mediating the environment in the property business. In Fineman, Stephan (Ed.) Business of Greening. London: Routledge, 54 – 77.

HLAA Housing Land Availability Analysis 2007 Bristol City Council, available at www.bristol.gov.uk

IPD Regeneration Index 2007 Summery available at www.englishpartnership.co.uk

Lützkendorf T. and D. Lorenz, 2007 Integrating sustainability into property risk assessments for market transformation Building Research & Information, 35 (6), 644 - 661

McAllister, I. and Sweett, C. 2007 Transforming Existing Buildings: The Green Challenge. RICS Report

Mortimer, N. D., Maha A. E. and J. F. Grant 2000 Patterns of energy use in non-domestic buildings. Environment and Planning B: Planning and Design. 27 (5) pp 709-720

Pivo G. and P. McNamara 2005 Responsible Property Investing. Real Estate Review, 8(1), 128-143

Pout, C. H. 2000 N-DEEM: The national non-domestic building energy and emission model. In Environment and Planning B: Planning and Design. 27 (5) pp 721-732

Scrase, J.I. 2001 Curbing the growth in UK commercial energy consumption. Building Research & Information, 29 (1), pp 51–61

Sayce, S, Ellison, L. and Parnell, P. 2007. Understanding Investment Drivers for UK Sustainable Property. Building Research and Information. 35(6), 629-643

Toke, D. and S. Taylor 2007, Demand reduction in the UK – with a focus on the non-domestic sector. Energy Policy 35 (4), pp. 2131-2140

Wagner A., M. Kleber, and K Rohlffs 2005. The passively cooled KfW building in Germany. International Conference “Passive and Low Energy Cooling 733 for the Built Environment”, May Santorini, Greece