Paper 131: Indicator for Sustainable Housing Design: from EcoHomes to the Code for Sustainable Homes

Bing Chen [1]*, Adrian Pitts [2], Ian Ward [3]

School of Architecture, University of Sheffield, Sheffield, UK[1]*
Bing.Chen@sheffield.ac.uk
Division of the Built Environment, Sheffield Hallam University, Sheffield, UK[2]
School of Architecture, University of Sheffield, Sheffield, UK[3]

Abstract

It is widely acknowledged that sustainability principles should be addressed in the housing market to tackle climate change. In the UK, many regulation- or policy-related housing assessment tools have been enacted to ensure the compulsory objective of carbon-neural new homes can be progressively achieved by 2016. Until now, however, there is no one of them can truly accommodate all the competing parameters in the design processes or apply to all circumstances of building construction alone. To select the most suitable ones and optimise the application according to their relevance, this paper aims to identify the specific characteristics of different assessment tools, particularly focusing on their innovative aspects relevant to designers today. Three prevailing sustainable housing assessment tools, Building Research Establishment's (BRE) EcoHomes, the Code for Sustainable Homes and Leadership in Energy and Environmental Design (LEED), have been closely compared. Based on the extensive studies, a general consensus is reached on the palette of environmental issues that should be addressed in the housing design processes. This set of sustainable housing design issues can be used as a prototype of the sustainability indicator to support the decision making processes, and as a communicational platform to get the message across between different stakeholder groups.

Keywords: housing assessment, EcoHomes, the Code for Sustainable Homes, LEED, sustainability, indicator

1. Introduction

It is widely acknowledge that tackling climate change should be envisaged as one of the overwhelming challenges and responsibilities for governments. Between various factors that contribute to global warming, more attention has recently been paid to the use of energy and its effect, through greenhouse gases emissions, on the world's climate. In the UK, three prevalent strategies have been enabled from an integrated perspective to incentivise investment in energy efficiency and low-carbon technologies and to change behaviour. They are regulations, emissions trading and taxation [1].

As stated by the Department for Communities and Local Government [2], between the possible activities, measures in greening built environment represent a huge opportunity for energy saving and carbon reductions. Therefore, it is expected that, after embedding measures to tackle climate change within the planning system, particular attention should be paid to increase building standards as a follow-up step.

This paper intends to focus on building standards in the domestic sector as energy efficiency and carbon reductions in this field play a central role in the tackling of climate change [3,4]. As pointed out by the Department for Communities and Local Government [5], there are around one-third of the total housing stocks in the UK will be built between now and 2050. In order to achieve the mandatory objective of carbon-neural new homes progressively by 2016 [3], many relevant regulations and policies have been enacted. In this shift, the Code for Sustainable Homes has been widely acknowledged as a benchmark based on which new housing standards are expected to be introduced step by step. In 2010, new homes must be built to the very high energy efficiency standards, with minimum requirement of three stars in the Code; then four stars in 2013 and six stars in 2016 by increasing the use of renewable energy sources at homes [3,6].

In the housing market, many assessment tools have been developed to introduce sustainability values and principles into mainstream practice and to foster the agenda of sustainable homes. Currently the potential interventions that might increase the effectiveness of these housing assessment tools are mainly concerned with completed products and their performance in use, e.g. Post-Occupancy Evaluation (POE) [7] and Design Quality Indicators (DQI) [8]. However, more attention is now also paid to the process that created them [9] and the knowledge transfer between different stakeholder groups in the decision-making processes [10].

To help different stakeholders better understand their responsibility and appropriately address the relevant issues, the existing housing assessment tools have been widely described and evaluated. Their implementations have also been analysed and compared in terms of certain features, such

as mandatory or voluntary, quantitative or qualitative, complex or simple and so on. Until now, however, there is no one of them can truly accommodate all the competing parameters in the market or apply to all circumstances of housing construction alone. To select the most suitable ones and optimise the application according to their relevance, therefore, this paper intends to identify the specific features of different assessment tools, particularly focusing on their innovative aspects relevant to designers today.

2. Existing Housing Assessment Tools

Today many housing environmental assessment tools coexist in the shared market, being influenced by and subsequently influencing each other. As shown in Table 1, a close comparison is made between four popular housing assessment tools, BRE's EcoHomes (by Building Research Establishment), National Home Energy Rating (NHER), the Building Research Establishment Domestic Energy Model (BREDEM), and the Standard Assessment Procedure (SAP). It is based on certain important features that might be relevant to designers today. Different sized bullets are used to highlight the specific aspects or purpose of the assessment tools.

Table 1: Close comparisons based on certain features

Certain features \ Assessment Tools		EcoHomes	NHER	BREDEM	SAP
Dimensions of sustainability	Environment	●	•	•	•
	Economics				
	Socio-Equity				
Nature of assessment	Voluntary	•	•	•	
	Mandatory				●
Target buildings	Individual	•	•	•	•
	Communities	•			
Phases of building life cycle influenced	Pre-design	•	•	•	•
	Planning	•	•	•	•
	Design	•	•	•	•
	Construction	•			
	Operation	•	•	•	•
	Demolition				
Scope of assessment	Energy/CO2	•	●	●	●
	Water	•			
	Materials	•			
	Waste				
	Pollution	•			
	Management	•			
	Transport	•			
	Well-being	•			
	Land & ecology	•			
	Functionality				
	Appliances	•	•	•	•
Web-based information	Free access	•	•	•	•
	Free download	•			•
Software available	Yes		•		•
	No	•		•	
Regional approach	Yes		●		
	No	•		•	•
Related to user's lifestyle	Yes			●	
	No	•	•		•

In practice, these four housing environmental assessment tools are interrelated. BREDEM is used as the basis for both the SAP and the NHER scales [11]. As a nationally recognised energy rating procedure, the SAP is incorporated into the NHER to allow for direct comparison between different dwelling types in different locations in terms of energy efficiency. BRE's EcoHomes consists of a series of assessment techniques and rating systems, such as the SAP, Life Cycle Assessment (LCA), and the Green Guide to Specification and so on.

Nevertheless, from Table 1, it can also be found that different housing environmental assessment tools would often like to address sustainability principles from different perspectives. Since uncertainties and substantial gaps still prevail in either design or assessment processes, there is no one assessment tool can truly accommodate all the competing parameters in the market or apply to all circumstances of housing construction alone until now. On the other hand, the emphasis on different aspects of sustainability may differ widely across the live projects in terms of practice. When evaluating building sustainability issues, therefore, different stakeholders would prefer to address the underlying problems from different dimensions, by different procedures, through different formats and to different extents, taking account of their intrinsically varying incentives.

Recently there is a trend that building assessment tools have evolved to assist building design professionals [12]. However, in the short term, the most significant aspect of building sustainability assessment tools is still focused on 'the integration of issues, different ways of knowing, different perspectives, values and objectives in decision making' [9]. Therefore, the choice of housing environmental assessments in the decision-making process becomes a dynamic balance between 'what is theoretically possible' and 'what is practically most desirable' [13]. In order to steer the decision making processes from a problem-oriented perspective, it is important to make discerning choices by clearly defining the distinct roles and characteristics of the variety of housing environmental assessment tools. Hence similar review procedures (e.g. Table 1) can help architects select the most suitable tools and optimise the application.

3. Sustainable Housing Issues

It is argued that an isolated review of the building environmental assessment tools would not be sufficient to move the construction industry of UK to a sustainable state [14]. To have a deeper insight into evaluating the performance of environmental management systems for housing development, more attention should be paid to 'the side-by-side comparison of their technical features' [15]. Further, since not all factors can be dealt with by such concerns of decision making, there is a trend in the current housing market that leads to 'a socially and environmentally more

accountable handling' of the trade-offs between conflicting demands [16].

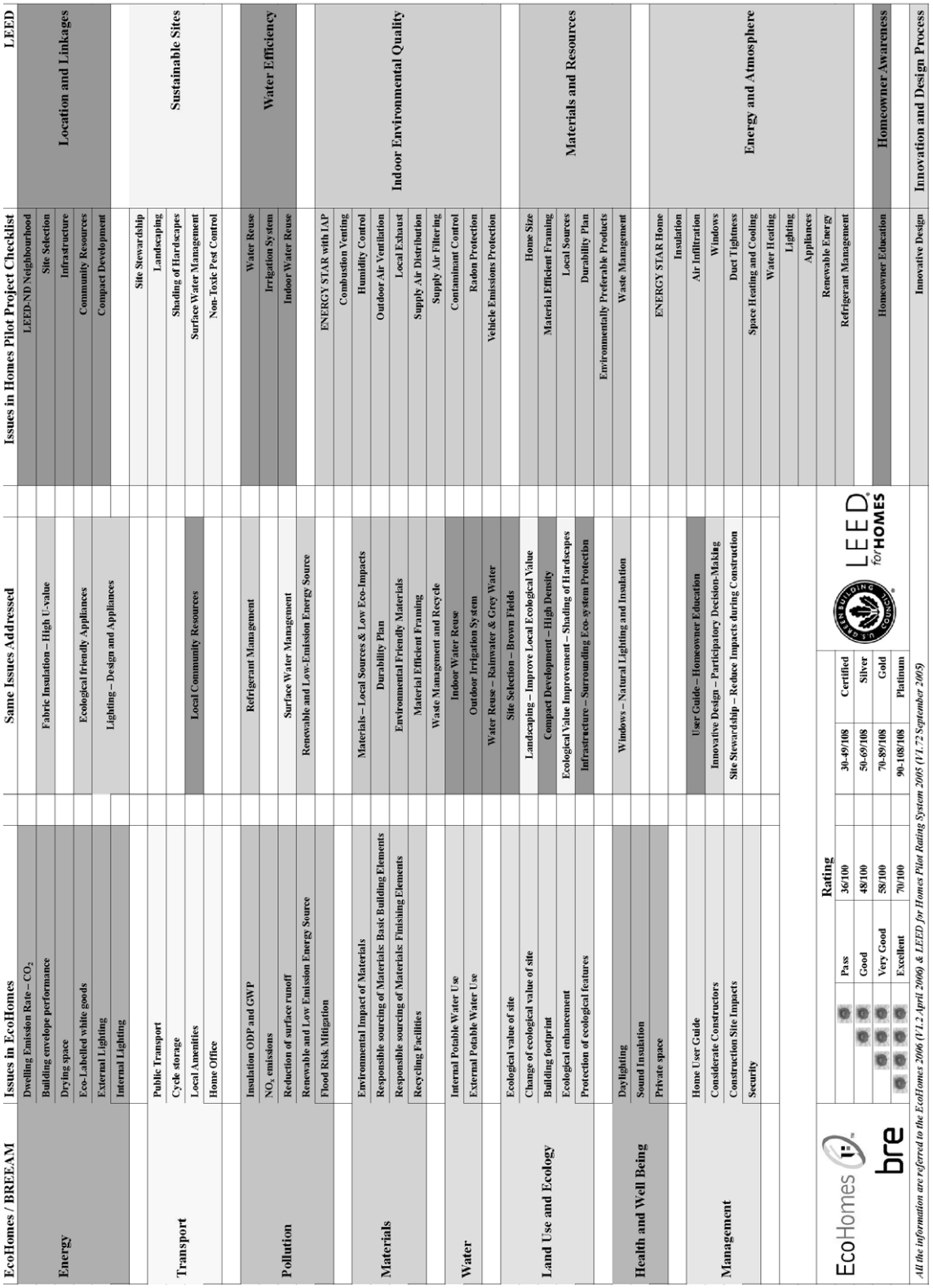

Fig 1. Latitudinal comparison of housing environmental issues addressed in EcoHomes 2006 and LEED for homes

To identify the palette of environmental issues that should be addressed in the housing design processes, LEED (Leadership in Energy and Environmental Design) for Homes in USA [17] and the EcoHomes by BREEAM (Building Research Establishment Environmental Assessment Method) in the UK [18] have been extensively examined and discussed in parallel in this paper. Each of them has been implemented in its national housing market and has been proved to be successful to some extent. As shown in Figure 1, although these two housing

environmental assessment tools are tailored for different national conditions, a general consensus has been reached. Some important issues have been addressed by both of them, such as fabric insulation, environmentally friendly appliances, light design and appliances and so on (issues in the middle column of Figure 1), although these issues have been classified into different categories in these two systems. To a great extent, these well-acknowledged housing environmental issues constitute a template of a 'minimal list of indicators' (standardization) which can be helpful for benchmarking purposes [19].

However, it is also important to note the principal difference between these two tools. LEED for Homes is more concerned with detailed design issues for single housing projects, such as issues in the category of 'Indoor Environmental Quality'. While in EcoHomes 2006, more attention has been paid to the communicational problems encountered in community development, such as issues in the category of 'Transport'.

To apply the housing environmental assessment tools to support the decision making processes, a further study is carried out based on the UK's circumstance, mainly focusing on EcoHomes and the Code for Sustainable Homes.

4. From EcoHomes to the Code for Sustainable Homes

As the housing version of BREEAM, EcoHomes aims to provide an authoritative rating for the property sector. Two relevant documents well known in the housing market are the Pre-Assessment Estimator and the Guidance [18]. Both of them are available online and can be free accessed. Compared with other sustainability regulations often remote from the design process, EcoHomes is a more straightforward, flexible and independently verified environmental assessment method [18] and has been revised more regularly. Furthermore, some important factors have also been embodied in the developmental targets of EcoHomes, such as integration through stakeholder participation, flexibility and one step ahead, transparency and accessibility and so on.

The Eco-point scale that underpinned EcoHomes was developed through a series of focus groups discussion. This procedure aims to 'establish a broad consensus on the weighting of different environmental impact categories' [20] and 'reconcile different expectations of an assessment tool' [16] among a variety of different cultural viewpoints. As a result, this checklist-based assessment tool involves assigning credits within each sub-area and establishes a weighting system between all areas that can be used for scoring.

Based on EcoHomes, the Code for Sustainable Homes (the Code) was released in 2006. After one year voluntary phase to gain experience in the methodology, it started to be applied as a mandatory rating requirement for all new homes from 2008. There are some differences between EcoHomes and the new Code. Compared with the retrospective manner of applying EcoHomes, the Code intends to assess the housing design processes from a more integrated perspective, from the early design stage review to the post construction review. Moreover, different levels in the Code are made up by achieving both 'the appropriate mandatory minimum standards' together with 'a proportion of the flexible standards' [21], which differs from the voluntary rating procurement of EcoHomes.

However, the Code also shares many important characteristics with its prototype EcoHomes. From a longitudinal comparison, it can be found that the scoring systems between these two assessment tools are similar. The Level 3 in the Code is approximately equal to the Very Good score in EcoHomes. Moreover, the palette of housing environmental issues addressed in these two assessment tools are almost same although they are classified into different categories and given with different credits. The main difference lays in that some issues, such as 'Construction Waste', 'Inclusion of composting facilities' and 'Lifetime Homes', have been firstly added to the new Code; while others, such as 'public transport' and 'local amenities' which used to be included in EcoHomes, have been removed. Certainly the credits for the same issue in different assessment systems also vary slightly.

Although the Code has been seen as a step forward by the Government, EcoHomes still plays an important role in housing market, especially for the sustainability assessment of existing housing stocks. Furthermore, since EcoHomes considers different housing environmental issues from a voluntary but balanced perspective, the credits available for each issue reflect its relative importance in the whole system. Hence in this paper, the framework of EcoHomes is used as the prototype of sustainability indicator to support the decision making processes.

5. Checklist-based Indicator for Sustainable Housing Design

It is argued that the methodologies often used to assess housing projects (for instance EcoHomes, the Code for Sustainable Homes and LEED for Homes) always attempt to quantify the often unquantifiable issues and require significant amounts of information to do so [22]. However, in the housing design processes, decisions are often made under some unlikely constraints, such as limited time, budget and so on. To apply assessment tools to assist design professionals, therefore, there is a need to develop a rapid but structured approach to compare the merits of different design measures across an agreed set of topics and obtain a picture of their relative importance. Principles related to efficiency and flexibility should also be addressed in terms of introducing this checklist-based indicator for sustainable housing design.

Architects should play an important role to introduce this indicator. It is expected that they could use this indicator as a communicational platform to get the message across and handle the trade-offs between different stakeholder

groups. On the other hand, it is also expected that this indicator could help architects make informed decisions and collaborate with other stakeholders efficiently at the key decision-points in the participatory design processes.

However, since EcoHomes is not designed for architect's specific demands, it is necessary to adjust its scheme towards typical design workflows and transfer its context to respond to those issues encountered in different decision-making stages. As a result, the scheme of EcoHomes is re-formulated to accompany the design phases as a hands-on guidance (Table 2). It is important to note that the environmental issues in EcoHomes need to be addressed at the very early phases of design decision-making (for instance 'brief' and 'sketch plans' according to Royal Institute of British Architects (RIBA's) Plan of Work [23]) to maximum benefits. In the indicator (Table 2), therefore, all the competing parameters in EcoHomes have been re-arranged according to a procedural sequence usually employed by architects' thinking.

Table 2: Sustainability indicator based on EcoHomes

Checklist: sustainable housing design	**EcoHomes 2006**	**Credits available**
♦ **Project Scheme and Management**		
Prefer to use brownfield site	Eco1	1.33
Plan to include local accessible amenities	Tra3	3.00
Protect local ecosystem in construction	Eco3	1.33
Constructors for site management	Man2	2.00
Site management to reduce the impacts	Man3	3.00
Safe and security issues	Man4	2.00
♦ **Master Plan**		
Enhance local ecological values	Eco2	1.33
Close to a public transport node	Tra1	2.00
High density (Floor Area / Footprint)	Eco5	2.67
Site-layout for natural daylighting & view	Hea1/2	2.625
Decide landscape categories	Eco4	5.33
♦ **Plan/Elevation/Section/Interior Design**		
Room and window design for daylighting	Hea1/2	2.625
Inter-/external naturally drying space	Ene3	0.92
Space and services for working at home	Tra4	1.00
High insulation standards	Ene2	1.83
Use ecological insulation materials	Pol1	0.91
Use sustainably sourced timber	Mat2+3	4.06
Material choice based on life-cycle rating	Mat1	7.23
Design and testing for sound insulation	Hea2	7.00
Private outdoor space	Hea3	1.75
Control systems for ex-/internal lighting	Ene5+6	3.66
Secure cycle storage	Tra2	2.00
Natural ventilation		
Passive solar design		
♦ **Supply & Reuse for Energy and Water**		
Onsite renewable/green energy supply	Pol4	2.73
Energy efficient heating/lighting	Ene1	13.75
Low-emission fossil fuel boiler/appliance	Pol2	2.73
Rainwater collection/sustainable drainage	Pol3	1.82
Low water use appliances	Wat1	8.33
Facilities to recycle rainwater	Wat2	1.67
♦ **Other details**		
Homes user guide	Man1	3.00
Energy-efficient white goods, i.e. fridge	Ene4	1.83
Facilities to recycle household waste	Mat4	2.71

The topics are grouped into five main categories: project scheme and management; master plan and landscape; plan, elevation, section, interior design; energy and water supply; other details. Compared with EcoHomes where all the issues are structured in a technical fashion, this new mapping procedure intends to reorganise these issues to be more related to the order of decision-making in an architectural project. It is important to note that the relationship between design measures and environmental issues are not always one to one. In contrast, integrated design thinking can address several environmental issues at the same time, while it is also possible that different design measures create similar environmental benefits.

Besides strategic direction to improve housing environmental performance as a qualitative checklist, this new indicator also provides a potential opportunity to allow architects to convert their decision making process from a qualitative procedure into a quantitative one. In EcoHomes, each design measure has been given a relevant credit in the *Pre-Assessment Estimator* and relevant detailed criteria in the *Guidance*. Hence architects may use these as a quantitative checklist (the column of 'credits available' in Table 2), decide to accept or reject a particular design measure according to its corresponding credit as well as how easy to meet the detailed requirements in real-life projects. Some issues in Table 2 have been highlighted as their corresponding issues in the Code have been required to achieve the mandatory minimum standards as entry levels. In terms of housing design, therefore, more attention should be paid to these issues.

However, whether this integrated decision making procedure will lead to a truly 'sustainable housing' is a more open question.

6. Conclusion

This paper intends to apply the existing housing environmental assessment tools to support the design process. Some principal research findings of this study have been summarised as following:

- Until now, there is no one housing environmental tool can truly accommodate all the competing parameters in the design processes alone. Thus, it is important to identify the specific characteristics of different assessment tools and make informed decisions through side-by-side comparisons.
- There is a general consensus on the palette of environmental issues that should be addressed in the housing design processes. These well-acknowledged issues can be used as a common language in the participatory decision-making processes or the worldwide debate about sustainable housing design.
- EcoHomes can be used as a checklist-based indicator for sustainable housing design. The combined determination, with both qualitative and quantitative perspectives, can help architects

consider the palette of environmental issues in an order of relative importance systematically, and encourage them to undertake analysis of alternative design measures consciously.

- Although this initial attempt might not be sufficient to bring forth green housing immediately, this study for EcoHomes will help architects increase their familiarity with a systematic thinking of environmental aspects by means of indicators.

Furthermore, it is argued that, besides adopting a progressive perspective, the ultimate success of the application of environmental assessment tools will depend on if, and to what extent, a consensus can be reached among the key stakeholders in the participatory decision making processes [16]. Therefore, besides addressing the specific characteristics of EcoHomes, such as integration, transparency and accessibility, this paper also highlights its potential responsibility for collaborative learning.

Since the system for value judgement used in EcoHomes can be seen as a common language that could help get the message across between different stakeholder groups, further work is expected to construct a communicational platform based on it to facilitate the knowledge transfer in the housing design processes.

7. Acknowledgements

Thanks are due to financial support provided by the Henry Lester Trust and the Great Britain-China Educational Trust.

8. References

1. Climate Change Strategic Framework, [Online], Available: http://www.defra.gov.uk/environment/climatechange/uk/legislation/pdf/CCBill-Strategy.pdf [1 June 2008]

2. Global Warming, Local Leadership: Speech by Ruth Kelly MP at the Green Alliance summit on local government and climate change, [Online], Available: http://www.communities.gov.uk/index.asp?id=1509388 [1 June 2008]

3. Building a Greener Future: Towards Zero Carbon Development, [Online], Available: http://www.communities.gov.uk/archived/publications/planningandbuilding/buildinggreener [3 June 2008]

4. Energy and climate change – Energy efficiency, [Online], Available: http://www.defra.gov.uk/environment/climatechange/uk/energy/efficiency.htm [3 June 2008]

5. Department for Communities and Local Government, (2006). *Code for Sustainable Homes – A step-change in sustainable home building practice*. London: Communities and Local Government Publications

6. Banfill, P. and A. Peacock, (2007). Energy-efficient new housing – the UK reaches for sustainability. *Building Research and Information*, 35(4): p.426-436

7. Bordass, B., Leaman, A. and Ruyssevelt P., (2001). Assessing building performance in use. *Building Research and Information*, 29(2): p.144-157

8. Gann, D., Salter, A. and Whyte J., (2003). Design Quality Indicator as a tool for thinking. *Building Research and Information*, 31(5): p.318-333

9. Kaatz, E., Root, D. Bowen, P. and Hill, R., (2006). Advancing key outcomes of sustainability building assessment. *Building Research and Information*, 34(4): p.308-320

10. Cole, R., (2005). Building environmental assessment methods: redefining intentions and roles. *Building Research and Information*, 35(5): p.455-467

11. NHER (National Home Energy Rating), [Online], Available: www.nher.co.uk/ [5 June 2008]

12. Hyde, R., Prasad, D. Blair, J. Moore, R., Kavanagh L., Watt M. and Schianetz K., (2007). In *the 24th Conference on Passive and Low Energy Architecture (PLEA)*. Singapore, November 551-558

13. Malmqvist, T. and M. Glaumann, (2006), Selecting problem-related environmental indicators for housing management. *Building Research and Information*, 34(4): p.321-333

14. Proposals for Introducing a Code for Sustainable Homes: a Consultation Paper, [Online], Available: http://www.defra.gov.uk/environment/climatechange/uk/energy/efficiency.htm [4 June 2008]

15. Cole, R., (2006). Shared markets: coexisting building environmental assessment methods. *Building Research and Information*, 34(4): p.357-371

16. Dammann S. and M. Elle, (2006). Environmental indicators: establishing a common language for green building. *Building Research and Information*. 34(4): p.387-404

17. Rating System for Pilot Demonstration of LEED for Homes Program Version 1.72 (September 2005), [Online], Available: http://www.usgbc.org/ShowFile.aspx?DocumentID=855 [7 June 2008]

18. EcoHomes 2006 – The environmental rating for homes: The Guidance / Pre Assessment Estimator – 2006 / Issued 1.2 April 2006, [Online], Available: http://www.breeam.org/ecohomes.html [7 June 2008]

19. Lutzkendorf, F. and D. Lorenz, (2006). Using an integrated performance approach in building assessment tools. *Building Research and Information*. 34(4): p.334-356

20. Howard, N., (1998). *Ecopoints – A Consensus for Building*. Watford: Building Research Establishment.

21. The Code for Sustainable Homes, [Online], Available: http://www.breeam.org/page.jsp?id=86 [7 June 2008]

22. Gething, B. and B. Bordass, (2006). Rapid assessment checklist for sustainable buildings. *Building Research and Information*. 34(4): p.416-426

23. RIBA ed., (1999). *Standard form of agreement for the appointment of an architect:*

(SFA/99). London: Royal Institute of British Architects