Sustainable building rating systems and high performance buildings

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ABSTRACT

The current rate of consumption across Europe is leading to environmental problems. We need to reduce our impact to nature - our ecological footprint – by two thirds to achieve a sustainable and globally equitable level. There is a strong need for more efficient and sustainable buildings. At present it is difficult to define the performance of buildings in an objective way to efficiency and sustainability. Goal of this project is to examine and to understand differences between different 'green' building assessment rating systems approaches when applied to high performance buildings. To get some experience we started by analyzing 30 buildings from Germany and the Netherlands, after which we selected the best 3 of both countries for a more thorough comparison. In this way we were sure to have real high performance buildings.
In total 6 buildings were compared and analyzed by using BREEAM, the ecological footprint, greencalc+ and LEED. The aim of the paper is to look if the current green building assessment methods are proper tools to use for the sustainable assessment of high performance buildings. These high performing buildings show that the assessment tools were not developed for such buildings which often have extreme design strategies as leading principles. As a result one should be careful with the interpretation of the out come of such assessment tools. Different tools give different results. However the possible trade of between sustainability and good indoor climate is not made in high performance buildings as both aspects have to be good. When focusing on these combined aspects there is a slight preference for LEED.

KEYWORDS

Green building assessment, BREAAM, LEED, Ecological footprint, Greencalc+.

INTRODUCTION

We need to reduce our environmental impact - our ecological footprint – by two thirds to reach a sustainable and globally equitable level. This can only be reached by sustainable design. Often decision makers assume that sustainable design is mainly about resource conservation – energy, water, and material resources. The last ten years, however, has seen a dramatic broadening of the definition of sustainability (Loftness et al. 2006). This broader definition of sustainability is represented in the US by the LEED™ (Leadership in Energy and Environmental Design) standard of the US Green Building Council (Loftness et al. 2006). There is a strong need for more efficient and more intelligent and green (sustainable) buildings. At present it is difficult to define the performance of buildings in an objective way to efficiency and sustainability. Goal of this project was to examine and to understand differences between different building rating systems approaches and to focus on the aspects of ventilation and indoor climate.

METHODOLOGY

In November 2003 a project was started, in which students compared 15 Dutch and 15 German modern office buildings. As a result of that former project in November 2004 the 4 best Dutch and German buildings were compared more thorough with each other and it was examined in which extent the Dutch and the German buildings are intelligent (Lony et al. 2006).

The research method we used as a starting point is derived from Stewart Brand's six general-purpose sheering layers for analyzing a building, called the six S's; Site, Structure, Skin, Services, Space plan and Set (chairs, pictures, appliances) (Brand 1994, Clements-Croome 2002).). The evaluation is based on the six principal aspects of Brand that can be applied to a comparison between buildings. An Intelligent Building is one that provides a productive cost effective environment through the optimisation of six basic elements; site, skin, systems, structures, services, space plan and stuff and the interrelationship between them. Based on these six aspects the comparison was made for the following pairs of similar buildings:

Hoftoren, Den Haag – Post Tower, Bonn (high rise office buildings)
Thermostaete, Bodegraven – Landesvertretung NRW, Berlin (small experimental sustainable offices)
Forum, Amsterdam – Spherion, Düsseldorf (top-end market offices)
Hoogheemraadschap, Leiden – Energieforum, Berlin (high quality sustainable offices)

The chart below shows the appreciations of the six S-aspects of the evaluated buildings on a scale from 0 to 100 %. Besides the evaluated two buildings the average of all the 8 evaluated buildings is shown in the graph as a reverence. Also the average total score on all the six S-aspects is given. For all the pairs of buildings that are compared a separate chart is made.

The resulting chart of the comparison between Hoftoren and Post Tower shows that the Post Tower is better on almost all aspects. Overall both buildings score high, but based on the aspects of the six S's the Post Tower is best appreciated, see Fig. 1.

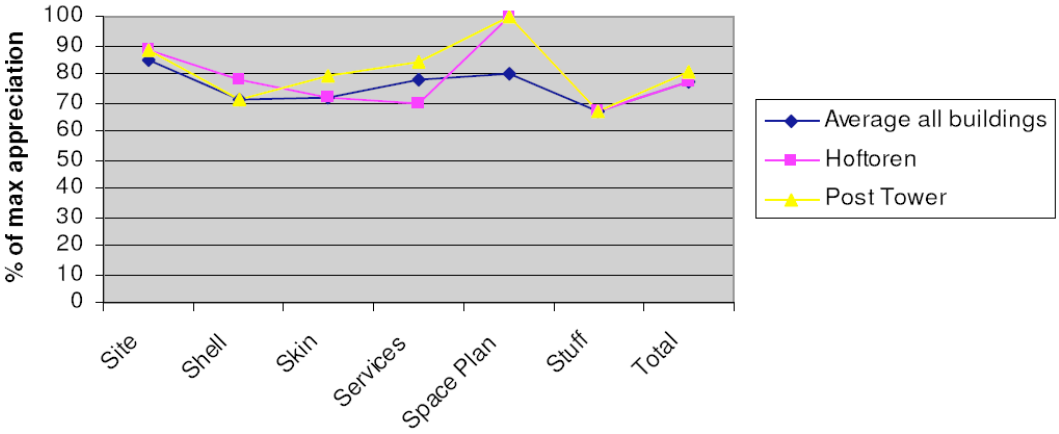

Figure 1. Results comparision buildings by the six-S rating system.

Comparing BREEAM, LEED, Greencalc+ and Ecological footprint.

Based on the experience gained with the former comparing of buildings the focus now became sustainability. As there are many sustainability building rating systems, with LEED and BREEAM the most popular ones, we wanted to look into more detail in two alternative methods: Ecological Footprint and GreenCalc+. Important is of

course also the right set of buildings by which you compare the different methods. Therefore in this second stage of the research we toke for evaluation the three best buildings from the Netherlands and Germany. To look for sensibilities we added three new buildings which were developed using specific sustainable design strategies: WWF building in Zeist (zero CO2 emissions), XX building in Delft (calculated life expectation 20 years) and the first Cradle-to Cradle office in Amsterdam. So the buildings are:
Thermo staete in Bodegraven (The Netherlands).
Spherion in Dusseldorf (Germany).
Energy forum in Berlin (Germany).
WWF in Zeist (The Netherlands).
XX building in Delft (The Netherlands).
Cardle to cardle office in Amsterdam (The Netherlands).

Ecological footprint
The Ecological footprint analysis compares human demand on nature with the biosphere's ability to regenerate resources and to provide services. It does this by assessing the biologically productive land and marine area required to produce the resources a population consumes and absorb the corresponding waste, using prevailing technology. This approach can also be applied to an activity such as the manufacturing of a product or driving of a car. This resource accounting is similar to life cycle analysis where in the consumption of energy, biomass (food, fibre), building material, water and other resources are converted into a normalized measure of land area called 'global hectares' (gha).
Per capita Ecological footprint (EF) is a mean of comparing consumption and lifestyles, and checking this against nature's ability to provide for this consumption. The tool can inform policy by examining to what extent a nation uses more (or less) than is available within its territory, or to what extent the nation's lifestyle would be represent able worldwide. The input values for this program are divided in the following groups:
- Building and construction:
- Energy & water:
- Food:
- Travel:
- Consumable items;
- Recycling;

Greencalc+
The development of GreenCalc started in 1997. After GreenCalc had been developed, the developers saw that one of its shortcomings was the inability to use the software for building types other than office buildings; this was the motivation to develop GreenCalc+, which suited also other building types, such as schools, health centres and stores, but also urban development projects (Sureac Trust, 2008). The Greencalc+ assessment method is a questionnaire which allows you to estimate how much land it takes to run and maintain your office. The GreenCalc+ software consists of four modules, each representing a different aspect of the building characteristics; mobility, materials, water and energy. The input values for this program are divided in the following groups:
- Materials:
- Energy:

- Water:
- Travel to and from work:

LEED

LEED was developed by the US Green Building Council (USGBC) for the US Department of Energy. The pilot version (LEED 1.0) for new construction was first launched at the USGBC Membership Summit in August 1998 (Lee and Burnett 2007). In March 2000, LEED Version 2.0 based on modifications made during the pilot period was released. Since then, LEED continues to evolve to respond to the needs of the market and to expand to cover other building types. The most current LEED for New Construction Version 2.2 was released in November 2005. Current versions for other building types, including schools, homes, etc. were either released in 2006 or scheduled to be released. So far LEED is one of the most recognized building environmental assessment schemes. LEED registered projects are in progress in 24 different countries, including Canada, Brazil, Mexico, India and China, and the World Green Building Council— an affiliation of seven national green building councils, including the US.

BREEAM

The first Building Research Establishment Environmental Assessment Method (BREEAM), launched and operated by the Building Research Establishment (BRE) in UK, came into prominence in 1990 (Lee and Burnett 2007). Version 1 BREEAM for offices was first revised in 1993. The second revision was launched in September 1998. The current BREEAM version for non-domestic premises is BREEAM 2008. It covers a range of building types, including offices; industrial premises eco-homes; courts; prisons; retail outlets; schools; multi-residential, etc. It is one of the best-known schemes and has embraced 15–20% of the new office building market in the UK. BREEAM has also been taken as a reference model when similar schemes were developed in Canada, New Zealand, Norway, Singapore and Hong Kong.

RESULTS

Comparing all programs with one another.
Many subjects are checked with the checklists of LEED and BREEAM. But not all subjects can be used for comparing all programs because of Ecological footprint and Greencalc+. Ecological footprint and Greencalc+ can only be compared at the aspects “materials, land use & ecology”, “energy”, “water” and “transport”. All assessment methods are expressed in different values, namely:
- Global hectares for the program “ecological footprint”.
- Earths environment costs (€) for Greencalc+.
- Credits for the checklists of LEED and BREAAM.

To compare all assessment methods, they need to be calculated in percentages per subject for each building (%). All assessment results of the subjects for the different tools are expressed in percentages so that they can be compared with one another. The results of the comparison of each specific aspect of the different assessment methods and buildings are given in the Fig. 1.
The total results of the 4 assessments methods shows that there is a rather big fluctuation in total score between buildings, see Fig.1. This makes it very difficult to use them as a management tool within the sustainable architectural design.

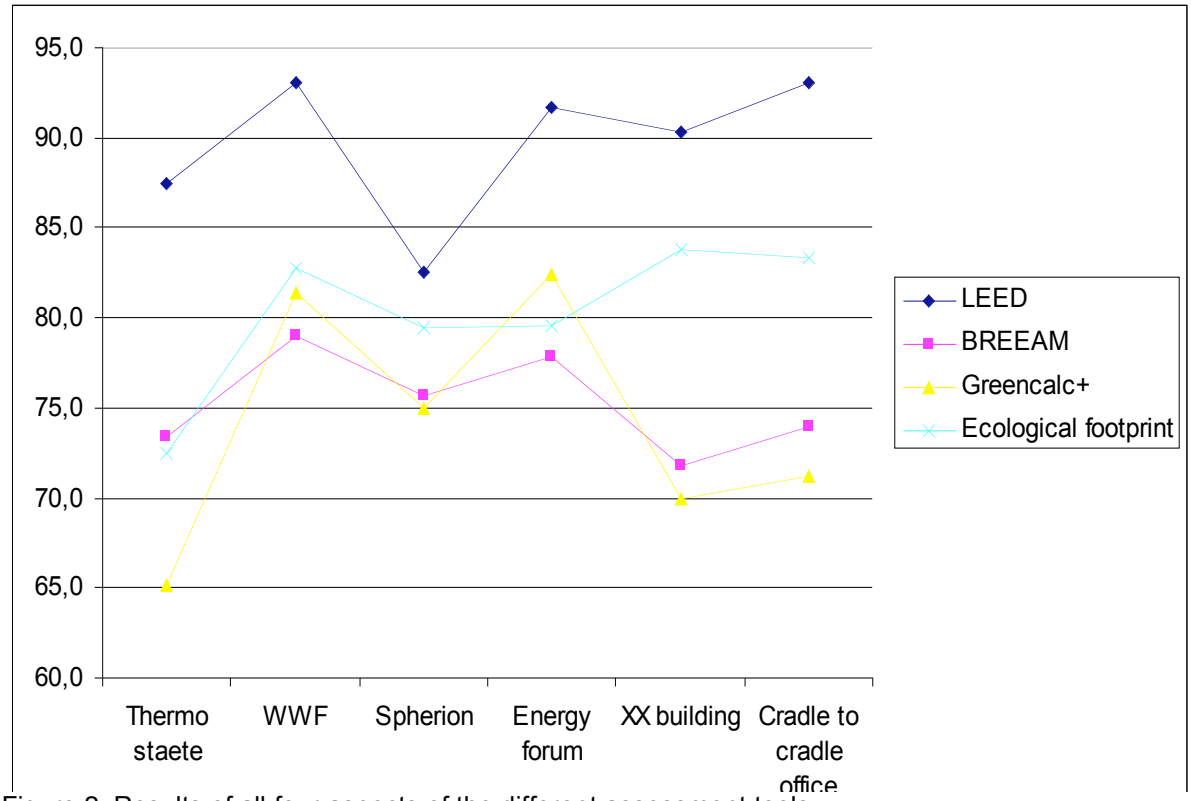

Figure 2. Results of all four aspects of the different assessment tools

As can be seen from Fig 2, there are quite some differences in the outcome of the comparison between buildings as the result of the different sustainable assessment tools. The following Fig. 3 shows the order of ranking from the best to the worst results, resulting from each different assessment method;

Ranking	1	2	3	4	5	6
LEED	WWF	C2C	EF	XX	TS	SF
BREEAM	WWF	EF	SF	C2C	TS	XX
Greencalc+	EF	WWF	SF	C2C	XX	TS
Ecological footprint	XX	C2C	WWF	EF	SF	TS

Figure 3. Ranking as a result from the evaluations by the different sustainable assessment tools.

Many aspects are evaluated with the assessment tools LEED and BREEAM. But not all aspects can be used for analyzing the performance of all aspects of a building because par example Ecological footprint and Greencalc+ can only be compared at the aspects “materials, land use & ecology”, “energy”, “water” and “transport”. Focussing on ventilation we therefore had to look at LEED and BREEAM. The aspect ventilation is part of the category Indoor Environmental Quality of LEED and is weighted with a maximum of 15 out of 69, where as the aspect ventilation is part of the category Health & wellbeing of BREEAM and is weighted with a maximum of 15 out of 100. So within LEED the aspect of ventilation is of more importance. When we look at the rating of the different categories we see that within LEED al project reach the same score 14 out of the maximum 15, where as with BREEAM the evaluation leads to differences between the project, a range from 10,4 to 12,7 out of a maximum of 15.

Results of all buildings with LEED.	Max. score	Thermo Staete	WNF	Spherion	Energy forum	XX	C-to-C office
Indoor Environmental Quality	15	14	14	14	14	14	14
Results of all buildings with Breeam. Health & wellbeing	15,0	12,7	12,7	11,5	11,5	11,5	10,4

DISCUSSION

A major challenge is the achievement of high sustainability, meaning energy efficient ventilation while providing a good indoor climate. In all the investigated high performance buildings the ventilation is good and there are only differences in evaluation depending on which sustainability assessment tool you use. It is difficult to determine the true value of the different assessment tools as they are still under construction and all have some flaws. Which will become the International tools is hard to tell, but probably it will be necessary to make a combination of the strong elements of each tool. This is closely related with the latest news on BREEAM and LEED (Building Sustainable Design, 2009); “BREEAM, LEED and Green Star are to collaborate in an effort to bring their environmental assessment rating tools into line The UK, US and Australian bodies will “map and develop common metrics to measure emissions of CO2 equivalents from new homes and buildings”. A working group will look at ways of achieving a better level of consistency in how and what the rating tools measure and how that information is reported. The agreement was signed at Ecobuild in London last month. The sustainability event also saw the launch of BREEAM In-Use, a scheme to help facilities managers reduce running costs and improve the environmental performance of buildings.It offers an online assessment tool and a third-party certification process. The scheme is in three parts:

- asset performance – inherent performance characteristics of the building based on its built form, construction and services;
- building management performance – policies, procedures and practices related to building operation; consumption of such resources as energy and water; environmental impacts such as carbon and waste generation; and
- organizational effectiveness – understanding/implementation of policies, procedures and practices; staff engagement; and delivery of key outputs.”

As the evolution of the different tools continues in the coming years, one key aspect will be if the design is assessed against a standard set of codes or regulations throughout, as with ASHRAE for LEED, or whether local and regional codes and regulations can be used, as with BREEAM (Rivera 2009). Important however is to realize that these assessment tools do not facilitate proactive investigation of the creative solution space of a project or the architectural aesthetics involved in building design. So as such they do not support innovation and synergy in building design (Hansen and Knudstrup 2009). It will be necessary to develop tools which facilitate proactive investigations of project specific solution spaces, whilst enabling of the project once it is finished(Hansen en Knudstrup 2009). At the moment is seems the focus is on the certification and not on the necessary innovation.

CONCLUSION

As there is a rapid increasing interest in high performance buildings no one can afford to wait for the developments in the field of sustainable assessment tools to settle down. At the moment from the perspective of ventilation of high performance buildings we have a slight preference for LEED as sustainable building assessment tool.

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