Energy Efficiency: Comparison between GREENSHIP and LEED

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ABSTRACT

This paper compares the energy efficiency in the two green building rating tools i.e. GREENSHIP and LEED. The study has been carried out by comparing the energy performance standard and the energy calculation method of both rating tools. GREENSHIP uses the OTTV (overall thermal transfer value) to measure the efficiency of energy use of the building design, while LEED uses ASHRAE standard for baseline building. The result shows that the energy standard uses in LEED rating tool is more stringent than the one uses in GREENSHIP and the energy calculation method uses in LEED is more accurate than the one uses in GREENSHIP.

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1. Introduction

Green building tool is a rating system to assess the environmental performance of buildings during the lifecycle of the building in order to quantify the quality of building performance. This assessment tool consists of many important aspects for making sure that the building is environmentally friendly. Basically, green building rating system consists of five categories as follows: Sustainable site, Water efficiency, Energy efficiency, Material and resources, and Indoor environmental quality.

There has been a growing movement towards green building since the second half of the 1980s, leading to the development of various methods for evaluating the environmental performance of buildings. Methods developed around the world include BREEAM (Building Research Establishment Environmental Assessment Method) in the UK, LEED (Leadership in Energy and Environment Design) in the USA, HK-BEAM (Hong Kong Building Environmental Assessment Method) in Hong Kong, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, GBTool (Green Building Tool) in Canada, Green Star in Australia, and so on. These methods have attracted interest around the world including Indonesia.

GREENSHIP is one of emerging green building tool developed by Green Building Council Indonesia (GBCI). GBCI has been established in 2009 and has become a member of World Green Building Council (WGBC). The GREENSHIP for New Building version 1.0 was launched in 17 June 2010. It is to assess the green performance of building design, construction and operation in Indonesia. The first building registered for this certification is the Minister of Public Works Building. In order to accommodate the existing building stocks, the GBCI has also launched the GREENSHIP for Existing Building in 13 January 2011 (GBCI, 2010a).

LEED is a well known green building rating tool developed by U.S. Green Building Council (USGBC) in 1996. It has been widely accepted in U.S., Canada, India, and it is internationally recognized around the world. According to USGBC website, currently there were 22,448 certified projects which are equal to 1.495 billion sf. around the world (USGBC, 2011a). The energy performance report shows that LEED certified buildings have 25-30 use less energy than the US national average (Turner & Frankel, 2008). Currently, LEED has nine rating systems as follows (USGBC, 2011b):

• New Construction (NC)
• Existing Buildings: Operations & Maintenance (EB: O&M)
This paper will compare the energy saving assessment of the two rating tools. To achieve the objective the paper will be carried out as follows:

1. Review the general aspect of the two rating tools
2. Review the criteria/standard adopted by the two rating tools
3. Review the energy assessment method used by the two rating tools

2. Review of the General Aspect

The comparison of categories between GREENSHIP and LEED NC 2009 are shown in Figure 1. As shown in Figure 1, GREENSHIP has six categories (GBCI, 2010b), while LEED NC 2009 has seven categories (USGBC, 2009). Both rating tools set the priority in the energy conservation which shown in the percentage of credits. However, the weights are different. GREENSHIP has 25% of energy credits, while LEED NC 2009 has 32%. Therefore, it is clear that LEED NC 2009 has higher concern in energy conservation than GREENSHIP.

![Figure 1: General Comparison between GREENSHIP and LEED NC 2009](image)

For the comparison purpose, the prerequisites and credits in the energy category of the two rating tools are shown in Table 1. GREENSHIP NB version 1.0 has two prerequisites and five credits, while LEED NC 2009 has three prerequisites and six credits. From Table 1, it is clear that not all prerequisites and credits have direct correlation between the two rating tools. The prerequisite 1 of GREENSHIP electrical sub metering is not set up as one of prerequisite in the LEED NC 2009. However, similar credit is listed in LEED NC 2009 as Credit 5 Measurement and Verification. The intent of EA Credit 5 is to provide for the ongoing accountability of building energy consumption over time meets the criteria of EEC Prerequisite 1. Both rating tools require a minimum energy performance which is listed as EEC Prerequisite 2 and EA Prerequisite 2, respectively. Both rating tools also provide credits that measure the energy efficiency and the onsite renewable energy.

Other credits such as EEC 2 Natural lighting and EEC 3 Ventilation are not part of Energy and Atmosphere (EA) category in the LEED NC 2009. These credits are listed in another category i.e. Indoor Environmental Quality (IEQ). The refrigerant impact on the environment is listed as EA Prerequisite 3 and EA Credit 4 in LEED NC 2009 but it is not listed in EEC. The refrigerant impact is a part of Material Resources and Cycle (MRC) category. This indicates that both rating system concern about the impact of refrigerant on the environment, especially on the ozone depletion and global warming. In order to make sure that all building energy systems working properly, LEED require the Fundamental Commissioning of Building Energy System and provide additional credits in EA Credit 3 Enhanced Commissioning. These commissioning prerequisite and credit are not listed as part of EEC in GREENSHIP, but it listed in the Building Environmental Management (BEM) category as credit BEM 4 Proper Commissioning. Even though some prerequisites and credits are listed...
in different categories, both rating tools covers almost the same prerequisites and credits related to the energy conservation.

Table 1: Comparison of Prerequisites and Credits in the Energy Efficiency Category between GREENSHIP and LEED NC 2009

<table>
<thead>
<tr>
<th>Prerequisite/ Credits</th>
<th>GREENSHIP NB version 1.0</th>
<th>LEED NC 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EEC Prerequisite 1 Electrical Sub Metering</td>
<td>EA Prerequisite 1 Fundamental Commissioning of Building Energy System</td>
<td></td>
</tr>
<tr>
<td>EEC Prerequisite 2 OTTV Calculation</td>
<td>EA Prerequisite 2 Minimum Energy Performance</td>
<td></td>
</tr>
<tr>
<td>Credits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EEC 1 Energy Efficiency Measure</td>
<td>EA Credit 1 Optimize Energy Performance</td>
<td></td>
</tr>
<tr>
<td>EEC 2 Natural Lighting</td>
<td>EA Credit 2 On-site Renewable Energy</td>
<td></td>
</tr>
<tr>
<td>EEC 3 Ventilation</td>
<td>EA Credit 3 Enhanced Commissioning</td>
<td></td>
</tr>
<tr>
<td>EEC 4 Climate Change Impact</td>
<td>EA Credit 4 Enhanced Refrigerant Management</td>
<td></td>
</tr>
<tr>
<td>EEC 5 On Site Renewable Energy</td>
<td>EA Credit 5 Measurement and Verification</td>
<td></td>
</tr>
</tbody>
</table>

Source: (GBCI, 2010b; USGBC, 2009)

For the next review, one prerequisite and one credit have been selected i.e. Prerequisite 2 and Credit 1. The requirements of both prerequisite/credit are listed respectively in Table 2 and 3 for GREENSHIP and LEED NC 2009.

Table 2: Description of Energy Performance Requirements of GREENSHIP

<table>
<thead>
<tr>
<th>Prerequisite/ Credit</th>
<th>Description of Requirement</th>
<th>Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 2 OTTV Calculation</td>
<td>OTTV Calculation shall be based on National Standard (SNI) 03-6389-2000 on Building Envelope Energy Conservation in Building Structures.</td>
<td>Required</td>
</tr>
<tr>
<td>EEC 1 Energy Efficiency Measure</td>
<td>OPTION 1 EEC 1-1. Energy modeling software Calculating energy saving by using Energy Modeling Software Simulation. The saving is a comparison on Energy Intensity requirement between the baseline and the designed building. Saving has to reach 10% reduction from baseline. Points will be awarded for every 2.5% reduction after (this calculation is mandatory for Platinum).</td>
<td>1-20</td>
</tr>
<tr>
<td></td>
<td>OPTION 2 EEC 1-2. Standardize Worksheet Calculating energy saving by using worksheet calculation between the baseline and the designed building. Saving has to reach 10% reduction from the baseline. Points will be awarded for every 2% reduction after.</td>
<td>1-15</td>
</tr>
<tr>
<td></td>
<td>OPTION 3 EEC 1-3. Prescriptive measures Conducting prescriptive separate energy saving measures by consider OTTV on Building envelope, artificial lighting, vertical transportation, and coefficient of performance on AC equipment.</td>
<td>1-5</td>
</tr>
<tr>
<td>EEC 1-3-1 BUILDING ENVELOPE</td>
<td>Every reduction of 3 W/m2 from 45 W/m2 OTTV baseline (SNI 03 - 6389 - 2000), attains 1 point.</td>
<td></td>
</tr>
<tr>
<td>EEC 1-3-2 NON-NATURAL LIGHTING</td>
<td>1. Energy requirement for lighting shall reach 30% lower than SNI 03 - 6197-2000 baseline. 2. Using 100% high frequency ballast for office room. 3. Light zoning for all office rooms which connect with motion sensors. 4. Locating light-switch in arm opening distance from the room’s exit door.</td>
<td></td>
</tr>
<tr>
<td>EEC 1-3-3 VERTICAL TRANSPORTATION</td>
<td>1. Using traffic management system in elevator which passes traffic analysis test, or using regenerative drive system. 2. Using saving energy features in elevator system connecting to motion sensors, or using sleep mode in escalator system.</td>
<td></td>
</tr>
<tr>
<td>EEC 1-3-4 COP</td>
<td>Using Chiller with COP minimum of 10 % higher than SNI 03-6390-2000 baseline.</td>
<td></td>
</tr>
</tbody>
</table>

Source: (GBCI, 2010b)
### Table 3: Description of Energy Performance Requirements of LEED NC 2009

<table>
<thead>
<tr>
<th>Prerequisite/Credit</th>
<th>Description of Requirement</th>
<th>Point</th>
</tr>
</thead>
</table>
| EA Prerequisite 2 Minimum Energy Performance | **OPTION 1. Whole Building Energy Simulation**
Demonstrate a 10% improvement in the proposed building performance rating for new buildings, or a 5% improvement in the proposed building performance rating for major renovations to existing buildings, compared with the baseline building performance rating. | Required |
| EA Credit 1 Optimize Energy Performance | **OPTION 1. Whole Building Energy Simulation**
Demonstrate a percentage improvement in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007 (with errata but without addenda) using a computer simulation model for the whole building project. Points will be awarded for every 2% improvement after 10% as specified in the Prerequisite 2. | 1-19  |

Source: (USGBC, 2009)

### 3. Review of the Criteria/Standard

As seen in Table 2, the GREENSHIP Prerequisite 2 OTTV calculation requires all registered buildings to carry out the Overall Thermal Transfer Value (OTTV) calculation. The OTTV should be calculated based on SNI 03-6389-2000 for Energy Conservation of Building Envelope (BSN, 2000) and the value should not exceed 45Watt/m². This SNI has been developed based on the reference from: 1) ASEAN-USAID, Building Energy Conservation Project, ASEAN = Lawrence Berkeley Laboratory, 1992; 2) ASHRAE, Standard on Energy Conservation in New Building Design, 1980; 3) BOCA, International energy conservation code 2000; and 4) The Development & Building Control Division (PWD) Singapore: Handbook on Energy Conservation in Buildings and Building Services, 1992.

On other hand, LEED NC 2009 minimum energy performance requires the building design to comply with ASHRAE Standard 90.1-2007 (ASHRAE, 2007). This standard regulates several sections as follows: 5) Building Envelope; 6) Heating, Ventilating and Air-conditioning; 7) Service Water Heating, 8) Power, 9) Lighting and 10) Other Equipment. The building design should comply with sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 of this standard. For small buildings, LEED provides opportunity to use a prescriptive ASHRAE Advanced Energy Design Guide. The conditions to use these respective guides are as follows:

- ASHRAE Advanced Energy Design Guide for Small Retail Buildings 2006. The building must meet the following requirements: less than 20,000 square feet and Retail occupancy.
- ASHRAE Advanced Energy Design Guide for Small Warehouses and Self Storage Buildings 2008. The building must meet the following requirements: less than 50,000 square feet and warehouse or self-storage occupancy.
Another prescriptive compliance path is that Advanced Buildings Core Performance Guide. The building should comply with the prescriptive measures identified in the Advanced Building Core Performance Guide developed by the New Buildings Institute. The building must meet the following requirements:

- Less than 100,000 square feet.
- Comply with Section 1: Design Process Strategies, and Section 2: Core Performance Requirements.
- Office, school, public assembly, and retail projects less than 100,000 square feet must comply with Section 1 and Section 2 of the Core Performance Guide.
- Other project types less than 100,000 square feet implement the basic requirements of the Core Performance Guide.
- Health care, warehouse and laboratory projects are ineligible for this path.

The use of OTTV as the only control parameter has been criticized. The method is inadequate and cannot ensure energy is used efficiently in the building. This is because the OTTV only deals with the building envelope and does not consider other aspects of building design (such as lighting and air-conditioning) and the coordination of building systems to optimize the combined performance (Yik & Chan, 1995). Before other energy codes are implemented, the effect of the OTTV standard on ‘real’ energy savings is questionable, although it helps to increase concern and awareness of energy efficiency matters (Hui, 1997). Yik and Wan (2005) also found that the OTTV calculated with the use of pre-calculated coefficients may not truly reflect the thermal performance of a building envelope. To get more accurate result, the use of OTTV should be combined with other code/standard. Many countries such as Hong Kong now moving towards energy performance criteria/code, in order to get more accurate results (EMSD, 2005).

4. **Review of the Energy Assessment Method**

The GREENSHIP Prerequisite 2 OTTV calculation requires simple method to comply this requirement. It requires the calculation of thermal transfer of the building envelope. This method only accounts some aspect of energy performance in buildings. This method does not account the use of more sustainable system such as daylight control. On the other hand, EA Prerequisite 2 of LEED NC 2009 requires energy simulation method to show the building design satisfaction to ASHRAE Standard 90.1-2007. Energy simulation is a method for predicting the energy consumption of a building. The analysis considers the building's numerous thermal characteristics including the materials of the walls and rest of the building envelope, the size and orientation of the building, how the building is occupied and operated, and the local climate. In addition, EA Prerequisite 2 provides prescriptive compliance for small buildings.

For the EEC 1 energy efficiency measure, GREENSHIP provides a performance based as well as prescriptive methods. The performance based energy simulation shall only be applied if the registered building intended for platinum certification. Energy simulation provides 1-20 points. Another performance based method is energy calculation method using Standardized Worksheet. Both energy simulation and Standardized Worksheet calculate the energy performance of baseline and design building. This is almost similar in LEED NC 2009. LEED NC 2009 also provides performance based and prescriptive methods. LEED NC 2009 provides energy simulation as performance based method for large buildings and prescriptive compliance methods based on ASHRAE Advanced Energy Design Guide and Advanced Buildings Core Performance Guide.

Giving above facts, the use of OTTV calculation cannot provide the energy performance of the building design which is based on the interaction many factors i.e. building envelope, heating and ventilating system, air-conditioning system, lighting and daylight system and also building schedule. Energy simulation, which considers all these parameters, should be applied. The OTTV calculation may only be useful for selecting building envelope materials.

5. **Conclusion**

In conclusion, in general comparison, GREENSHIP and LEED has similar structure and almost cover all energy conservation aspects in their rating. However, they have a big difference in terms of energy assessment criteria and method. GREENSHIP uses OTTV as energy assessment criteria, while LEED NC 2009 uses ASHRAE standard for this purpose. Because the OTTV only consider the building envelope, it therefore less stringent in comparison to ASHRAE standard which considers building envelope, heating, ventilating and air-conditioning, water heating, lighting, power, other equipment. Energy simulation which calculates the interaction of all...
building systems will give more representative and accurate energy performance than a quite simple OTTV calculation method. It is recommended that the forthcoming version GREENSHIP NB to use performance based standard/criteria for energy efficiency and use more accurate energy calculation method i.e. energy simulation.

References


