LEED Certification of Campus Buildings: A Cost-Benefit Approach

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Abstract        This is the first comprehensive cost-benefit analysis of Leadership in Energy and Environmental Design (LEED) buildings certified within the higher education sector. Sixteen institutions of higher education (IHEs) were surveyed with the findings focused on the upfront green premium and down the line energy savings. The net present value (NPV), internal rate of return (IRR), and discounted payback period were calculated to determine the financial feasibility of LEED certified buildings within the higher education sector. The findings indicate mixed results when looking at the projects from both an upfront construction cost and full lifecycle perspective.

There are potential benefits and costs for building green on campus. In regards to Leadership in Energy and Environmental Design (LEED) certification for campuses, there are opportunities for universities and colleges to get involved in order to improve their social impact, environmental impact, be a marshal in this new and emerging field, and help create down-the-line value within the community (Ried, 2008). Additionally, institutions of higher education (IHEs) are in a good position to capitalize on the long-term benefits of LEED certification, such as potential cost savings, since they are typically long-term landholders (Ried, 2008). However, a common barrier to adoption of green development policy is the perceived increased upfront costs to build green versus conventional buildings. For example, Richardson and Lynes (2007) discover perceived higher initial capital costs to be a financial barrier in green building at the University of Waterloo in Ontario, Canada.

There is a lack of existing research on actual green building costs to uncover if this perception is warranted. The literature is mixed when determining if there is an upfront green building premium for LEED-certified buildings. To date, there has not been a comprehensive cost-benefit analysis study conducted that looks at the costs and benefits of green building across IHEs. Furthermore, although there have been studies conducted with a sample of LEED-certified buildings, there has been no reported comprehensive cost benefit analysis of a sample of LEED-certified campus buildings nationwide. As shown in Exhibit 1, it is apparent that LEED registrations, which signify intent to seek LEED certification in the higher education sector, are increasing. Therefore, it is important to know if
LEED registration and certification makes economic sense for the higher education sector.

In 2013, there are 2,291 LEED-certified higher education projects and 3,141 LEED-registered higher education sector projects that signify intent to seek LEED certification (J. Van Mourik, personal communication, September 16, 2013). When looking at the number of postsecondary Title IV institutions, which are allowed to participate in Title IV federal student financial aid programs, there are over 7,300 institutions in the United States (National Center for Education Statistics, n.d.). When comparing LEED-certified higher education projects to the number of postsecondary Title IV institutions, it is clear that many IHEs are not participating in LEED, especially when considering that multiple higher education LEED projects may be on one campus. Although the higher education sector within the U.S. Green Building Council (USGBC) is relatively new, the benefit of over 7,300 IHEs participating in a successful LEED certification building policy could be significant since this policy could generate positive environmental and fiscal outcomes. Because of this potential significance, it is important to examine the costs and benefits of existing campus LEED-certified building projects. This examination can uncover the validity of this perceived upfront cost barrier.

The purpose of this study was to discover if the perceived upfront green premium financial barrier is valid by looking at actual initial costs of LEED-certified campus buildings versus conventional campus buildings to discover whether there is an actual upfront green premium. As an upfront green premium was discovered, the time to recover these upfront costs was calculated. Additionally, a cost benefit analysis was performed to examine the initial building costs and operating costs throughout the building lifecycle.
Literature Review

The LEED-certified building literature with regard to financial feasibility can be divided into the upfront green premium and the energy performance during the operational phase of a building.

Upfront Green Premium Literature

Various researchers have found an upfront green building premium. Kats et al. (2003) explore the upfront green premium of 25 office buildings and eight school buildings in California and find the upfront green premium to be $4/sf. Kats (2006) explores the additional cost to build green schools by using a sample of 30 K-12 green schools constructed between 2001 and 2006 within ten states and finds on average a green premium of $3/sf. Kats, Braman, and James (2010) explore the additional cost of building green by using a larger sample of 170 green buildings across multiple sectors in 33 states and eight countries completed between 1998 and 2009 and find a typical cost premium of about $3/sf to $9/sf.

There have also been mixed results when examining the upfront green premium. Matthiessen and Morris (2004) examine the cost of going green with LEED used as the basis for determining the level of sustainable design. They find that many projects are achieving LEED certification within budget and within comparable cost ranges as non-LEED projects and stress that there are high cost and low cost green buildings. Matthiessen and Morris (2007) re-examine the cost of going green with LEED used as the basis for determining the level of sustainable design. They find that there is a continuing problem with the perception that green is an added feature and therefore an added cost. They again find that many projects are achieving LEED certification within budget and within comparable cost ranges as non-LEED projects. Houghton, Vittori, and Guenther (2009) assess 13 LEED-certified and LEED-registered healthcare construction projects and find mixed results, with the upfront green premium ranging from 0% to 5%.

Operational Energy Savings Literature

When reviewing the energy costs of green buildings in operation, there have been studies that show positive results. For example, Kats et al. (2003) find that energy savings of $0.44/sf per year justify the upfront green premium cost. Kats (2006) determines the average annual energy savings of a sample of 30 K-12 green schools to be $0.38/sf. Furthermore, Kats, Braman, and James (2010) find annual energy savings for 60 LEED certified buildings ranging from $0.10/sf to $2/sf.

There has also been mixed results with regard to green building operating costs. Stegall and Dzombak (2004) look at the energy cost implications for New House, the first LEED-certified silver university residence hall in the U.S. at Carnegie Mellon University, based on energy modeling. When compared to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 baseline, there is a 33% increase in energy efficiency. However, it is important to note that the heat recovery system in New House greatly influences energy
figures. When compared to a similar non-LEED Carnegie Mellon building with a heat recovery system, energy usage is 6%–12% more in New House (Stegall and Dzombak, 2004). Newsham, Mancini, and Birt (2009) examine whether LEED-certified buildings are living up to their expectations by re-analyzing 100 LEED-certified buildings of various types compared to the general U.S. commercial building stock using data supplied from the Turner and Frankel (2008) study. On average, the sample uses less energy when compared to the general U.S. commercial building stock, but 28%–35%, depending on the parameters of the comparison, of the LEED-certified buildings use more energy than conventional buildings.

There have also been negative results when looking at the actual energy performance of LEED-certified buildings. Scofield (2002) examines the first 24 months of energy performance of the Adam Joseph Lewis Center, a 13,600-square foot all-electric two-story classroom building completed in January 2000 and the first green building at Oberlin College in Ohio. An important finding of the study includes no energy benefits for the first 24 months of the building’s operation.

**Deficiencies in the Studies**

Much of the current literature is outside of the higher education sector, but can be applied to the higher education sector as an IHE has various building types on its campus. However, initial construction costs and operating costs for the full lifecycle need to be examined at IHEs since a campus typically does not move based on occupancy, rental rates, and sales per square foot. Furthermore, the building will most likely be owned by the university its entire life.

**Data**

The sample was obtained by first identifying the LEED-certified campus buildings in the U.S. This population was identified by utilizing a database called “Higher Ed LEED registered and certified projects,” which can be found on the Center for Green Schools’ website, a division of the USGBC and last updated in July 2013 (http://www.centerforgreenschools.org/main-nav/higher-edu/buildings.aspx). The LEED New Construction (LEED-NC) filter was utilized as LEED-NC is the appropriate version of LEED applicable for the higher education sector for new construction and major renovations of individual buildings. The participants, directors of facilities or someone in a similar role within the IHE, were sent an email with an online survey instrument that was taken from Appendix A of Kats, Braman, and James (2010) and slightly modified. The surveys were anonymous to encourage the sharing of sensitive financial information.

**Methodology**

There were three quantitative methods employed to answer the two research questions. The first research question, is there a green premium for LEED-certified campus buildings, was answered by gathering the green premium dollar per square
foot figures from the data collection sheets, where available, and calculating the average, median, and mode green premium of the sample. After reviewing the sample for items such as outliers, with the possibility of trimming or removing, the most appropriate measure was used to measure the average green premium of the sample.

The second quantitative method performed was a net cost-benefit analysis on the sample of LEED-certified buildings collected during the data collection phase of the study to determine whether the energy saving benefits outweighed the costs of LEED-certified campus buildings throughout the building lifecycle. The timeframe used in this study was 25 years. Kats, Braman, and James (2010) conservatively used a 20-year time period for their cost-benefit study on all building types within multiple sectors. A critique of using the same time period for all building types and sectors is that it does not account for the different uses, purposes, and goals of the building owners. As the current study focused on one sector, the higher education sector, one timeframe seemed appropriate. Furthermore, the costs and benefits were discounted over a timeframe that is longer than the private sector as IHEs use buildings for a longer time as they tend to be the sole building owner throughout the building lifecycle. According to Castaldi, the general life expectancy of a school building is about 50 years (as cited in Chan and Richardson, 2005, p. 7). Also, Weber and Kalidas (2004), who perform a cost-benefit case study of a LEED-certified silver residence hall at Carnegie Mellon University, mention that they modeled the project life from 20–40 years, with 20 years being liberal and 40 years being a high estimate if the time period does not include major renovation. Therefore, 25 years seemed to still be conservative so that benefits were not overstated.

This green premium dollar per square foot was used as the upfront costs of LEED-certified campus buildings and inputted into year zero of the net cost-benefit analysis. The net energy savings, using ASHRAE 90.1 2007 as a baseline, were inputted throughout the 25-year timeframe. Kats, Braman, and James (2010, p. 4) used a 7% discount rate and justified this rate by noting that “this rate is equal to or higher than the rate at which states, the federal government, and many corporations have historically borrowed money, and thus provides a reasonable basis for calculating the current value of future benefits.” As this study strictly focused on the higher education sector, the discount rate used was lower. A discount rate of 3.5% seemed reasonable as the timeframe was not intragenerational and private investment was not crowded out (Moore et al., 2004).

Calculating project performance criteria was done using the NPV for each survey. NPV was calculated by adding all discounted cash flows together. It is important to note that alternatives, such as using funds on projects other than LEED-certified campus buildings, were not measured, which is a limitation of this study. The internal rate of return (IRR) was also calculated.

The third quantitative method used was the discounted payback period in order to ascertain the payback period for LEED-certified campus buildings. The discounted payback period takes into account the time value of money by discounting the cash inflows of the project by using a 3.5% discount rate. Note
that the discounted payback period was not used in isolation, but merely another calculation tool employed to analyze the data.

**Results**

**Upfront Green Premium**

The average function was employed to answer the first research question pertaining to the upfront green premium for LEED-certified campus buildings. Information was gathered on the green premium $/sf figures from 16 data collection sheets. Responses ranged from $0.00/sf to $235.00/sf. In this case, the median of $5.41/sf was used to better represent the population as there was an extreme outlier and the average function would have been skewed by this outlier. The distribution is positively skewed as the mean exceeds the median. This is because there is a high green premium/sf outlier.

The relationship between LEED level and green premium $/sf was reviewed after removing the outlier of $235.00/sf. As Exhibit 2 illustrates, there is no relationship between LEED level and green premium/sf. The lowest green premium $/sf was a LEED level platinum building and the highest green premium $/sf was a LEED level silver building.

**Annual Energy Savings**

Information was gathered on the energy savings per year per square foot from the same 16 data collection sheets. Responses ranged from $0.25/sf to $42.37/sf. In
this case, since there was an outlier, the median of $0.32/sf was used to better represent the population as there was an outlier and the average function would have been skewed by this outlier. The distribution is positively skewed as the mean exceeds the median. This is because there is a very high annual energy savings per square foot outlier.

The relationship between LEED level and energy savings per square foot per year was reviewed after removing the outlier of $42.37/sf. As Exhibit 3 illustrates, there is no relationship between LEED level and energy savings per square foot per year. The lowest annual energy savings $/sf were LEED level platinum buildings and the highest annual energy savings $/sf was a LEED level gold building.

**Net Cost-Benefit Analysis**

In order to address the second research question of lifecycle energy benefits versus the upfront costs of LEED-certified campus buildings, a net cost-benefit analysis was performed. Calculating project performance criteria was done using NPV, IRR, and the discounted payback period for each survey with a discount rate of 3.5% and a building lifecycle of 25 years. The NPV, IRR, and discounted payback period for each of the 16 surveys are shown in Exhibit 4. NPVs ranged from $232.20 to $698.32. IRRs ranged from 20.18% to 51.02%. The discounted payback period ranged from 0 years to 10.48 years. There were 10 surveys where the discounted payback period was not calculated as it exceeded the building lifecycle cutoff of 25 years.

**Discussion**

Previous studies have failed to focus on the higher education sector as it relates to LEED-certified buildings. Therefore, there was limited literature and data on the subject. However, when reviewing the literature, the results showed an upfront green premium of $0–$9/sf. For the annual energy savings, results ranged from $0.10 to $2/sf. The results for the green premium ranged from $0.00/sf to $235.00/sf. When the outlier is removed, the green premium ranged from $0.00/sf to $12.00/sf. The annual energy savings ranged from $0.17/sf to $42.37/sf. When the outlier was removed, the annual energy savings ranged from $0.17/sf to $0.75/sf. When comparing the existing results to the current results without the outliers, they seem to be somewhat in line.

There were two extremely high outliers in this study. Firstly, there was a green premium reported of $235/sf. The respondent may have answered in a different measurement versus dollar per square foot. That is why the median was used in this case. Secondly, there was an annual energy savings of $42.37/sf reported. Again, the respondent may have answered in a different measurement versus dollar per square foot and that is why the median was used in this case as well.

It was surprising to see that there was not a relationship between green premiums and LEED certification level. The lowest green premium $/sf was a LEED level
**Exhibit 3** | Relationship between LEED Level and Energy Savings $/sf/Year

![Energy Savings Chart](chart.png)

**Exhibit 4** | Net Cost-Benefit Analysis Calculations

<table>
<thead>
<tr>
<th>NPV</th>
<th>IRR</th>
<th>Discounted Payback Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>(232.20)</td>
<td>-20.18%</td>
<td>n/a</td>
</tr>
<tr>
<td>(5.74)</td>
<td>-1.72%</td>
<td>n/a</td>
</tr>
<tr>
<td>(4.09)</td>
<td>-0.36%</td>
<td>n/a</td>
</tr>
<tr>
<td>(2.39)</td>
<td>-0.36%</td>
<td>n/a</td>
</tr>
<tr>
<td>(1.37)</td>
<td>1.10%</td>
<td>n/a</td>
</tr>
<tr>
<td>(1.26)</td>
<td>1.26%</td>
<td>n/a</td>
</tr>
<tr>
<td>(1.23)</td>
<td>1.25%</td>
<td>n/a</td>
</tr>
<tr>
<td>(1.09)</td>
<td>1.53%</td>
<td>n/a</td>
</tr>
<tr>
<td>(0.40)</td>
<td>2.81%</td>
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<td>(0.28)</td>
<td>3.03%</td>
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<tr>
<td>2.99</td>
<td>14.66%</td>
<td>7.64</td>
</tr>
<tr>
<td>4.24</td>
<td>10.65%</td>
<td>10.48</td>
</tr>
<tr>
<td>4.64</td>
<td>17.22%</td>
<td>6.47</td>
</tr>
<tr>
<td>5.31</td>
<td>14.13%</td>
<td>7.93</td>
</tr>
<tr>
<td>10.89</td>
<td>51.02%</td>
<td>2.07</td>
</tr>
<tr>
<td>698.32</td>
<td>n/a</td>
<td>0.00</td>
</tr>
</tbody>
</table>
platinum building and the highest green premium $/sf was a LEED level silver building. This could be due to different building projects obtaining different LEED points in order to achieve their particular LEED certification level. For example, one building project may have spent more money to obtain 1 LEED point for brownfield development versus development density and community connectivity for 5 LEED points. The municipality and location of the IHE within that municipality may determine if an IHE would even qualify for the development density and community connectivity. For example, it is unlikely a building would qualify, for example, if it is in a rural community with strict zoning density restrictions.

It was also surprising to see that there was not a relationship between annual energy savings and LEED certification level. The lowest annual energy savings $/sf were LEED level platinum buildings and the highest annual energy savings $/sf was a LEED level gold building. Again, this could be due to different building projects obtaining different LEED points in order to achieve their particular LEED certification level. For example, one building project may have decided to obtain 2 LEED points for introducing green power while another project may have opted to obtain 2 LEED points for material reuse. This focus on introducing green power versus material reuse could potentially cause an increase in energy savings for one project versus another.

For the surveys where NPV was greater than 0, LEED-certified campus buildings were profitable. For the surveys where IRR was greater than the discount rate of 3.50%, LEED-certified campus buildings were profitable. For the discounted payback period, results less than the building lifecycle of 25 years made a campus building project profitable. It was interesting that only six surveys had a positive NPV. Additionally, only six surveys had IRRs greater than 3.5% and payback periods less than 25 years. These results show that the majority of campus buildings in this study did not make sense financially. However, there were still multiple building projects that did make sense financially.

**Conclusion**

Incentives/grants can be one way to lower the upfront green premium for the higher education sector. Future research should look at public policy regarding LEED to see what incentives and/or grants help in decreasing the upfront green premium when building to LEED certification standards. Many states, municipalities, and IHEs have enacted policies to require buildings be built to LEED standards. Implementing incentives and grants rather than strictly requirements can help incentivize private IHEs to build to LEED standards that do not have a LEED requirement in place.

As no relationship was seen between the upfront green premium and LEED level, it would be interesting to take a more detailed look at projects to uncover why this may be. This could include collecting and reviewing LEED checklists to see which credits were obtained and whether specific credits cost more than others to obtain. Furthermore, common themes or trends could be revealed.
Although the majority of the projects in this study did not make sense financially by the measures of NPV, IRR, and the discounted payback period, there were multiple projects that demonstrated positive financial results. Therefore, future research is recommended to review financially favorable projects in order to understand why their projects work from a financial perspective.

Another recommendation would be to educate decision makers at IHEs on the value of building lifecycle analysis versus strictly upfront construction costs. This may involve changing the perspective of many presidents and provosts who have decision-making powers as perspectives on building costs have historically been more short-sighted versus long-sighted. This education is essential so decision makers understand the short- and long-term ramifications of building projects. Furthermore, building lifecycle analysis is especially important at IHEs where building lifecycles tend to be longer as the IHE is typically the sole owner of the building.

Many IHEs have enacted policies to require buildings be built to LEED standards. This may be due to the LEED rating system being the leader in green building rating systems. However, there may be campus buildings that are being constructed using other green rating systems. This would be interesting to look into for future research to see the distribution of various green building systems among IHEs, as well as the relative upfront and down the line costs and savings.

Additionally, buildings may be being built to LEED standards or other green building rating system standards, but not being certified due to the cost of certification. This may partially explain why many IHE campus buildings are non-LEED certified. This would be helpful to look into in the future.

LEED certification standards are uniform across the U.S. However, different regions within the country have different climates. It would be interesting to see whether certain LEED points are easier to achieve in different climates and different densities.

Furthermore, as we live in a global context, looking abroad for solutions to green building rating systems would be recommended for future research. Searching internationally for green building rating systems that are succeeding and failing would be useful to review for implementation in the U.S. Perhaps adoption and adaptation of a foreign green building rating system may offer better solutions financially and environmentally going forward.

One limitation of this study is that there may be some flaws in the database used. In the database, some projects labeled as higher ed seem to be private industry, such as geisinger, dunn construction, Bald Head Island Conservancy, Gateway Canyon Resort, Naval Air Station Whidbey Island, Smithsonian Conservation Biology Institute, etc. Therefore, numerous projects in the database may not be accurate. However, this database is the best source of information for campus LEED-certified buildings.

Another limitation of this study is participation was not random as permission was needed from the IHE to obtain the data of interest. There were voluntary
study participants sharing certain types of data, which can create a potential bias in the selection of buildings. For example, IHEs only experiencing positive financial results may choose to participate. Also, the data set was not representative of the national population of LEED-certified campus buildings. Furthermore, I did not compare actual to projected energy and water consumption.

I also did not examine specific credits within the LEED checklist. As IHEs may select different credits based on the type of building and location of their campus, this may affect upfront building costs and operating costs, which were not taken into account in this study. Also, I used the USGBC guidelines for energy baselines although some states and/or localities may require higher baselines for conventional buildings. This can cause overinflated energy savings as buildings not even considering LEED would have had to build to higher standards than these baselines.

The purpose of this study was to examine whether the perceived upfront green premium barrier is valid by looking at actual initial costs of LEED-certified campus buildings versus conventional campus buildings to determine if there is an actual upfront green premium. This study confirms the majority of findings in the literature regarding the existence of an upfront green premium. In this study, an upfront green premium of $5.41/sf was determined for LEED-certified campus buildings. Therefore, the perceived upfront green premium barrier may be valid for LEED-certified campus buildings. However, other considerations such as environmental and community impact should be taken into account, as part of an IHE’s mission is commitment to service versus solely economic feasibility.

Moreover, the energy savings found in this study confirm the majority of findings in the literature as well. In this study, the annual energy savings was found to be $0.32/sf. This should help foster adoption of the LEED green building rating system among campus buildings as there are down the line savings associated with the costs. As the majority of the cost benefit analyses do not show justification from a financial perspective, it could be important to include other down the line savings. It should be noted that it is difficult to quantify some down the line benefits.

This study should prove helpful to policymakers at higher education institutions either considering implementation of a LEED-certified building or institutions that already have one or multiple LEED-certified buildings. Furthermore, this study fills the gap in the literature in multiple ways. First, it provides a comprehensive cost-benefit analysis of a sample of LEED-certified campus buildings nationwide, which can be helpful to state and federal policymakers whom have the ability to provide IHEs incentives, such as grants, for upfront costs to build LEED-certified buildings. Second, this study has produced more recent findings for a sample that focuses strictly on the higher education sector. Additionally, this study provides construction and energy operating costs for a sample of campus LEED-certified buildings within the U.S. that helps to confirm the perceived green premium. However, it was also found that there are operating energy savings that help to address upfront green premium barriers.
In conclusion, the LEED green building rating system continues to grow at IHEs. Cost may not be the whole picture for IHEs as they tend to operate under a different ethos than private industry. IHEs may have a higher tendency to implement policies that encourage environmental responsibility, although it may not make financial sense. However, as seen from this study, although the upfront green premium is reinforced, there are operating energy savings when viewing the project from a building lifecycle perspective.

References


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