

# Building Green Infrastructure Across University Campuses: A Research

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**Abstract:** Universities and corporations across the United States are investing in Leadership in Energy and Environmental Design (LEED®) green buildings as they are more economically, socially, and environmentally friendly. By means of a case study, this paper shows how a regional university in the Midwest part of the United States, has successfully incorporated sustainability as its core value and has made significant progress in all areas of the triple bottom line. This paper focuses mainly on its commitments to LEED® green building certification and green infrastructure. It discusses its journey and success in these two areas through a real case application of converting one of its oldest buildings on campus from a “no” LEED® certification to “Silver” LEED® certification. Throughout this paper, specific recommendations as to how these initiatives can be implemented across the globe, and the benefits that can be expected to be accrued, are presented.

**Keywords:** Climate, Environment, Green Infrastructure, LEED, Sustainability

## I. INTRODUCTION

According to the Intergovernmental Panel on Climate Change (IPCC), a 1.5°C increase in global temperature relative to pre-industrial levels leads to substantial increases in the frequency and/or intensity of certain extreme events [1]. However, it also states that “stringent demand-side policies (e.g., tightened efficiency standards for buildings and appliances) driving the expansion, efficiency and provision of high-quality energy services are essential to meet a 1.5°C mitigation target while reducing the reliance on CDR” [2]. The United States Green Building Council (USGBC) establishes one such efficiency standard through its Leadership in Energy and Environmental Design (LEED®) certification program. This paper focuses mainly on its commitments to LEED® green building certification and green infrastructure. It discusses its journey and success in these two areas through a real case application of converting one of its oldest buildings on campus from a “no” LEED® certification to “Silver” LEED® certification. Throughout the paper specific recommendations, processes and best practices are provided. The authors recommend that these suggestions be integrated in infrastructure projects by both developing and developed nations. If the construction companies are truly committed to sustainability and would like to reap economic, environmental, and social benefits; focusing on LEED buildings and green infrastructure is the right way to go.

## II. PRESCRIPTIVE LITERATURE

### A. Submission of the paper

LEED® certification provides an independent validation of the highest level of sustainability in the construction and operation of a building. The certification is earned through the scoring of points as a part of a rating system across many categories such as Location & Transportation, Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, Innovation and more. The construction or renovation project must adhere to prerequisites and credits across various measurements for building excellence “from integrative processes to building materials to indoor air quality” [3]. Prerequisites are mandatory elements which must be achieved in the course of a building project to be awarded LEED® certifications. Credits on the other hand, may be selectively pursued to gain points toward LEED® certifications. Based on the number of credits achieved, a “Certified”, “Silver”, “Gold” or “Platinum” certification is awarded to the building project.

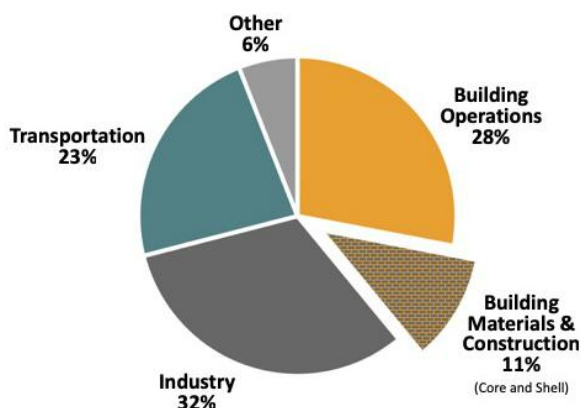
The prerequisites and credits are part of an appropriately selected rating system that most matches the building project. The latest version of the LEED® certification (version 4.1) consists of six rating systems i.e. Building Design & Construction (BD+C), Operations & Maintenance (O+M), Interior Design & Construction (ID+C), Residential, Cities & Communities, Recertification. The rating system are, in practice, selected such that maximum number points are scored with the least amount of resource burden. With every new version, there is an increased stringency in terms of the level of standards of sustainability.

According to the International Energy Agency, the combination of buildings and buildings construction sectors are responsible for nearly 40% of total direct and indirect carbon dioxide emissions [4] which is represented in Figure 1. As stated by the IPCC, to simply limit the temperature increase to 1.5°C to there must be a significant decrease in the amount of these emissions as well as improvement in energy efficiency in the buildings and buildings constructions sectors. LEED® certified buildings, when compared to buildings with no LEED® certification, were found to emit 34 percent less CO<sub>2</sub>, consume 25 percent less energy and 11 percent less water, and have diverted more than 80 million tons of waste from landfills [5]. This varies with the level of certification awarded with Platinum LEED® certified buildings having the best savings amounts. In addition to the sustainability aspect of LEED®, health and happiness of the occupants of the LEED® certified

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building were seen to be higher than their counterparts in buildings without any LEED® certification [6]. Employees that worked in LEED® certified buildings were found to have greater productivity as well as better recruitment and retention rates [7].



**Fig. 1. Global Direct and Indirect Emissions of CO<sub>2</sub> [8]**

Energy usage and carbon emissions data from 343 U.S. colleges and universities were analyzed and were found to have declined by 13 percent between 2007 and 2014 [9]. According to the purveyors of that study, the results of the analysis indicates a “real need to drastically accelerate campus energy conservation efforts and efficiency investments”.

### III. CASE STUDY: GRAND VALLEY STATE UNIVERSITY & RESULTS

#### A. Background Information

A university that has incorporated such sustainability goals into its core values is Grand Valley State University (GVSU) located in Allendale, Michigan, USA. GVSU explicitly states the importance of Sustainability in its charter [10]. It strives to provide current students all that they need without jeopardizing the needs and resources of future students. Sustainability best practices is modeled around the promotion of “social responsibility, practicing fiscal responsibility, and encouraging environmental stewardship”. GVSU has also been named one of the United States’ most environmentally responsible colleges by The Princeton Review for nine consecutive years by its inclusion in the 2018 edition of “The Princeton Review’s Guide to 399 Green Colleges” [11]. In addition to this honor, the largest national grassroots environmental organization, called the Sierra Club, has named GVSU as one of the greenest schools in the United States of America and has included GVSU in their annual list of Cool Schools which ranks schools “that have a strong commitment to environmental improvement and are making significant efforts to operate sustainably” [12].

#### B. Green LEED and Infrastructure Projects at GVSU

The Office of Sustainability Practices at GVSU has many projects and initiatives including a decade long running Sustainable Agricultural Project which is a fully operational farm that students use for experiential learning. As part of its LEED Facilities initiative, the buildings at GVSU feature

sustainable design and all new building projects are constructed to achieve LEED® Silver certification or better. Grand Valley currently has 24 completed or under construction LEED®-certified building projects [13]. The initiative itself is fulfilled in conjunction with the Facilities Planning department at GVSU. This has helped GVSU be in the top 15 percent of campuses in the United States in terms of reduction in energy-related greenhouse gas emissions. The LEED®-certified buildings on GVSU’s campuses use 40 percent less water, 30 percent less energy, and 75 percent less material than regular buildings that are not LEED®-certified [13].

According to Norman Christopher, Executive Director of Sustainability Practices at GVSU, in addition to focusing on LEED building certification, GVSU is also focused on investing in green infrastructure. Whenever a new LEED building is constructed or existing building is converted into a LEED building, GVSU efforts focus on ensuring cost-efficient tactics such as vegetation, to ensure proper water flow so that the environment can be protected. Other green infrastructure initiatives include rainwater harvesting, porous and permeable pavements, green vegetation roofs, green parking, and downspout disconnections. These are all best practices and components of green infrastructure that every construction organization, regardless of location, needs to incorporate in order to reap the economic, and environmental benefits in the short and long-term [14].

#### C. Green LEED Transformation Case Application

The Lake Huron Hall building on the Allendale Campus is in the planning phase to be renovated such that it receives LEED® Silver certification by the USGBC, which would further GVSU’s LEED Facilities Initiative. As one of the oldest buildings on the GVSU campus, Lake Huron Hall holds a level of historic value to the community and to the alumni. However, current students have opined that the building has a “prison feel” to it. The age of the building has also contributed to the energy inefficiency of the building. Facilities Planning, in partnership with the University’s preferred architectural and engineering services firm as well as its LEED® consulting firm, developed and implemented a plan to obtain LEED® certification for the living center by following the process shown in Figure 2.



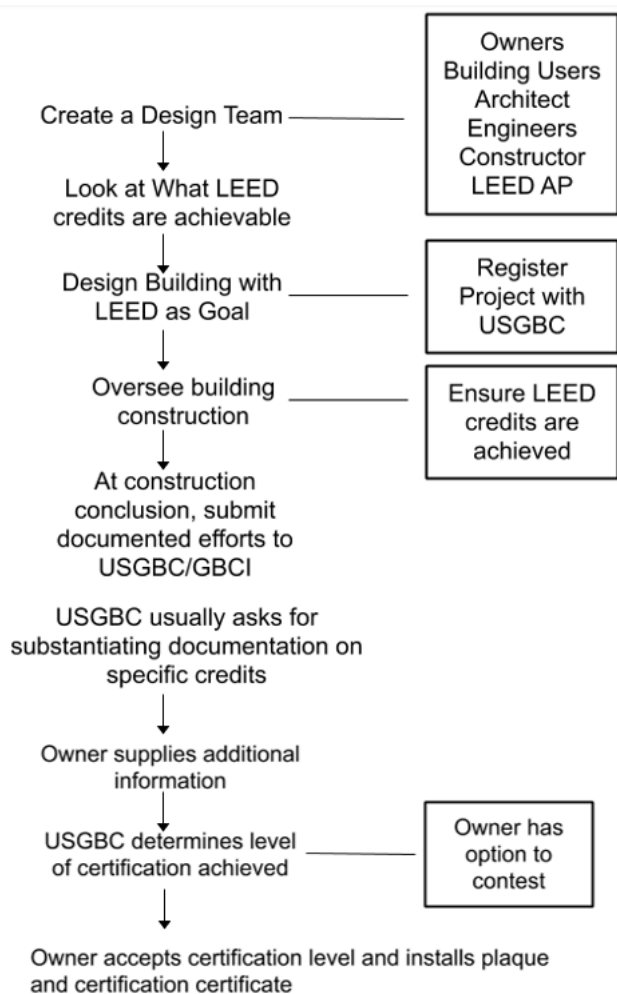


Fig. 2. Process of LEED® Project

Once the decision was made to pursue a LEED® certification and the tentative allocation of funds was finalized, one of the co-authors of this study, along with the responsible Project Manager from Facilities Planning, an architectural and engineering services firm and a LEED® consulting firm worked together to decide which rating system and which version to adopt, which credits may be easily attained and whether the credits that are not as readily achievable should be sought after. The selection of the version of the rating system plays a significant role in the certification level that will be received. Figure 3 shows how the same renovation project is scored by different versions of the same rating system. For the purposes of the Lake Huron Hall Renovation Project, LEED v4 for BD+C (New Construction and Major Renovations) was selected.



Fig. 3. LEED® Credits scored by the project in different rating systems

Once consensus was reached, the certification level which was landed on was accepted. Following this phase, schematic diagrams for the construction as well as all the various tools of project management for the life of the project were developed. One of the tentative schematic blueprints of Lake Huron Hall post renovation is provided in Figure 4.

Fig. 4. Lake Huron Hall Renovation Preliminary Schematic Diagram – Basement Level

The next phase, the implementation of the project, required documentation to be sent to the USGBC through their online portal as part of the certification requirements so as to ensure all the practices and processes also aligned with the sustainability and environmental safety directives.

On completion of the project, the final documentation regarding the clean-up and waste disposal process also had to be submitted along with the final application for the LEED® certification. Subsequent to the completion of the renovation process, GVSU was able to reap the benefits of the energy and resource savings and was able to include the newly Silver LEED® certified to their LEED Facilities initiative. Part of the checklist that demonstrated the sufficient scoring of credits to reach the Silver LEED® certification is depicted in Figure 5. The explanations for that scoring is provided in a redacted manner in Figure 6.

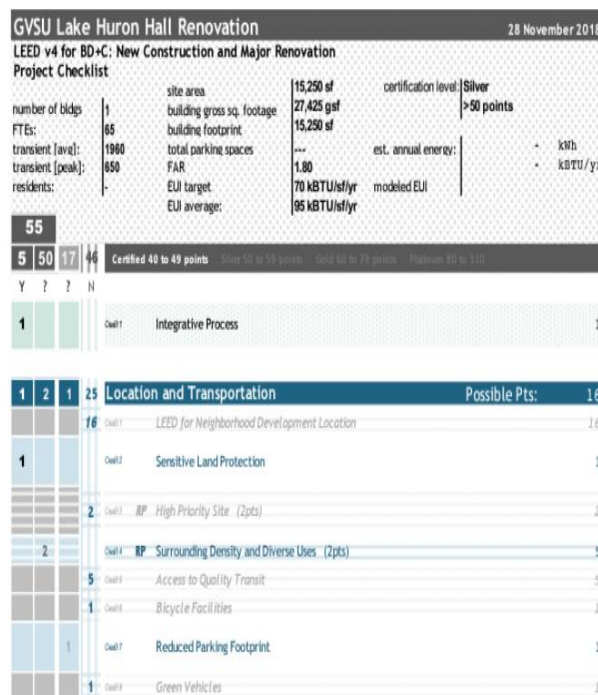


Fig. 5. Partial LEED® Scorecard for Lake Huron Hall Renovation Project

owner (O)	contractor (CM)	architect (RA)	civil (CE)	landscape (LA)	mechanical (ME)	electrical (EE)	plumbing (PE)	commissioning (Cx)	date	party	extended	responsible	notes
									11.14.2018				required as per OPR (KPI 4.2.7.2.1) // perform analysis, and develop OPR before end of SD
// The transportation sector is responsible for one-quarter of energy-related greenhouse gas emissions													
									11.14.2018	-n/a-			// NOT TARGETED // not within a LEED ND project boundary
									11.14.2018				existing building // no additional footprint // no site improvements in scope
									11.14.2018	-n/a-			// NOT TARGETED // points for developing on sites w/ federal and/or state "high priority" designations
									11.14.2018				explore diverse uses available on campus
									11.14.2018	-n/a-			// NOT TARGETED // no public transit serving the site
									11.14.2018	-n/a-			// NOT TARGETED //
									11.14.2018	GVSU			// possible // GVSU to provide campus-wide parking analysis to determine if credit requirements are met (.24 spaces / (student + faculty + staff))
									11.14.2018	-n/a-			// NOT TARGETED //

Fig. 6. Partial LEED® Scorecard Rationales for Credits Received

IV. CONCLUSION

Adopting an initiative to prioritize the energy efficiency, efficient resource consumption and minimization of its carbon footprint through LEED® certifying its buildings, Grand Valley State University has been able to improve its campus’ operational efficiency and to live up to its core value of Sustainability. The financial benefits through the energy savings and the added benefits from modernizing one of GVSU’s original buildings with its historic value, may be replicated on any university’s campus through becoming familiarized with and prioritizing the LEED® certification process. Institutions that serve to imbibe knowledge in future generations should value and adopt sustainability practices to express their focus on the future.

V. REFERENCES

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VI. AUTHORS PROFILE



Dr. Jaideep Motwani is Chair and Professor of Management at the Seidman College of Business, GVSU. He received his Ph.D. degree in Operations Management from UNT. He has published more than 200 articles in prestigious journals such as Operations Research, IEEE Transactions of Engineering Management, European Journal of Operations Management, among others. In 2004, Dr.

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