

2. **Project Title:** Environmental Stewardship through Interdisciplinary Research and Design:
A case study-based approach to the design of a sustainable research and teaching campus

Project Team:

PI: Aimee Buccellato (ARCH)

coPI: Dr. David Go (AME)

Collaborators (not funded):

Dr. Jarek Nabrzyski (CSE/ CRC)

Dr. Charles Vardeman (CSE/CRC)

Dr. Jennifer Tank (BIOS)

3. **Project Goals/ Questions to be addressed:**

The Notre Dame Linked Experimental Ecosystem Facility (ND-LEEF) will become a model facility for the advancement of critical environmental change research related to land use, global change, and invasive species biology. The vision for ND-LEEF extends beyond the cutting-edge research:

As Notre Dame’s premiere facility for the advancement of research, education, and policy on innovative stewardship of our natural resources, ND-LEEF is intended to become an enduring and didactic example of how to achieve maximum institutional impact (teaching, research, outreach, and action) **with minimal impact on the natural environment.**

Accordingly, the campus of buildings designed to support this important work should be planned and executed in the most environmentally responsible way possible – starting with a guiding Master Plan, to design of the buildings, and the materials and methods employed in their construction and operation. The proposed research will guide the campus of “Living Lab” buildings designed to facilitate multi-disciplinary inquiry into a range of issues related to the built environment and its impact on the natural environment and human health. With my collaborative team, we will initiate a plan for an unrivaled living pilot for research in sustainable building design, systems, and technologies, **using the future ND-LEEF campus as a model design problem and test-bed for the development of new Tools, Methods, and Practices to foster sustainable building design and greater stewardship of energy and resource consumption.** Using the ND-LEEF Research Campus as a test-bed, the following synergistic research and research-in-design activities are proposed:

PART I: Case Study I: The Design of a Model Sustainable Research and Teaching Campus

Case Study II: The Morrison Family Education and Outreach Pavilion at ND-LEEF

PART II: An Experiment in Scoping, Programming, Logistics and Visualization: generating a research-and-values-based roadmap for the potential ND-LEEF Research Campus

4. **Importance of Topic:**

The building sector is responsible for 40% of domestic primary energy consumption annually and 72% of U. S. electricity consumption, a figure that is projected to increase to 75% by 2025, regardless of advances in non-traditional energy sources¹; the Architecture, Engineering, Construction, and (building) Operations industry (AECO), and the institutions that educate future leaders in those fields, have a responsibility to acknowledge the myriad of ways that our building design and construction decisions impact the environment and human health. When leading methods of sustainable building design “valuation”, like the USGBC’s LEED Rating System², are proving ineffective in influencing actual building energy consumption, **through our proposed research on design and construction, Notre Dame has an opportunity at ND-LEEF to become a leading voice in sustainable building design, and to further emphasize our calling, as Catholics, to stewardship and the care of all of God’s creation.**

¹ U. S. Department of Energy (a), Energy and Information Administration, 2008, “Building Energy Databook”: DOE/EIA-0384(2007), U.S. Department of Energy and Annual Energy Review 2007

² U. S. Green Building Council, Leadership in Energy and Environmental Design (LEED) Green Building Rating System, <http://www.usgbc.org/LEED>

5. **Likely Impact and Influence of Project:**

We have a truly unique opportunity to establish an unprecedented multi-disciplinary research facility at ND-LEEF, a campus of Living Laboratories that people will come to do research in *and* on; one that will help Notre Dame say and achieve many valuable things, in our teaching, our research, and our advancement of environmental change initiatives. The proposed research by this multi-disciplinary collaborative team will facilitate the following:

1. **Impact as a model of sustainable building design and construction:** ND-LEEF will attract leading experts across multiple disciplines, including building science, technology, and material design; a facility capable of demonstrating innovative and marketable approaches to sustainable building technology, materials, and design.
2. **Impact on scholarship and discourse on sustainable design:** if executed, the novel Living Lab buildings can provide real-time feedback to design and simulation models via post-occupancy data and sensor networks (an important way to compare design-simulated and actual building performance). The collection of empirical data (i.e., post-occupancy building performance analysis) on this unique research campus will place Notre Dame at the forefront of a widening research space in the areas of building performance and health impacts.

With the proposed research, our multi-disciplinary investigation of the campus will support research goals and publication in various interrelated realms: architecture, engineering, computer science, environmental and human health. This research will:

1. **Enhance our teaching and undergraduate research mission across multiple disciplines,** including exposure to real-world application of synergistic activity in innovation, design, and problem solving, especially with respect to the world's grand challenges, like energy use, resource consumption, and the proper stewardship of our natural resources.
2. **Further strengthen the model novel municipal-institutional partnership** between Notre Dame, the ND-ECI, and the St. Joseph County Parks Department.

6. **Goals and Mechanisms for translation to products, management, or policy:**

Publications and proof-of-concept(s) resulting from the proposed research on the ND-LEEF test-bed will greatly expand current research and pedagogical goals on the discourse about sustainable building design. The results from the proposed research will be incorporated into a comprehensive vision and research-and-values-based roadmap for achieving the full potential of this unique campus, in the form of documents and tools that will directly impact our ability to target funding sources that are aligned both in mission and scope with our intentions for the novel interdisciplinary research facility (see "Experiment" Section below).

7. **Approach and Methods:**

CASE STUDY I: THE DESIGN OF A SUSTAINABLE RESEARCH AND TEACHING CAMPUS

1. Conduct a series of optimization schemes to evaluate and promote optimized building-site response and the benefits and trade-offs associated with critical design decisions.
2. Use simulations and data to generate a set of best practices to guide the design and material choices associated with this particular design problem.
3. Develop additional novel frameworks for design optimization that consider the competitive balance between operating energy and embodied energy (and attendant impacts):
 - a) Develop a novel framework using the Design of Experiments (DOE) method (with coPI Go, AME)
 - b) Using the GreenScale method and novel Digital Design and Analysis Tool (GST; currently in development with Nabrzyski (CRC), Vardeman (CSE), and also Paolucci (AME).

CASE STUDY II: MORRISON EDUCATION & OUTREACH PAVILION: Track, Measure; Tell the Story

1. Conduct building Life Cycle Inventory (LCI) prior to the Fall 2014 construction of The Morrison Family Education and Outreach Pavilion (the ND-LEEF gateway building designed by PI Buccellato).
2. Assess LCI data collected on the building materials, methods of extraction, transportation, fabrication, manufacture, and construction of the Pavilion in comparison to other, contemporary materials and modes of construction.
3. Utilize case study and gateway building to advance research and teaching about sustainable design and building practices:
 - a) as a tool for demonstrating the myriad ways that the decisions we make in the built environment impact the natural environment and human health;
 - b) as a test-case for Tools and Methods being developed by Research Team and Collaborators.
4. Contribute LCI data to on-going research using Ontology Design Patterns to link sustainability data related to the built environment using novel cyber-infrastructure (with Collaborators Nabrzycki and Vardeman, the Center for Sustainable Energy-ND, and collaborators at Wright State and the University of California Santa Barbara; see: <http://www.greenscale.org/>).

AN EXPERIMENT IN SCOPING, PROGRAMMING, LOGISTICS AND VISUALIZATION: Generating a research-and-values-based roadmap for the ND-LEEF Research Campus

1. **Engage ND research community:** Faculty research goals will shape the future design of the buildings, therefore we will conduct brainstorming sessions with key Faculty to discuss ways that the ND-LEEF campus can meaningfully facilitate, advance, and expand ND teaching, research, and outreach across multiple disciplines, particularly in areas related to sustainable building design and technology, building systems, and energy.
2. **Commence expanded scope and programming activities:** We will research new strategies for carrying out this type of novel building campaign with the following activities:
 - Visit and study examples of existing premiere sustainable campuses and building sites, and meet with the architects and experts involved in their execution.
 - Discuss our goals and broader mission with leading sustainable design, construction, and policy experts.
 - Document unique building site logistics and budget so that future design and execution is aligned with ND stewardship, the values-based campus master plan, and Notre Dame and ND-ECP's broadest possible teaching, research, and outreach goals.

8. Plans to financially expand topic:

Part I: We will submit competitive proposals with the Department of Energy and NSF.

Part II: We will facilitate private and institutional funding through Notre Dame's Development Office

9. Timeline of Activities & Deliverables:

Summer 2014	Part 1, Case Study 2	LCI Data and Analysis, produce poster design and teaching tools for installation/ use in Pavilion
	Part 2	Commence preliminary feasibility studies, plan facility visits & fall brainstorming sessions
Fall 2014	Part 1, Case Study 1	Commence building modeling and optimization schemes, test framework DOE, test case using GST
	Part 2	Conduct expanded scope, programming, and visualization activities
Spring 2015	Part 1, Case Study 1	Deliver framework DOE, pursue novel optimization scheme using framework & GST
	Part 2	Assemble best practices and visual tools for use in fundraising
Summer 2015		Complete work funded under this proposal; pursue publication & funding venues

10. **Budget and Budget Justification:**

Personnel	Total \$ request	# months	annual salary	FY14 Fringe
RAPs	NA			.267
PDFs	NA			.233
Grad	\$ 4,097.28	8 or 32 wks	\$3,840.00	.067
Undergrad	\$ 11,750.40	Summer + 32 weeks (2 semesters @ 10 hrs/wk)	Use standard rate of \$3,840/12 Weeks (summer) or \$8/hr	.02
Post-pro/ Consult.	\$ 8, 300.00			
Travel	\$ 7,620.00			
Equipment	NA			
Supplies	\$ 750.00			
Total Request	\$ 32,517.68			

Budget Justification, by Project:

Case Study 1: Track, Measure; Tell the Story

(1) Undergraduate RA; (summer duration) LCI & Analysis	\$ 3916.80
Graphics Design & Coordination (Heather/ Kristina time)	\$ 800.00
Supplies:	
- Poster (printing costs)	\$ 500.00
- Miscellaneous (project consumables)	\$ 50.00
Travel (possible, to vendors for LCI info/ documentation)	<u>\$ 500.00</u>
	\$ 5766.80

Case Study 2: A Case Study of the Design of a Sustainable Research and Teaching Campus

(2) Undergraduate RA (2 semesters or eq. summer duration)	\$ 7,833.60
(1) Graduate Student RA (2 semesters or \$10.00/hr, 12hrs/wk, 32wks)	\$ 4,097.28
Supplies:	
- Miscellaneous (project consumables)	<u>\$ 50.00</u>
	\$ 11,980.88

Scoping, Programming, and Visualization:

(1) Graduate Student or Expert Contractor (modeling & graphics)	\$ 5,000.00
\$20.00-50.00/ hour; 100 hours (or greater equiv.)	
Honoraria – Expert Consultants (3 @ \$500 each)	\$ 1,500.00
Graphics Design & Coordination (Heather/ Kristina time)	\$ 1,000.00
Supplies:	
- Miscellaneous (project consumables)	\$ 150.00
Site Visits/ Visits to Consults?:	
- Flights (2 people, 3 round trip @ \$600.00 each)	\$ 3,600.00

- Accommodations (2 rooms @ \$180.00/ night; 3 nights, 3 trips)	\$ 2,520.00
- Ground Transpo'	\$ 600.00
- Food per diem \$50.00/ day; 8 days	\$ 400.00
	<u>\$ 14,770.00</u>

PROJECT TOTAL: \$ 32,517.68

**** Additional Project Personnel** (Summer 2014 and 2015)

Buccellato	1.5 months (total, <u>not included in proposal budget</u>)	\$ 10,000.00
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