

**Center for Sustainability Data Research – Notre Dame (CSDR-ND)**  
SEI Round 6 | Track 1 Proposal

Internal Principal Investigators:

**Aimee P. C. Buccellato**, School of Architecture  
**Charles F. Vardeman**, Center for Research Computing, Dept. of Computer Science & Eng.  
Jarek Nabrzyski, Center for Research Computing, Dept. of Computer Science & Eng.  
Tracy Kijewski-Correa, Department of Civil Engineering and Geological Sciences  
David Hachen, Department of Sociology  
Natalie Meyers, Hesburgh Libraries

Potential External Principal Investigators:

Melissa Bilec, Dept. of Civil & Environmental Engineering, Univ. of Pittsburg; Director  
Bruce Haglund, College of Architecture & Interior Design, University of Idaho  
Kiel Moe, Harvard University Graduate School of Design  
Ralph Muehlesien, College of Architecture, Illinois Institute of Technology; Principal Building  
Scientist, Argonne National Laboratory  
Kate Simonen, College of Built Environments, University of Washington  
Ryan Smith, College of Architecture and Planning, University of Utah  
Kevin Van Den Wymelenberg, College of Architecture & Interior Design, University of Idaho

Energy Theme: Net energy use in the built environment

Project Description:

**Buildings are the largest consumer of domestic energy and resources.** In 2006, buildings accounted for 40 percent of domestic primary energy consumption and 72 percent of U. S. electricity consumption, a figure that is projected to increase to 75 percent by 2025<sup>1</sup>, regardless of advances in non-traditional energy sources.

What current research—and the tools available to both research and practice—lacks is reliable and uniform data and processes to holistically measure and evaluate the long-term impact of building practices on the environment *alongside* building operating energy use. Various methods and practices are used to evaluate operating energy. Far less focus exists in education and practice on measuring the "*in toto*" costs of the materials and methods used to achieve optimized building performance, particularly embodied energy<sup>2</sup>. Existing functionality of building design and analysis tools and large gaps in building data and information are significant barriers to achieving substantive reduction of net building energy use.

In order to transform the way that buildings and infrastructure are designed today and to ensure a more sustainable built environment – and future – we need a transformative approach, one that leverages the full body of data, knowledge, and expertise that is literally embedded in the built world. **We need tools and infrastructures for data and knowledge acquisition, discovery**

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<sup>1</sup> "U. S. Department of Energy and Annual Energy Review 2007" (2008): DOE/EIA-0384(2007)

<sup>2</sup> Life cycle analyses have shown that embodied energy—or the combined energy consumed in the making of a building, including all of the energy expended in the extraction of materials, their manufacture, transport, and assembly—can vary between 2 and 38 percent of the energy consumption of a conventional building over its lifetime (estimated 30 years). In the low-energy buildings studied—buildings designed with the express purposes of reducing energy consumption—embodied energy accounted for up to 46 percent of life cycle energy use, demonstrating that a reduction of energy use in operation does not always imply a reduction in net energy use. (From Hernandez and Kenny: "Development of a Methodology for Life Cycle Building Energy Ratings" *Energy Policy* 39, no. 6 (2011): 3779–3788. doi:10.1016/j.enpol.2011.04.006).

**and sharing between communities so collective knowledge, experience and more importantly data, can be pooled and accessed widely.** By leveraging the collective knowledge of the wider professional community, the challenges of realizing truly sustainable, energy efficient design can be addressed in an unprecedented fashion.

#### Anticipated Outcomes

Many disciplines, like the medical and bio-sciences and civil engineering, utilize sophisticated methodologies to access and utilize data and metadata and drive innovation. However, such methodologies – and the communities built around them – have not yet propagated to the building professions, and this has broad implications for the public, as well as the private sector, because resource and energy consumption is a pressing societal problem. The broader intended outcome of this Track 1 Proposal is to create a coalition of a core Community of Experts (researchers and interested stakeholders) who will pursue funding to create a **Center for Sustainability Data Research at Notre Dame** (CSDR-ND). The purpose of this center would be to support the construction of cyber-infrastructure (CI) for gathering and broadly disseminating sustainability data and research while fostering the creation of virtual communities and collaborative networks.

We have identified target communities that have facets of data relative to the sustainability problem that as of yet have had no motivation or means to share data with the wider community. By gathering – and tethering – a diverse Community of Experts, we will begin building the data community and cyber-infrastructure to utilize it (the data) and also act as a scaffold on which to grow and sustain the community of users. Part of the virtual community/ network research will focus on creating the appropriate mechanisms to enable data contribution and use within a particular community; for example, integration of CI-coursed data into industry-standard tools used by the architectural design community, mobile device applications targeted at the construction and building community, and web portal interfaces targeted at local and national policy planners and government officials to share already existing Linked Open Data (LOD).

Research on creating infrastructure for data interoperability between heterogeneous data sets collected as part of this effort will be explored. Particularly, the use of ontologies or ontology patterns to specify a shared conceptualization of different domain specific terminology between architects, manufactures, builders, public policy experts and the energy production domain. Lastly, the center will explore connections to existing efforts for opening data relative to energy sustainability such as the Department of Energy and Obama Administration Energy Data Initiative (EDI) in support of open data: <http://www.whitehouse.gov/blog/2012/05/22/unlocking-power-energy-data>. Additional, viable funding Programs (within NSF): Environmental Sustainability, CyberSEES, and Sustainability Research Networks.

This multi-institutional and multidisciplinary center will bring together experts in Data and CyberInfrastructure (CRC–Nabrzyski and Vardeman) to build a technical foundation to facilitate data contribution, sharing and analysis with experts on building community sourced data (iCeNSA – Hachen and Engineering Kijewski-Correa) with domain experts in School of Architecture (Buccellato). We will explore potential external collaborators for this center including experts in the area of geospatial data ontologies (SOCoP Berg-Cross, USGIF Moller) and knowledge synthesis (Hitzler) and sustainable Design (Simonen et al) and community development.

**PROPOSED ENGAGEMENTS: TRACK 1**

Organize core Community of Experts (PI's and key industry participants) and establish connection with Spatial Ontology Community of Practice (SOCoP).

- I. Initiate and Tether the Community of Experts | **Sustainability Data Community Forum**
- II. Develop Concepts and Design Patterns for Sustainability Data | **Sustainability Data GeoVoCamp**

<b>I. Sustainability Data Community Forum</b>	
Type of Activity:	Workshop: Stakeholder presentations & break-out sessions
Location and Venue:	Notre Dame School of Architecture Santa Fe Studio, Santa Fe Building, Chicago
List of Targeted Collaborators, Invitees, Attendees:	(see attached)
Proposed Start Date and End Date:	July 25 – 26, 2013
Key Themes:	Building Sector Impacts (energy) The state-of-the-art (existing tools and data, data gaps, access, quality, collaboration) Barriers to mitigating building energy use and broader ecological impacts
Deliverables:	Videotaped Proceedings and written report; Wiki Seed community data contributions

<b>II. Sustainability Data GeoVoCamp</b>	
Type of Activity:	Geospatial Vocabulary Workshop: GeoVoCamp
Location and Venue:	ND-CRC or SOCoPs Fall 2013 workshop venue (loc. TBD)
List of Targeted Collaborators, Invitees, Attendees:	Gary Berg-Cross, Pascal Hirtzler, Werner Kuhne, John Moeller, SOCoP workshop participants
Proposed Start Date and End Date:	September 14-15, 2013
Key Themes:	Geo-semantic capability to link sustainability data and research information (i.e., supply chain, smart-grid, building, and energy) to be accessed, used, and shared by the building industry and the public
Deliverables:	Proceedings including concepts and design patterns to link and share seed community data and support the further development of cyber-infrastructure for sustainability data and community network

**PROPOSED BUDGET: TRACK 1**

Detailed Budget			
Labor \$3,200	Materials \$	Facilities \$8,600	<b>Total \$29,800</b>
Travel \$18,000	Other \$	Other \$	
<b>Budget Justification</b>			
<p><b>Labor:</b> Salary (+ benefits) for CRC Staff Member to coordinate workshops and travel for funded participants</p>			
<p><b>Facilities:</b> Workshop I: hosting costs &amp; catering (3 meals: dinner, breakfast, and lunch) Workshop II: shared (with SOCoPs) hosting costs &amp; catering (2 meals: lunch)</p>			
<p><b>Travel:</b> Workshop I: travel to Chicago &amp; accomodations for funded (non-local) experts (10), PI's* (6), and Notre Dame Collaborators (7; see attached list)</p> <p>Workshop II: travel to GeoVoCamp Site &amp; accomodations for funded experts (3), if hosted at ND-CRC, or PI's Buccellato &amp; Vardeman, if held at SOCoP 2013 venue.</p>			
<b>* Principal Investigators:</b>			
Aimee P. C. Buccellato	Assistant Professor, School of Architecture		
Charles F. Vardeman	Computational Scientist, Center for Research Computing Research Assistant Professor, Computer Science and Engineering		
Jarek Nabrzyski	Director, Center for Research Computing		
Tracy Kijewski-Correa	Associate Professor, Civil Engineering and Geological Sciences		
David Hachen	Associate Professor, Sociology Co-Director, Interdisciplinary Center for Network Science and Applications		
Natalie Meyers	Associate Librarian, Hesburgh Digital Library Initiatives		

**TARGETED COLLABORATORS, ATTENDEES, INVITEES**

<b>Seed Community of Experts &amp; Industry Collaborators</b>			
<b>INDUSTRY</b>	Matthew Bronski	Associate Principal, Simpson Gumpertz & Hegel Structural Engineering	Boston, Massachusetts
	Cheryl Cheiko	Senior Technical Director, WoodWorks, Mid-west region US Wood Products Council	Chicago, Illinois
	Jeanne Gang, Architect	Principal, Studio Gang	Chicago, Illinois
	Mary Inchauste (ND), Architect	Associate Principal, CSO Architecture, Inc.	Indianapolis, Indiana
	Charles Liddy (ND '72)	Principal, Miller Dunwiddie Architecture	Minneapolis, Minnesota
	Tim Morey	Project Manager, Ziolkowski Construction	South Bend, Indiana
	Ryan O'Dell	Skanska USA (construction)	Grand Rapids, Michigan
	Timothy Panzica (ND)	Executive Vice President, Panzica Construction Company	Cleveland, Ohio
	Lance Rouch	Marvin Windows	Warroad, Minnesota
	Michael Ryan ('04)	Director of Architecture and Engineering, Ryan Companies, US, Inc.	Minneapolis, Minnesota
Shelley Simon ('75)	Partner, Beardsley Design Associates	Syracuse, New York	
<b>GOV'T.</b>	Scott Ford (ND '01, '10)	Director, Department of Community and Economic Development	South Bend, Indiana
	Kevin Nelson (ND '93)	Senior Policy Analyst, Office of Sustainable Communities, US EPA	Washington, DC
	Gary Gilot, PE	Consultant, Department of Public Works, City of South Bend (former Director)	South Bend, Indiana
<b>RESEARCH</b>	Prof. Melissa Bilec	Department of Civil & Environmental Engineering, University of Pittsburg; Director, Construction Management and Green Construction Programs	Pittsburg, Pennsylvania
	Prof. Bruce Haglund	College of Architecture & Interior Design, University of Idaho	Moscow, Idaho
	Prof. Ralph Muehleisen	College of Architecture, Illinois Institute of Technology; Principal Building Scientist, Argonne National Laboratory	Chicago, Illinois
	Prof. Kiel Moe	Graduate School of Design, Harvard University, Head, Energy & Environment & Design Group	Cambridge, Massachusetts
	Prof. Kate Simonen	College of Built Environments, University of Washington; Founder, Carbon Leadership Forum	Seattle, Washington
	Prof. Ryan Smith	College of Architecture and Planning, University of Utah Director, Integrated Technology and Architecture Center	Salt Lake City, Utah
	Prof. Kevin Van Den Wymelenberg	Integrated Design Lab, University of Idaho	Moscow, Idaho

<b>Spatial Ontology Community of Practice (SOCoP) Collaborators</b>			
	Gary Berg-Cross, PhD	Executive Secretary, SOCoP	Potomac, Maryland
	Deborah MacPherson	Specifications & Research, Cannon Design	Arlington, Virginia
	John Moeller	SOCoP Representative; Fed. Geographic Data Committee, US Geological Survey	Reston, Virginia
<b>Notre Dame Collaborators</b>			
	Prof. David Go	Department of Aerospace and Mechanical Engineering	
	Prof. Samuel Paolucci	Department of Aerospace and Mechanical Engineering	
	Prof. Panos Antsaklis	Department of Aerospace and Mechanical Engineering	
	Prof. Mihir Sen	Department of Aerospace and Mechanical Engineering	
	Prof. Ashley Thrall	Department of Civil Engineering and Geological Sciences	
	Rachel Novick	Program Manager, Office of Sustainability	

## CARBON LEADERSHIP FORUM

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Professor Aimee Buccellato  
School of Architecture  
314 Bond Hall  
Notre Dame, IN 46556

March 21, 2013

Dear Aimee,

Re: Sustainability Data Research

I am writing to express my strong support for your proposed research to advance the construction of cyber-infrastructure to gather and broadly disseminate “sustainability data”. This proposal directly addresses the need for higher quality transparent data regarding building sustainability that I have identified within my own research: quantifying the environmental impacts of material manufacturing, material use and disposal, building construction and operations etc.

My research is focused on bringing the data and methods of life cycle assessment (LCA) to design and construction practice. I joined the University of Washington with over 15 years of experience in practice and have brought together a consortium of building industry professionals (including architects, engineers, a general contractor and material manufacturers) to fund, influence and collaborate on the LCA research. In each of our research projects we have run up against the challenge of inadequate and confusing data and identified the need for better data collection standards and unifying methods to integrate the data.

I believe that this is a proposal that will require the diverse talents that the Notre Dame team is putting together: architects, policy makers, computer scientists and sociologists coupled with expertise in building performance analysis provides the appropriate diversity of perspectives to be able to identify opportunities and methodologies to develop a functional and self supporting open source platform to collect, compile and disseminate the growing data about the environmental impact of buildings and help us design and construct a more sustainable built environment.

Sincerely,



Kathrina Simonen, RA, SE, LEED-AP  
Assistant Professor of Architecture  
Director, Carbon Leadership Forum

Cell 415 641 1421



**CITY OF SOUTH BEND**  
**PETE BUTTIGIEG, MAYOR**  
**OFFICE OF THE MAYOR**

March 20, 2013

Professor Aimee Buccellato  
University of Notre Dame  
School of Architecture  
314 Bond Hall  
Notre Dame, IN 46556

Dear Aimee:

The City of South Bend enthusiastically supports your research team's efforts to advance open data sharing, particularly as it relates to sustainability and the built environment. As the CEO of this large municipality, I am acutely aware of the costs, both ecological and financial, of the City's infrastructure. In 2010, the City spent close to \$3.1 million dollars to pay for the electricity consumed that year. Fuel consumption for the city's fleet of vehicles totaled 868,656 gallons (or the equivalent of 1 rail tanker full of fuel every 8 days). Beyond the obvious usage of energy and associated costs, our energy consumption is linked to a great many other costs, including maintenance; the type of equipment we use (vehicles, lighting fixtures, motors); hours of operation; demand charges related to the time of day; and tariff charges all systemically affect energy consumption and cost.

Through various efforts, including those of our Municipal Energy Office, we are working towards a more sustainable future for South Bend. We are investing in renewable energy, seeking ways to increase building energy efficiency, and making innovations to our transportation and waste management networks. Some of these efforts are advanced through municipal regulation and some through unique research partnerships like the one you and your colleagues have proposed. The potential for the City to utilize cyber-infrastructure that will collect heterogeneous data from multiple data sources within our municipality – and beyond – will significantly impact our ability to track, assess, and influence our energy and resource consumption.

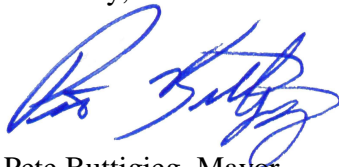
We have recently partnered with Code for America, an organization that leverages the power of web-based technologies to help governments enhance their civil infrastructure and foster lasting community engagement. As we proceed in our effort to develop a GIS tool to assist in



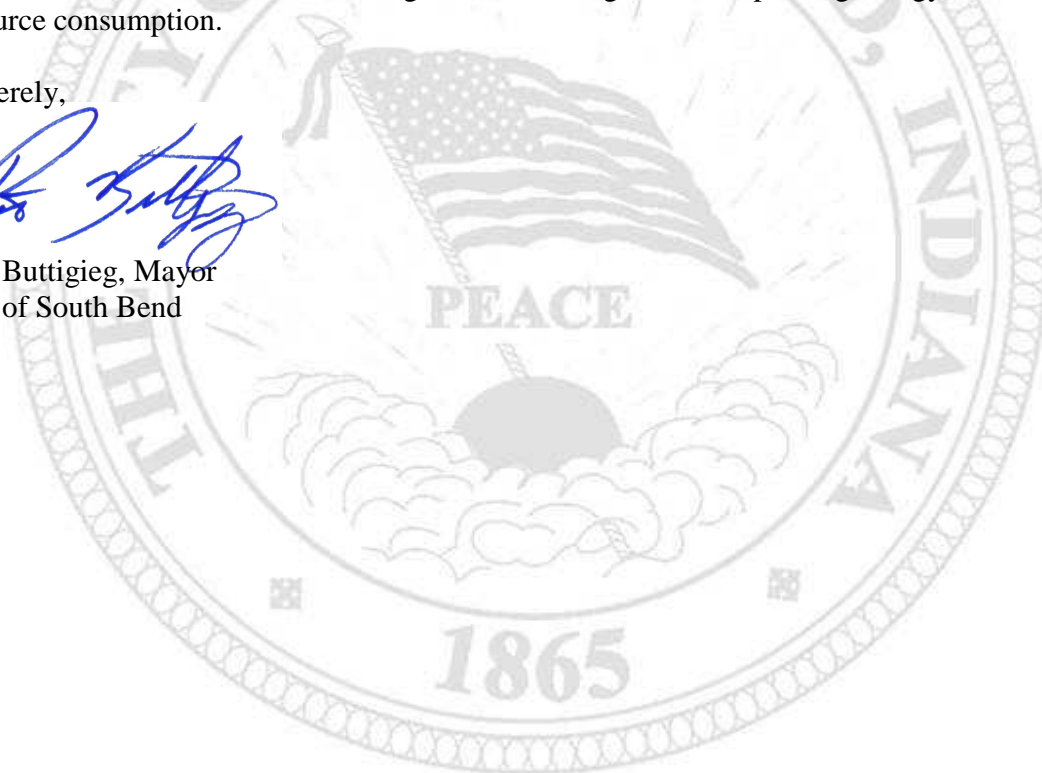
economic development decision-making, we recognize that shared data can be a very powerful tool for social good. The data infrastructure that you are proposing has great potential to bolster these efforts, in terms of the scope of data that we hope to access and share with this new tool. I am enthusiastic about this opportunity to partner with you and your research team to further harness the power of open data to help inform City policy and project decision-making, influence future outcomes and decisions, and better communicate those decisions and their potential impact with the public.

There have already been a number of successful partnerships between the City and the University involving cyber-infrastructure, like the CSOnet pioneered by Notre Dame faculty that uses sensors to help us maintain our storm-water system, and the GreenCloud, a partnership with your colleagues in the Center for Research Computing that helped to save a beloved public building, the Ella Muesel-Ellison Botanical Garden and Conservatory. Our municipal energy office has also successfully partnered with the Center for Sustainability at Notre Dame on various education and outreach initiatives that have been a great benefit to our shared communities. We look forward to the City's participation in the workshops and to applying the results of this work towards furthering South Bend's goals for improving energy efficiency and resource consumption.

Sincerely,



Pete Buttigieg, Mayor  
City of South Bend





UNIVERSITY OF  
**NOTRE DAME**  
CAMPUS SERVICES  
OFFICE OF SUSTAINABILITY

100 Brownson Hall  
Notre Dame, Indiana  
46556-5602 USA

**Rachel Novick, Ph.D.**  
*Education and Outreach Program Manager*

Telephone (574) 631-1439  
Facsimile (574) 631-0240  
Email: [rnovick@nd.edu](mailto:rnovick@nd.edu)

March 20, 2013

Prof. Aimee P. C. Buccellato  
School of Architecture  
University of Notre Dame  
314 Bond Hall  
Notre Dame, Indiana 46556

Dear Aimee,

The Office of Sustainability is pleased to commit to your CSEND SEI proposal to create cyber-infrastructure (CI) to gather, disseminate, and promote the sharing of sustainability data. The broad sharing of knowledge and support for in-depth collaboration is critical for all aspects of environmental sustainability, and none more than the design and construction of our built environment. The coalition of experts that will be gathered under this proposal and your seed efforts have the potential to positively transform the context in which design and construction decisions are made on a national scale, in direct support of the University mission that “learning becomes service to justice.”

The initial phase of your project will provide a direct benefit to our sustainability goals here at Notre Dame. The University has set ambitious targets for the reduction of carbon dioxide and other greenhouse gas emissions over the next two decades, and, as is typically the case, the vast majority of our carbon footprint stems from our built environment. Like most campuses, our buildings span a wide range of ages and technological systems, making assessment of their embodied and utilized energy challenging. The potential for cyber-infrastructure to consolidate heterogeneous data delivered from multiple data sources will significantly expand our ability to make better use of energy and resources and to articulate trade-offs and life cycle costs of the various design and construction choices that are available to us.

I look forward to partnering with you in the initial workshops and to gathering and assessing campus building infrastructure data in the first phase of the project, and to applying the results of this work towards furthering our campus sustainability goals. I believe that this partnership will help make Notre Dame a model for other campuses also pursuing a sustainable built environment.

Sincerely,

Rachel Novick

## Aimee Buccellato

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**Subject:** FW: Draft Letter of support for proposed work on Ontologies for Sustainable Building

**From:** John Moeller <[jjmoeller@cox.net](mailto:jjmoeller@cox.net)>

Date: Tue, Mar 19, 2013 at 12:31 AM

Subject: Re: Follow up on Letter of support for proposed work on Ontologies for Sustainable Building

To: Gary Berg-Cross <[gbergcross@gmail.com](mailto:gbergcross@gmail.com)>

The Spatial Ontology Community of Practice (SOCoP) consists of a group of experts from academia, industry and government who are working to foster collaboration among researchers, technologists and users of spatial knowledge and reasoning in the development of spatial ontologies for use in the Semantic Web. SOCoP was started as a part of the Federal Chief Information Officer Council and has continued as a multi-sector collaboration through the combined interest and contributions of the participating members.

As part of its activities SOCoP has hosted or participated in a number of geospatial VoCamps to explore a wide variety of semantic and ontological issues. A topic of interest is the potential development of a geo-semantic data capability to link supply chain, smart-grid, building, and sustainable energy research information together for use in architectural, construction and maintenance processes. The Spatial Ontology Community of Practice is willing to support Dr Vardeman and Professor Buccellato in developing, promoting and conducting a geoVoCamp. Dr Vardeman has participated in a previous SOCoP Workshop and we are confident that collaboration would be of significant value to the SOCoP community. We envision that the geoVoCamp would be an excellent vehicle to bring together Architects, Engineers, Builders, materials manufacturers and ontologists to agree on the concepts and design patterns needed for data linkage, storage and sharing among the relevant communities. We see such a VoCamp as an important part of building a robust set of geospatial ontologies and collaboration networks.

We look forward to working with Dr Vardeman and Professor Buccellato in promoting the increased use of geospatial semantic and ontology tools as part of sustainable energy research initiatives.

John Moeller

[202-494-2671](tel:202-494-2671)

[john.moeller@usgif.org](mailto:john.moeller@usgif.org)

[jjmoeller@cox.net](mailto:jjmoeller@cox.net)

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Gary Berg-Cross, Ph.D.

[gbergcross@gmail.com](mailto:gbergcross@gmail.com)

<http://ontolog.cim3.net/cgi-bin/wiki.pl?GaryBergCross>

NSF INTEROP Project

<http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0955816>

SOCOP Executive Secretary

Knowledge Strategies

Potomac, MD

240-426-0770