

## **Draft Proposal**

# **ZERO CARBON BUILDING TECHNICAL FEASIBILITY STUDY**

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Check if applicable:

Animal subjects \_\_\_\_\_

Human subjects   x

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## **Abstract**

Zero carbon buildings present both opportunities and challenges in the pursuit of a low carbon emission economy. To maximize the potential to reduce greenhouse gas emission related to the operation of residential and commercial buildings within California, this project proposes to take a holistic approach by integrating all aspects of building operations including transportation, water, wastewater, waste, landscaping, and renewable energy potential. Task 1 identifies leading edge strategies for the reduction of greenhouse gas emissions from buildings. Task 2 provides modeling and evaluation of the strategies identified in Task 1 and integrates these strategies to optimize carbon reductions. Project results will include not only the technical feasibility of producing efficient and effective zero carbon buildings, but also economic and policy considerations. Implementation strategies which address all aspects of building operation will be organized into a framework and program design which can be utilized to develop a path towards transitioning to zero carbon buildings within California.

## Introduction

California's Assembly Bill 32 requires the state to reduce greenhouse gas emissions to 1990 levels by 2020. In California, twenty-four percent of greenhouse gas emissions are due to buildings [CEC, 2013], making the reduction of greenhouse emission from buildings an essential component of overall greenhouse gas reduction efforts. To that end, zero-net-energy residential and commercial buildings are policy goals for California. Achieving zero-net-energy buildings and zero greenhouse gas buildings will require many of the same methods and innovations; however the two strategies are not identical. Typically zero net energy (ZNE) buildings are defined as buildings that produce as much energy as they use. However, the production of energy usually does not coincide with the demand of the building, and therefore ZNE buildings typically are tied to the electricity and/or gas grid. A ZNE building could use natural gas for heating purposes and offset this energy use by producing electricity from a solar PV system. Therefore, not all ZNE buildings are zero greenhouse gas buildings. Li et al (2013) reviewed recent research into energy efficiency and renewable energy strategies used to achieve zero energy buildings.

For a zero net carbon or zero greenhouse gas (ZGHG) buildings, all parts of the building operation must be considered including not just energy usage within the building but also waste, water, and transportation impacts. These processes would need to either generate zero greenhouse gases (either on-site or off-site) or would have the gases emitted offset. The challenge is to change the operation of buildings to include reduction or elimination of greenhouse gases associated with water, waste, transportation, and building systems in addition to the reductions required for energy, and thereby transform zero net energy strategies into zero net greenhouse gas strategies.

There is much current research into the best way to implement carbon emission reduction in buildings. Pan (2014) suggests that zero carbon buildings should be regarded as 'complex socio-technical system'. Pan compares 5 case studies of zero carbon buildings world-wide and reports a variety of driving forces, assumptions, building types, and rationales behind the implementation of these buildings. Xing et al. (2011) reviewed retrofit techniques to approach zero energy in existing building stock in England and developed a hierarchical path towards that goal. Davies and Osmani (2011) approached the issue of refurbishment of existing housing stock from an architect's point of view and suggested policies to increase adoption of low carbon technologies in the United Kingdom. Although not all of the issues are relevant to California, the effort does point to some universal issues such as costs, taxes, and incentives. Stadler, et al (2014) described a model that can be used to optimize distributed energy resources and building retrofits, providing a holistic approach which may help reduce some of the cost issues associated with building retrofits.

A holistic approach to ZGHG buildings requires not just a consideration of energy consumption, but also consideration of associated services which contributed to the production of greenhouse gases, including water, waste, and transportation. Reduction or elimination of net water usage is an essential element of the design of a zero-GHG building because water delivery and treatment accounts for approximately 19% of all electrical energy use in the State of California (CEC, 2005). The concept of net-zero water management in buildings is a current and developing area of research which includes both reduction of usage and offset strategies (Joustra and Yeh, 2015).

A combination of traditional water-saving measures coupled with more cutting-edge technologies such as grey water re-use, rainwater collection and composting toilets can contribute to net-zero water usage. The concept of net zero greenhouse gas emissions from water usage in buildings is related to but not identical to net zero water, since ZGHG strategies can include offset for emissions from water usage and allow for non-net zero water. However, net-zero water usage strategies can be incorporated into the overall ZGHG plan. A number of site performance strategies can influence the carbon footprint of new building, including vegetation, water infrastructure and building orientation. In addition water and landscaping can be used in the offset of carbon through sequestration (Jain et al, 2009). Vegetation species can affect carbon sequestration rates, and coverage will affect sequestration and temperature control of sites through means such as canopy, greenroofs or greenwalls. Innovative designs such as living walls (Natarajan et al, 2014) can have impacts on both sequestration and energy usage. Landscape strategies for treating wastewater and greywater can reduce carbon footprints of water treatment. Eliminating or reducing water use for landscape irrigation will positively impact a site's carbon footprint. Building orientation on site also affects potentials for passive cooling to reduce energy use. Renger et al (2015) extended these concepts to consider the potential for net positive carbon impacts over a building's life-cycle through the use of renewable energy and building integrated vegetation.

To achieve zero net carbon buildings, the waste management must be considered: construction, retrofit, occupancy, and end use. Waste production during the life cycle, with an emphasis on operations, can be investigated using the strategies of the Waste Management Hierarchy as defined by the California Waste Management Act of 1989, AB 939 (1989). Strategies including reduction, reuse, composting, recycling, and transformation can reduce the waste requiring transportation and landfilling. Some transformation strategies can also be used to provide energy production. Techniques and strategies for the processing and recycling during the construction and end use phases of ZNB are discussed in Vigil (2006). A case study of construction waste reuse at decommissioned military base in San Francisco is discussed in CIWMB (2002). Strategies for waste management during the occupancy phase of buildings are given in Tchobanoglous, et al (1993)

The transportation sector contributes about 39 percent of California's greenhouse gas emissions, a fact that highlights the importance of the state's efforts to promote low-carbon alternative and renewable transportation fuels [CEC, 2013]. The transportation sector has not only continued to increase emissions but it has also been the sector with the greatest absolute emissions growth in the two decades leading up to 2009 (the great recession). Due to recently enacted federal emissions standards and recent patterns in the VMT (vehicle-mile travelled) the emissions are stabilizing (Lazarus, 2013) ; but emissions are far from the zero carbon transportation goal. Reducing the transportation related emissions for new buildings would not only have a positive impact of mitigating climate change but also increase the benefits from mobility to the society due to increased use of active modes such as walking and bicycling.

Reduction in transportation emissions generated by buildings and communities requires addressing technological, behavioral, as well as political challenges. The biggest challenge in this regard may be that conventional transportation planning is generally automobile-oriented. California Environmental Quality Act (CEQA) requires the identification, analysis, and

mitigation of transportation-related impacts of proposed land-use projects. Transportation system performance is primarily evaluated based on the use of congestion intensity indicators such as roadway level-of-service (LOS) and the travel time index (TTI). Recently, many transportation planning practitioners have criticized over-reliance on roadway LOS (e.g., Litman, 2012). Moreover, multi-modal LOS analysis has now been incorporated into the most recent Highway Capacity Manual (TRB 2010). The upcoming edition of the Traffic Engineering Handbook edited by one of the investigators builds on the theme for multimodal LOS analysis. SB 743 requirements to amend the CEQA Guidelines (Title 14 of the California Code of Regulations) to provide an alternative to LOS for evaluating transportation impacts should aide in new buildings to have reduced GHG emissions. Spatial impact of transportation would ensure that the neighboring residential and commercial buildings will also benefit from new ZNE buildings.

The development of an effective policy framework for carbon reduction in buildings requires more than an understanding of the technical issues involved. The development of a policy framework and program design must be iterative and built on the lessons learned from past strategies implemented both in California and elsewhere. Climate action plans and associated strategies (Boswell, et al 2012) provide the context in which zero carbon building policies and programs are likely to be most effective and insight into policy approaches that have demonstrated successful implementation.

The key to designing effective zero greenhouse gas buildings is to integrate all aspects of building operations using a holistic approach. Buildings, the most durable artifacts our society produces, have impacts on the environment that outlive their makers. Decisions made in the earliest stages of design – literally freehand sketches on a piece of trace paper – affect a building's energy use for 50 years or longer. This project presents the opportunity to offer solutions that will bring both new and existing buildings in closer performance alignment with climate, to satisfy needs for heating, cooling, lighting, water, waste, and transportation while simultaneously achieving the goal of zero greenhouse gas emissions.

## **Project Objectives**

This project will provide a comprehensive evaluation of the technical feasibility of net zero carbon (greenhouse gas) or near zero carbon residential and commercial buildings in California. It will include both new construction and retrofit opportunities for existing buildings. The focus will be on building operation, as opposed to analysis of building materials and construction. The approach taken will integrate all aspects of building operations including transportation, water, wastewater, waste, landscaping, and renewable energy potential. Implementation will be considered in terms of policy and programmatic pathways, as well as economic costs and benefits.

## Technical Plan

This project will provide a comprehensive, integrated approach to achieving zero greenhouse gas buildings. The focus will be on strategies to reduce the carbon impacts from all aspects of building operation including water, waste, and transportation. The goal is to propose adjustments to the built environment that respond so effectively to the conditions of climate that the majority of the need for heating, cooling and lighting is addressed architecturally before utilizing mechanical and other building systems. The ideal building will minimize the impact on water, waste, transportation resources, while maximizing the production of renewable energy and carbon sequestration. The challenge will be to propose climatic adaptability, building adjustments that can be tuned and switched for optimal performance under a variety of conditions and uses.

### ***Task 1: Identification of Leading-Edge GHG Reduction Strategies***

Task 1 identifies best practice from research literature and professional publications, as well as conducts an evaluation of existing GHG emissions reduction measures both in California and elsewhere. The development of a policy framework and program design must be iterative and built on the lessons learned from past strategies implemented both in California and elsewhere.

The task is comprised of investigation of research to comprehensively address all aspects related to energy and greenhouse gas emissions from buildings in California and may be iterative based on the strategies identified by the project team. Topics will include:

- *Water Management and Usage:* Identify leading edge and near-development water management and water use strategies, based on current practice and current research activities. These efforts will focus on both new construction and retrofit techniques for residential and commercial buildings. Water use and water management strategies include both in-building usage (such as appliances, plumbing fixtures, HVAC, etc.) and out-of-building practices such as landscaping. Efforts will include research into both potable water management and rainwater management such as Low Impact Development.
- *Grey Water Collection and Re-use:* Use of grey water for non-potable water uses has only recently been legally permitted by building codes in California, and therefore its use and designs have been limited. For the proposed research the newest designs and evaluations of grey water systems will be researched and the feasibility of grey water re-use will be fully explored. Grey water will ideally be collected from sinks and showers, treated and stored on-site and re-used for non-potable functions such as outdoor irrigation.
- *Rainwater Collection:* The feasibility of rainwater collection will be investigated in the context of the California climate. Research by one of the authors of this proposal showed that rainwater harvesting is challenging in California because of the long dry season which necessitates large storage volumes (Ferguson, 2009). Methods to store

water on-site by integrating cisterns into building design will be considered. Due to regulatory issues, the rainwater will likely be used only for non-potable uses such as showers.

- *Composting Toilets:* Toilets account for about 21% of the embedded energy associated with California urban water use (Christian-Smith, et al. 2012). Since it would be difficult to re-use wastewater from toilets, composting toilets will be considered as an alternative to flush toilets. Composting toilets are typically used at remote locations, but have found little application in residential or commercial buildings because of health and odor concerns. However, a commercial building was recently constructed in Seattle which incorporates a six-story composting toilet system (Gonchar, 2013).
- *Waste Management:* Identify best practices and promising technologies for reducing the impact of wastes on greenhouse gas emissions from buildings operation including waste reduction and reuse strategies, composting and recycling opportunities, and transformation to fuels and energy. Construction and demolition debris management during new construction and retrofit phases will also be considered. Review existing waste processing regulations at state and local levels that contribute to the goal of zero net carbon buildings.
- *Transportation:* Review of exiting climate calculators that can potentially estimate transportation---related GHG impacts and the level of data specificity required by the models. These tools include INDEX, URBEMIS, and Sustainable Communities Model (coolcalifornia, 2015). In addition, review literature that represents the advances in trip generation and transportation emissions estimation for new projects. Reviewing these studies is required to make sure that VMT for projects are not overestimated by using the traditional transportation impact methodologies and the future construction can be evaluated based on a more holistic approach and not based on impact on automobile travel. The review will also identify the existing tools (e.g., Cool California Local Government Toolkit) which can benefit from inclusion of models that estimate transportation related GHG emissions resulting from emerging residential and commercial development.
- *Renewable Energy:* Investigate current technology for BIPV (Building Integrated Photovoltaics), bifacial photovoltaics, conventional photovoltaics, solar thermal water heating, energy storage, wind energy and other possible renewables for residential and commercial building level generation.
- *Landscaping:* Evaluate current state-of-the-art and leading edge strategies in areas such as carbon sequestration rates of plant materials; impact of vegetative temperature control on building energy use, and heat island effect; energy demands of traditional and green infrastructure methods of treating wastewater and greywater; energy demands for irrigation systems; and guidelines for orientation for passive cooling.
- *Building Systems (other than thermal):* Evaluate current state-of-the-art and leading edge strategies in the areas of comfort and performance systems including : Daylighting and electric lighting integration, opportunities for photovoltaics and building-integrated photovoltaics, and controls (for lighting).



- *Thermal Strategies*: Evaluate current state-of-the-art and leading edge strategies in the areas of thermal conditioning such as: building envelope modification, thermal storage strategies and options, direct gain opportunities, natural ventilation, shading strategies, user interactivity and controls.
- *HVAC Systems*: Evaluate current state-of-the-art and leading edge zero net energy residential and commercial building design and operating strategies. Identify additional strategies for zero net greenhouse gas buildings.
- *Existing Energy Efficiency and Sustainability Policy in CA*: California already has measures that mandate and encourage energy efficient, low GHG emissions buildings (e.g. Title 24, CalGreen, AB32). The intent of this step is to evaluate the effectiveness of these measures, identifying both barriers and areas of success.
- *Energy Efficiency and Sustainability Policy Outside CA*: Communities outside CA (both inside and outside the US) are pursuing aggressive GHG emissions reduction measures focused on buildings. The strategies employed in these communities will be evaluated for effectiveness and applicability to California.

## ***Task 2: Building System Simulation and Integration***

A zero greenhouse gas emission future will require modifications in California's built environment. This project will identify, analyze, and propose alterations and upgrades for new and existing residential and small-scale commercial buildings. Task 2 focuses on exploration and application of opportunities identified in Task 1. Alternatives will be explored through the use of modeling, parametric studies, case studies, and other appropriate means to optimize (cost and performance) and integrate solutions for building energy, lighting, climate control, water, landscaping, waste, and transportation. Recommendations will focus on regions throughout California, with representatives from each of the state's sixteen climate zones. The result will be a set of recommendations as well as a matrix of improvements (organized according to climate zone, cost, and relative effectiveness) and a comparison to existing standards and metrics. The feasibility of achieving long term zero net carbon goals will be considered. Specific efforts within Task 2 will include:

- *Water Systems*: Identify or develop appropriate building simulation modeling system(s) to evaluate the carbon budget for water management strategies identified and compare to current Green Building Standards. For successful strategies, prepare cost estimates to determine construction costs, operation & management (O&M) costs, and simple payback period
- *Wastewater Systems*: Identify or develop appropriate systems to evaluate the carbon budget for wastewater management strategies identified and quantify the impact both on building and community-wide systems. For successful strategies, prepare cost estimates to determine construction costs, operation & management (O&M) costs, and simple payback period.

- *Waste Management:* Identify or develop appropriate systems to evaluate the carbon budget for waste management strategies identified and quantify the impact both on building and community-wide systems. Quantify potential for energy production and potential impacts from such systems. For successful strategies, prepare cost estimates to determine construction costs, operation & management (O&M) costs, and simple payback period.
- *Transportation Systems:* ZNE scenarios will include evaluation of several interlinked strategies and will require modeling of the emissions reduction resulting from these strategies. Overall thrust of scenarios that would be evaluated through the models will include regulatory and pricing mechanisms that provide direct incentives to reduce single occupant vehicle travel, thereby reducing VMT and emissions; development of denser, transit-oriented land-use; emergence of clean and efficient vehicle technologies; investment in alternative mobility (transit, bicycle, pedestrian) infrastructure to provide supply for the shift in mobility patterns resulting from above.
- *Transportation Framework Development:* The model formulation will allow for different stages of these scenarios to be evaluated. The modeling framework used here will be informed by elasticity of policy changes (e.g., Litman, 2011; Salon, 2012). An overview of the modeling framework is provided in Figure 1. Note that since this framework incorporates the surrounding existing land use as well as policy goal status; it will allow for identification and prioritization of building types for which retrofitting to zero carbon status would be most beneficial in terms of reduced emissions. It is important to note that transportation emissions are closely linked with land use and land use decisions are made at the local level. Hence, a framework allowing for flexibility in the mix of policy options to arrive at ZNE (transportation sector) is critical to its wide ranging applicability.

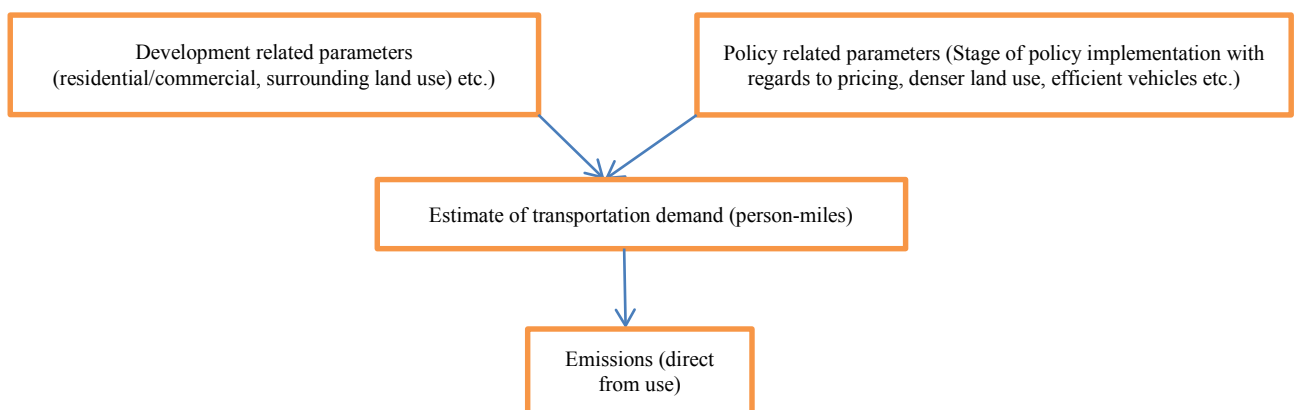


Figure 1: Framework for transportation related emissions estimation for new ZNE buildings

- *Renewable Energy:* Determine feasibility for each renewable energy technology and combinations of technologies that can be incorporated into design of buildings,

including the interrelationship with other building systems. Determine cost premium and payback period estimation for onsite generation. Determine estimates of cost effectiveness of providing building energy through various renewable generation technologies in terms of \$/MT CO<sub>2</sub> reduced.

- *Energy Simulations:* Building energy simulations implementing ZNE standard building types and leading-edge GHG reduction design and operating strategies to determine best design and operating practices for the different California climate zones. Comparative analysis between the ZNE building energy simulation results and the zero/near-zero GHG emissions energy simulation results to determine opportunities as well as challenges moving to zero GHG emissions. Evaluating the best combination of ZNE and GHG reduction strategies.
- *Vegetation:* Assess vegetative, water infrastructure, and orientation design solutions at the site scale with regards to enabling zero/near zero GHG emissions for new building, including carbon sequestration rates of plant materials, impact of vegetative temperature control on building energy use, heat island effect, energy demands of traditional and green infrastructure methods of treating wastewater and greywater, energy demands for irrigation systems, and guidelines for orientation for passive cooling. Comparison of site solutions with applicable portions of the California Green Building Code. Evaluate opportunities and challenges for using site performance strategies for carbon reduction and offsets in retrofit conditions.
- *Issue-specific policy research based on measures identified in Task 1:* If Task 1 identifies measures necessary for development of zero-carbon buildings that have policy or regulatory implications not already investigated in Task 1, they will be added to the range of strategies assessed.
- *Implementation Strategies:* Building on the information from Task 1 and Task 2, a suite of strategies that encourage or mandate implementation will be developed. This set of recommendations will be reviewed by the project team to assure that they result in the changes required to achieve a zero-carbon building. It is anticipated that this step will be iterative with sequential adjustments being made based on project team feedback.
- *Implementation Strategy Refinement:* The implementation strategies identified, addressing all aspects of building operation, will be organized into a framework and program design. This draft framework will then be subject to review by the research community, governmental staff (including CARB), the building community, and other key stakeholder groups. Focus groups and digital survey techniques will be used to solicit feedback aimed at assuring effectiveness of measures, feasibility of implementation, envisioned fiscal impacts, and political willingness.

### ***Task 3: Data Analysis and Reporting***

Task 3 includes analysis and integration of the information from Tasks 1 and 2, as well as regular quarterly reporting, drafting a final report, and finalizing the draft final report.

The project team will provide regular progress reports, showing the status of the project and any interim results. A draft final report, which follows ARB guidelines, will be completed at the end of the project. The report will include results which can be used to assess the practicality, costs, technical approaches, implementation, challenges, and feasibility of achieving zero carbon buildings. The project team will work with the ARB to assure that an acceptable final report is submitted. In addition, the project team members believe that peer-reviewed publication is an important method of communicating scientific knowledge and expect to publish scientific findings, as applicable, in peer-reviewed journals. The ARB will be provided with a complete electronic data set to facilitate any future analysis or modeling that the district wishes to undertake.

## **Data Management Plan**

All data will be stored on password protected computers and be backed-up on a secure server and/or external back-up device. Aspects of the technical plan will utilize human subjects through activities such as focus groups, surveys, and interviews. Confidentiality will be preserved for all participants. Participation is strictly voluntary and can be discontinued at any time. All human subjects related computer files will be stored on password protected computers and be backed-up on a secure server and/or external back-up device. All physical data (paper) collected in these efforts will be stored in locked file cabinets with associated names and affiliations stored securely in a separate location. All methods and protocols will conform to the guidelines approved by the human subjects review committee at Cal Poly San Luis Obispo.

## **Project Management Plan**

Dr. Tracy Thatcher will be the Principal Investigator and direct the overall project. Dr. Thatcher is currently an Associate Professor in the Department of Civil and Environmental Engineering at Cal Poly San Luis Obispo. Prior to her appointment at Cal Poly, Dr. Thatcher was a Staff Scientist at Lawrence Berkeley National Laboratory in the Indoor Environment Department. Dr. Thatcher has over 15 years of research experience. Her expertise lies in the area of indoor air quality. She played a key role in the planning and execution of two large field experiments investigating pollutant transport in urban environments (Joint Urban 2003 in Oklahoma City and Urban Dispersion Program 2005 in New York City). Dr. Thatcher will utilize her experience managing large scale field experiments to assure the success and efficient coordination of the Zero Carbon Buildings Project.

The project team was chosen to provide a balance of expertise in the variety of sub-specialties relevant to providing zero carbon buildings including water, waste, transportation, building systems, landscaping, renewable energy, and policy. The project team will have regular meetings to assure coordination between all aspects of the project. All team members are located on the Cal Poly San Luis Obispo campus, which will facilitate coordination and cooperation between researchers. Multiple graduate and undergraduate students will provide effort to reach the project goals. Each graduate student and undergraduate student will work under the direct supervision of a specific member of the scientific team.

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## **Curriculum Vitae**

# Key Scientific Personnel

PI - Tracy L. Thatcher PhD, PE; Environmental Engineering, Cal Poly San Luis Obispo

Bret Betnar; Landscape Architecture, Cal Poly San Luis Obispo

Ellen Burke, PLA, LEED AP; Landscape Architecture, Cal Poly San Luis Obispo

Dale Dolan, PhD; Electrical Engineering, Cal Poly San Luis Obispo

Adrienne Greve, PhD; City and Regional Planning, Cal Poly San Luis Obispo

Yarrow Nelson, PhD; Environmental Engineering, Cal Poly San Luis Obispo

Rebekah Oulton, PhD, PE, LEED AP; Environmental Engineering, Cal Poly San Luis Obispo

Anurag Pande, PhD; Civil Engineering, Cal Poly San Luis Obispo

Steffen Peuker, PhD; Mechanical Engineering, Cal Poly San Luis Obispo

Sandy Stannard, Registered Architect, LEED AP; Architecture, Cal Poly San Luis Obispo

Samuel Vigil, PhD, PE, LEED AP, Environmental Engineering, Cal Poly San Luis Obispo

## CURRICULUM VITAE

**Tracy L. Thatcher**

Associate Professor  
 Civil and Environmental Engineering  
 California Polytechnic State University  
 San Luis Obispo, CA 93407

EDUCATION

Ph.D. Civil and Environmental Engineering, University of California, Berkeley, May 1996  
 M.S. Civil and Environmental Engineering, University of California, Berkeley, 1991  
 B.S. Chemical Engineering, University of California, Davis, 1984

PROFESSIONAL EXPERIENCE

Associate Professor, Cal Poly San Luis Obispo, Civil and Environmental Engineering,  
 September 2005 to present  
 Teaching courses in environmental engineering with a specialization in air quality.  
 Participation on department committees, as needed. Environmental Engineering  
 Program Coordinator. Advisor to the student chapter of the Society of  
 Environmental Engineers.

Scientist, Lawrence Berkeley National Laboratory, Berkeley, CA 94720. 1998-August 2005  
 Research areas focus on experimental studies of gas and particle transport into and within  
 buildings.

University of California, Berkeley, Lecturer, Fall 1996-Spring 1998.

University of California, Berkeley, Graduate Student Instructor

Graduate Student Researcher, University of California, Berkeley, CA 94720. 1990-1996.  
 Research focused on particle deposition within the indoor environment.

Guest Researcher, Lawrence Livermore National Laboratory, Livermore, CA 94550. Summer  
 1993. Designed and performed a study of particle transport, deposition, and resuspension  
 in a residence.

Environmental Engineer, Hewlett-Packard Company, San Jose Components Group, 1987-  
 1990, Cupertino Site, 1985-1987. Responsible for wastewater treatment, air pollution  
 control, environmental monitoring, and chemical use reduction for a mixed use facility  
 with semiconductor manufacturing, fabrication, and office spaces.

University of California, Santa Cruz Extension, Co-Instructor, *Computer Applications in  
 Environmental Engineering*, 1987.



## PROFESSIONAL COMMITTEES AND RECOGNITION

Registered Professional Civil Engineer, State of California, License Number C58360  
 Student Competition (ECi) Coordinator, AWMA Long Beach Conference 2014  
 Full Member, Air Resources Board Research Screening Committee, April 2003 – Sept 2013, the Research Screening Committee is a legislatively mandated group which provides scientific review of projects and research plans and must approve proposals before they can be sent by the staff to the Air Resources Board.  
 Outstanding Departmental Professor in the College of Engineering – 2013  
 SWE Most Supportive Professor Award – 2012  
 Editor, Journal of Green Building (2006-08)  
 Award for Excellence in Technology Transfer, 'Minimizing Casualties from a Chem/Bio Attack: Preparation, Training, and Response Resources', DOE's Federal Laboratory Consortium, 2004  
 Chair, Indoor Aerosols Working Group, American Association of Aerosol Research, 2002  
 Outstanding Performance Award, Lawrence Berkeley National Laboratory, Winter 2000, Fall 2001, Spring 2002  
 Department of Energy, Environmental Restoration and Waste Management Fellow, 1991 - 1995  
 Outstanding Graduate Student Instructor Award, UC Berkeley, 1995-96.

## Peer Reviewed PUBLICATIONS

- Thatcher, T. L.**, Kirchstetter, T. W., Malejan, C. J., & Ward, C. E. (2014) Infiltration of Black Carbon Particles From Residential Woodsmoke into Nearby Homes. *Open Journal of Air Pollution*, 3(04), 111.
- Thatcher, T. L.**, Kirchstetter, T. W., Tan, S. H., Malejan, C. J., & Ward, C. E. (2014). Near-Field Variability of Residential Woodsmoke Concentrations. *Atmospheric and Climate Sciences*, 4(04), 622.
- Sippola, M. R. , Sextro, R. G. and **Thatcher, T. L.** (2014) Measurements and Modeling of Deposited Particle Transport by Foot Traffic Indoors, *Environmental Science and Technology* V48 (7), 3800-3807
- T. W. Kirchstetter and **T. L. Thatcher** (2012) Contribution of organic carbon to wood smoke particulate matter absorption of solar radiation, *Atmos. Chem. Phys.*, V12, 6067-6072
- Thatcher, Tracy**; Tan, Stella; Malejan, Christopher; Ward, Courtney; and Kirchstetter, Thomas (2011) Assessing near-field exposures from distributed residential wood smoke combustion sources. California Air Resources Board, Contract Number: 07-308; [http://www.arb.ca.gov/research/single-project.php?row\\_id=64811](http://www.arb.ca.gov/research/single-project.php?row_id=64811)
- Melissa M. Lunden, Thomas W. Kirchstetter, **Tracy L. Thatcher**, Susanne V. Hering and Nancy J. Brown, (2008) Factors affecting the indoor concentrations of carbonaceous aerosols of outdoor origin, *Atmospheric Environment*, V 42:22, 5660-5671
- S. V. Hering, M. M. Lunden, **T. L. Thatcher**, T. W. Kirchstetter & N. J. Brown (2007) Using Regional Data and Building Leakage to Assess Indoor Concentrations of Particles of Outdoor Origin, *Aerosol Science and Technology*, V41 N7: 639-654

- Thatcher, T. L.** (2006) Indoor Air Quality in Energy Efficient Housing, *Journal of Green Building*, V1 N2: 32-38.
- Jayaraman, B. , Finlayson, E.U., Sohn,M.D., **Thatcher, T.L.**, Price, P.N., Wood, E.E., Sextro, R.G., and Gadgil, A.J. (2006) Tracer gas transport under mixed convection conditions in an experimental atrium: Comparison between experiments and CFD predictions, *Atmospheric Environment* V40:5236–5250
- Thatcher, T. L.**, Wilson, D.J., Wood, E.E., Craig, M.J., and Sextro, R.G. (2004) Pollutant Dispersion in a Large Indoor Space : Part 1 – Scaled experiments using a water-filled model with occupants and furniture, *Indoor Air*, V14: 258-271. LBNL/PUB 50248
- Finlayson, E.U., Gadgil, A.J., **Thatcher, T.L.**, and Sextro, R.G. (2004) Pollutant dispersion in a large indoor space Part 2 - Computational Fluid Dynamics (CFD) predictions and comparison with a scale model experiment for isothermal flow, *Indoor Air*, V14: 272-283. LBNL/PUB 50105
- Thatcher, T. L.** , Lunden, M. M., Revzan, K. L., Sextro, R. G., and Brown, N. J.(2003) A concentration rebound method for measuring particle penetration and deposition in the indoor environment, *Aerosol Science and Technology* V37:847-864. LBNL/PUB 51631
- Lunden, M.M., Revzan, K. L., Fisher, M.L., **Thatcher, T.L.**, Littlejohn, D., Hering, S.V., and Brown, N.J. (2003) The Transformation of Outdoor Ammonium Nitrate Aerosols in the Indoor Environment, *Atmospheric Environment*, V37:5633-5644 , LBNL/PUB 52795
- Lunden, M.M., **Thatcher, T.L.**, Hering, S.V., and Brown, N.J., (2003) The use of time- and chemically-resolved particulate data to characterize the infiltration of outdoor PM-2.5 into a residence in the San Joaquin Valley, *Environmental Science and Technology*, V37:4724-4732. LBNL/PUB 52221
- Thatcher, T.L.**, Lai, A.C.K., Moreno-Jackson, R., Sextro, R.G., and Nazaroff, W.W. (2002) Effects of Room Furnishings and Air Speed on Particle Deposition Rates Indoors, *Atmospheric Environment*, V36(N11), 1811-1819. LBNL-48414.
- Fischer, M.L., Price, P.N. , **Thatcher, T.L.**, Schwalbe, C.A., Craig, M.J., Wood, E.E., Sextro, R.G., and Gadgil, A.J. (2001) Rapid Mapping of Tracer Gas Concentrations in Air, *Atmospheric Environment*, V35(N16):2837-2844. LBNL-44820
- Lai, A.C.K., **Thatcher, T.L.**, and Nazaroff, W. W.(2000) Inhalation Transfer Factors for Air Pollution Health-Risk Assessment, *Journal of the Air & Waste Management Association*. **50**, 1688-1699. LBNL-43712
- Thatcher, T. L.** and Nazaroff, William W (1997) Effect of Small-Scale Obstructions and Surface Textures on Particle Deposition from Natural Convection Flow, *Aerosol Science and Technology*, **27**, 709-725.
- Thatcher, T. L.** and Nazaroff, William W (1996) Particle Deposition from Natural Convection Flow onto Smooth Surfaces, *Aerosol Science and Technology* , **25**, 359-374.
- Thatcher, T L** and Layton, David W (1995) Deposition, Resuspension, and Penetration of Particles within a Residence, *Atmospheric Environment*, **29**, 1487-1497.

## REPORTS (not published elsewhere)

- Thatcher, Tracy;** Tan, Stella; Malejan, Christopher; Ward, Courtney; and Kirchstetter, Thomas (2011) Assessing near-field exposures from distributed residential wood smoke combustion sources. California Air Resources Board, Contract Number: 07-308; [http://www.arb.ca.gov/research/single-project.php?row\\_id=64811](http://www.arb.ca.gov/research/single-project.php?row_id=64811)
- Black, D.R.; **Thatcher, T.L.**; Delp, W.W.; Derby, E.A.; Chang, S-C; and Sextro, R.G. (2003) Data Summary Report of Commercial Building Experiments in Salt Lake City, UT from May 17 to June 10, 2002, LBNL/PUB-53810.
- Price, P. N.; Sohn, M. D.; Gadgil, A. G.; Delp, W.; Lorenzetti, D. M.; Finlayson, E. U.; **Thatcher, T. L.**; Sextro R. G.; Derby, E. A.; Jarvis, S. A. (2002) Protecting Buildings From a Biological or Chemical Attack: actions to take before and during a release, LBNL/PUB-49932, <http://securebuildings.lbl.gov/>.
- Price, P. N.; Delp, W.; Sohn, M. D.; **Thatcher, T. L.**; Lorenzetti, D. M.; Sextro, R. G.; Gadgil, A. G.; Derby, E.; Jarvis, S. (2002) Advice for first responders to a building during a chemical or biological attack, LBNL/PUB-867.
- Thatcher, T.L.**, McKone, T.E., Fisk, W.J., Sohn, M.D., Delp, W.W., Riley, W.J., and Sextro, R.G. (2001) Factors affecting the concentration of outdoor particles indoors (COPI): Identification of data needs and existing data, LBNL-49321
- Lunden, M.M., **Thatcher, T.L.**, Littlejohn, D., Fischer, M.L., Kirchstetter, T.W., Brown, N.J., Hering, S., and Stolzenburg, M. (2001) Building a predictive model of indoor concentrations of outdoor PM-2.5 in homes, LBNL-48929
- Thatcher, T.L.** and Daisey, J.M. (2000) Reducing mortality from urban terrorist releases of chemical and biological agents: I. Filtration for ventilation systems in commercial buildings, LBNL-44350
- Thatcher, T.L.**, Sextro, R.G., and Ermak, D. (2000) Database of physical, chemical, and toxicological properties of chemical and biological (CB) warfare agents for modeling airborne dispersion in and around buildings, LBNL-45475
- Gadgil, A.G., Finlayson, E.U., Fischer, M.L., Price, P.N., **Thatcher, T.L.**, Craig, M.J., Hong, K.H., Housman, J., Schwalbe, C.A., Wilson, D., Wood, E.E., and Sextro, R.G. (2000) Pollutant transport and dispersion in large indoor spaces: A status report for the large space effort of the Interiors Project, LBNL-44791.

# Bret Owen Betnar

747 Leff Street • SLO, CA 93401 • 215-756-5936 • bretbetnar@gmail.com

## CURRICULUM VITAE

### EDUCATION

- 2010 **University of Pennsylvania**  
MLA - Master of Landscape Architecture
- 1997 **Louisiana State University**  
BLA Bachelor of Landscape Architecture
- 1996 **Höchstschule für Technik Rapperswil**  
Study Abroad Program

### ACADEMIC APPOINTMENTS

- 2014-2015 **Lecturer in Landscape Architecture (full-time)**  
Landscape Architecture Department  
California Polytechnic University - San Luis Obispo
- 2011-2014 **Assistant Professor of Landscape Architecture**  
Academic Advisor (2-years)  
Faculty Advisor for Student GP-ASLA (2-years)  
Landscape Architecture Program  
University of Nebraska - Lincoln
- 2009 **Teaching Assistant (with Cora Olgyay)**  
Workshop III: Site Engineering + Stormwater Management  
University of Pennsylvania - School of Design
- 2011-2015 **Guest Critic**  
California Polytechnic University - San Luis Obispo  
University of Nebraska - Lincoln  
University of Illinois at Urbana - Champaign  
WAAC Virginia Tech - Alexandria
- 2003-2009 **ESL Instructor**  
DeliEnglish Camp, Seoul, South Korea  
Sunshine English Academy, Masan, South Korea  
Jung-Chul English Junior, Jin-hae, South Korea
- 1998-1999 **Snowboard Instructor - Lesson Sales**  
Winter Park Resort, Winter Park, Colorado  
(Awarded Level 1 Certification as Snowboard Instructor)

## PROFESSIONAL EXPERIENCE

- 2010-2011 **Landscape Architect**  
Lee and Associates, Inc., Washington, District of Columbia
- 2000-2003 **Partner - Principal Designer**  
Phoenix:Dragon Design Build, Boulder, Colorado
- 1998-2000 **Landscape Architect - Junior Planner**  
2001-2002 Winston Associates, Inc., Boulder, Colorado
- 2002-2003 **Landscape Architect - Draftsman**  
dKahn Studio, Eldorado Springs, Colorado
- 1992-1994 **Laborer (Summer)**  
Irrigation and Construction Crews  
Landscapes Unlimited, Inc. Golf Course Development  
Lincoln, Nebraska

## GRANTS + AWARDS

- 2014 **CS\_ASALA Merit Award: Analysis + Planning**  
ASLA Central States Conference  
*Scotts Bluff National Monument Trails Master Plan* (Faculty Advisor)
- 2014 ***Site + Feasibility Design for Scotts Bluff Nat'l. Mon. Entrance***  
National Park Service (Served as PI until resignation from UNL)  
\$9,360
- 2014 **UCARE Grant: Faculty Sponsor - Laura Koch**  
*Incorporating Use of 3D Models in a Site Engineering Course*  
Undergraduate Creative Activities and Research Experiences (UCARE)  
University of Nebraska - Lincoln  
\$2,000 (Awarded)
- 2014 **UCARE Grant: Faculty Sponsor - Yuekun Yang**  
*E-Trail Application Proof-of-Concept*  
Undergraduate Creative Activities and Research Experiences (UCARE)  
University of Nebraska - Lincoln  
\$2,000 (Awarded)
- 2013 **Teaching + Engagement Development Grant**  
*Engaging Nebraska, Impacting Communities, Transforming Students*  
Rural Futures Institute with College of Arch. match (PI: Jeff Day)  
\$4,177
- 2012-2014 **Participant**  
Peer Review of Teaching Project and Advanced Program  
University of Nebraska - Lincoln  
\$1500

- 2012 ***Scotts Bluff National Monument Trails Master Plan***  
National Park Service,  
LARC 412 University of Nebraska - Lincoln (PI: Kim Wilson)  
\$19,227
- 2012 **UCARE Grant: Faculty Sponsor - Kaylyn Nerverve**  
*The Landscape of Coastal Defense: Vauban Forts in the United States*  
Undergraduate Creative Activities and Research Experiences (UCARE)  
University of Nebraska - Lincoln  
\$2,000
- 2012 ***A Newcomer's View of Nebraska's Oregon Trail Landscape***  
Animated Digital Poster  
Rural Futures Institute Conference  
University of Nebraska - Lincoln  
\$1,000
- 2010 **ASLA Award of Excellence: Analysis + Planning**  
*Sh\*t scape: Mumbai's Landscape In-Between*  
ASLA Student Awards
- 2008-2010 **Chair's Merit Scholarship**  
Department of Landscape Architecture  
University of Pennsylvania

## PUBLICATIONS, CONFERENCES + LECTURES

\*Requested by Editor \*\*Refereed Conference Abstracts \*\*\*Lectures

- 2014 ***Trail or E-Trail: Electronic Trails as a Sustainable Management Tool for Public Lands\*\****  
CELA Conference - Proceedings  
Baltimore, Maryland
- 2014 ***People, Paper + Clay: A Case Study of Service-Learning in Introductory Site Engineering for Landscape Architects\*\****  
30th National Conference on the Beginning Design Student -Proceedings  
Chicago, Illinois
- 2013 ***10-Minute Map: Uncovering an Alternative Narrative for Nebraska's Oregon Trail Landscape\*\****  
CELA Conference - Proceedings  
Austin, Texas
- 2013 ***Sh\*t scape: Mumbai's Landscape In-Between\****  
*Landscape Architecture Frontiers*, Vol. 1, Issue 3, pp. 142-151.  
English/Chinese
- 2012 ***A Newcomer's View of Nebraska's Oregon Trail Landscape***  
Animated Digital Poster  
Rural Futures Institute Conference  
Lincoln, Nebraska

- 2011-2012      *Sh\*tscap\*\*\*\**  
 British Columbia Society of Landscape Architects - Annual Conference  
 Vancouver, British Columbia, Canada  
 Pecha Kucha Vol. 13.  
 Omaha, Nebraska
- 2009      *Grading IS Design\*\*\*\**  
 LARP 611 Workshop III: Site Engineering and Stormwater Management  
 University of Pennsylvania
- 2000      *The Real Life of a CAD Monkey\*\*\*\**  
 Environmental Design 4365: Technology and Practice  
 University of Colorado

## MEMBERSHIPS + ASSOCIATIONS

- 2014      *American Society of Landscape Architects - Associate Member*
- 2014      *Great Plains Trails Network - Board Member*
- 2012      *Sigma Lambda Alpha - Member*

# ELLEN BURKE, PLA, LEED AP

265 Warren Way, San Luis Obispo, CA 93405 | 917.776.6639 | eburke02@calpoly.edu

## EDUCATION

- 2002-2005 **Harvard University Graduate School of Design**, Cambridge, MA  
Master of Landscape Architecture
- 1993-1997 **Vassar College**, Poughkeepsie, NY  
Bachelor of Arts, Film Studies, with Departmental Honors

## TEACHING APPOINTMENTS

- 2014-present **California Polytechnic State University**, San Luis Obispo, CA  
Department of Landscape Architecture  
*Full-time Lecturer*  
Courses Taught: LA 202, 405, 436
- 2012-2014 **Academy of Art University**, San Francisco, CA  
Department of Landscape Architecture  
*Instructor*  
Courses Taught: LAN 680, 665, 223, AE 42
- 2012 **University of California, Davis**  
Department of Environmental Design  
*Visiting Lecturer in Landscape Architecture*  
Courses Taught: LDA 120

## PAPERS, PUBLICATIONS AND CITATIONS

- 2013 **Citation – *Designing Urban Agriculture* by April Phillips**  
Wiley, 2013  
*Project Featured: Chapter 2 – Scent of Orange, Chongqing*
- 2013 **Publication – “Regional Food Resilience: Mapping Potential Adaptations to San Francisco Bay Area’s Food System”**  
in *Food: An Atlas*, Editors: Darrin Jensen and Molly Roy  
Co-authored with N. Claire Napawan
- 2012 **Citation – Landscape Architecture Magazine**  
“A Feast of Ideas”, October 2012
- 2011 **Article – “Securing a Food Future in Cities: A Case Study in Re-purposing Military Bases”**  
in Civil Eats, Grist



- 2010                    **Paper – “Farm Plus: Hybrid Agricultural Landscapes”**  
in *Bracket One: On Farming*, Editors: Heather Ring and Mason White  
Juried Paper Selections by Charles Waldheim and Fritz Haeg

## HONORS AND AWARDS

- 2007                    **Pacific Horticulture Gold Medal** for ‘Mending Fences’  
San Francisco Garden Show

## GRANTS

- 2014                    ***Landscape Performance Education Grant***  
Landscape Architecture Foundation  
PI (\$2,500)
- 2014                    ***SLO Map (pending)***  
Art Place America  
PI, LOI submitted Oct 31, 2014
- 2008                    ***Farm Plus: Hybrid Agricultural Landscapes***  
Patrick Curran Research Fellowship, SWA Group  
PI (\$10,000)
- 2004                    ***Agri-Cultural Landscapes of Yunnan Province***  
Penny White Travel Grant, Harvard GSD  
(\$2,800)
- 2003                    ***Dudley Street Neighborhood Initiative***  
Community Service Fellow, Harvard Graduate School of Design  
(\$6,000)

## INVITED TALKS

- 2014                    ***Designed Agriculture: Systems of Sustenance***  
College of Architecture and Planning, University of Colorado, Denver  
Public Lecture Series
- 2012                    **Panel Lecture – *Scales of Designed Agriculture***  
ASLA Northern California Chapter, June 2012

## LECTURES/PRESENTATIONS

- 2014                    ***Designed Agriculture: Systems of Sustenance***  
California Polytechnic State University  
EDES 406 Sustainable Environments
- 2013                    ***Urban Agriculture: Priorities and Technologies***  
Academy of Art University, ARC 650 Architecture Design Studio

2012 **Farm Plus: Hybrid Agricultural Landscapes**  
University of California, Davis, LDA190 Pro Seminar

## PROFESSIONAL PRACTICE – SUMMARY

2012 – present **Grow City Studio, Principal**, San Francisco, CA  
2008 – 2012 **Associate, SWA Group**, Sausalito, CA  
2005 – 2008 **Designer/Project Manager, SWA Group**, Sausalito, CA

## COMMUNITY ENGAGEMENT/SERVICE

2014- present **ELSEE Garden Pilot Project Monitoring Professor**  
Sustainable Sites Initiative (SITES)  
San Jose, CA  
2014 – present **Food Hub Working Group**  
San Luis Obispo County Food System Coalition  
2012- present **Advisory Board, A Home Away from Homelessness**  
San Francisco, CA

## LICENSE/AFFILIATIONS

Registered Landscape Architect, State of California, License #5637  
LEED Accredited Professional, US Green Building Council  
San Francisco Urban Agriculture Alliance  
California Native Plant Society

## PROFESSIONAL PRACTICE – DETAIL

**Grow City Studio**  
San Francisco, CA

<i>Winchester Boulevard Agrihood Plan</i> (consultant), San Jose, CA	in progress
<i>Oak Street Residence</i> , Mill Valley, CA	in progress
<i>Wandell Residence</i> , Palm Springs, CA	in progress
<i>Urban Adamah 6<sup>th</sup> Street Campus</i> , Berkeley, CA (shortlist)	2014
<i>College Hill Demonstration Garden</i> , San Francisco, CA	2013
<i>Argonne Elementary Edible School Yard</i> , San Francisco, CA	2012
<i>Feasibility Study for Establishing a Production Garden on Alameda Beltway</i> , (consultant), Alameda, CA	2012-2013
<i>Native Hedgerow/Farmscaping</i> , APC Urban Farm, Alameda, CA	2012

**SWA Group**

Sausalito, CA

<i>Rancho San Ramon Park</i> , San Ramon, CA, staff/lead/PM	2005-20013
<i>2K Barn, Private Estate</i> , Bridgehampton, NY, lead designer	2012
<i>Scent of Orange Master Plan</i> , Chongqing, China, designer/PM	2010-2012
<i>Grand Central Creative Campus</i> , Glendale, CA, designer/PM (Bohlin Cywinski Jackson, Architect)	2009-2012
<i>Palo Alto Arts Center</i> , Palo Alto, CA, lead designer/PM (Mark Cavagnero Associates, Architect)	2008-2012
<i>Mc George School of Law</i> , Sacramento, CA, designer/PM (Pfau Long, Architect)	2009
	2009
<i>The Preserve Master Plan</i> , Stockton, CA, designer/PM (with Gensler & Sherwood Design Engineers)	
<i>The Preserve: Agriculture Sustainable Action Plan</i> , lead	2009
<i>Courthouse Square</i> , Santa Rosa, CA, designer/PM (Studios Architecture, Architect)	2009
<i>Paradise Vineyards Winery</i> , Sonoma, CA, designer (BAR Architects, Architect)	2009
<i>Plot 16, Moscow International Business District</i> , Russia, designer/PM (Skidmore, Owings & Merrill, Architect)	2008
<i>Riversong Open Space Design</i> , Shanghai, China, staff designer	2007-2008
<i>Private Estate</i> , Bridgehampton, NY, designer/PM	2006-2009
<i>Key Biscayne Urban Design Plan</i> , Key Biscayne, FL, staff	2005
<i>Korean Winter Olympics Competition Bid</i> , PyeongChang, S.Korea, staff	2005

## Dale S.L. Dolan

Hood Associate Professor  
Electrical Engineering Department  
California Polytechnic State University  
San Luis Obispo, California 93407

dsdolan@calpoly.edu  
805-756-2495

### **EDUCATION & ADDITIONAL QUALIFICATIONS**

- |                            |   |
|----------------------------|---|
| January 2005 – March 2009  | <b>Ph.D. in Electrical Engineering</b><br><i>University of Toronto</i> , Department of Electrical and Computer Engineering<br>Toronto, Ontario, Canada                                    |
| May 2003 – April 2005      | <b>Master of Applied Science in Electrical Engineering</b><br><i>University of Toronto</i> , Department of Electrical and Computer Engineering<br>Toronto, Ontario, Canada                |
| September 1999 – May 2003  | <b>Bachelor of Applied Science in Electrical Engineering</b> with honours<br><i>University of Toronto</i> , Department of Electrical and Computer Engineering<br>Toronto, Ontario, Canada |
| July 1997                  | <b>Ontario Certificate of Qualification</b><br><i>Ontario College of Teachers</i> , Intermediate/Senior Biology and General Science   |
| September 1996 - June 1997 | <b>Bachelor of Education</b> , <i>with distinction</i> (minimum average of A)<br><i>University of Western Ontario</i> , Faculty of Education<br>London, Ontario, Canada                   |
| September 1990 - June 1995 | <b>Honours Bachelor of Science in Zoology</b><br><i>University of Western Ontario</i> , Faculty of Science<br>London, Ontario, Canada   |

### **EMPLOYMENT AND PROFESSIONAL ACTIVITIES**

**Windy Hills Caledon Renewable Energy** *Board of Directors: Chair/President* (May 2006 – May 2010), *Treasurer* (May 2004 – July 2007) Led organization whose objective is to install large scale (~10 MW) community wind turbine project. Technical lead for Connection Impact Assessment process with Hydro One Networks, Principal for administering Ontario Trillium Foundation two year Grant, application and implementation of Ministry of Energy Community Conservation Initiatives program, technical presentations at community meetings and for individual stakeholders, collaboration with Town of Caledon municipal planning officials. \*Solely or largely responsible for obtaining four large separate grants.

- Ontario Trillium Foundation, 2005-2007, \$150,000 Feasibility Grant
- Ontario Ministry of Energy, 2006-2007, \$23,500 Community Conservation Initiatives Grant
- Federation of Canadian Municipalities, 2007-2008, \$100,000 Green Municipal Funds Grant
- Ontario Community Power Fund, 2007-2009, \$300,000 Project Development Grant

**DTD Renewable Energy Consulting Ltd.** *President and Technical Consultant* (May 2005 – Sept 2012)  
Coordination of consulting services, renewable energy project feasibility, wind assessment sub-contracting, aeronautical clearances, site assessments, land lease negotiations.

**World Wind Energy Conference 2008.** *Executive Committee Member* (December 2006 – August 2008) Executive management of all aspects of 7<sup>th</sup> annual World Wind Energy Conference 2008: Community Power – Energy Autonomy for Local Economies. Kingston, Ontario June 2008.

**Ontario Sustainable Energy Association (OSEA)** *Board of Directors: Chair* (November 2007 - 2009), *Director* (September 2005 - 2009), *Chair Interview Committee* for executive director position, *Interview Committee* for staff positions, *Advisor/Reviewer* for community power guidebooks. OSEA is an umbrella organization formed to implement community sustainable energy projects across Ontario with an annual operating budget of ~\$500,000. OSEA proposed Standard Offer Contracts in Ontario and hosted the 2008 (WWEA) World Wind Energy Association Conference in Kingston, Ontario.

**Town of Caledon Wind Solutions Business Case Committee** *Co-Chair* (May 2005 – 2009), Town of Caledon committee whose objective is to investigate feasibility of wind energy projects in the Town of Caledon and feasibility of municipal involvement.

**OPA Transmissions Constraint and Generation Options Working Group** (February 2007 – August 2007), Ontario Power Authority working group whose objective was to resolve transmission constraint issues around Bruce Peninsula.

**University of Toronto** *NSERC Summer Studentship* (May-Aug 2002) Devised and executed a genetic circuit research project that included lab techniques in cloning as well as a literature review to enumerate operon parameters.

## TEACHING/ACADEMIC EXPERIENCE

<b>2014-Present</b>	<b>Hood Associate Professor</b> <b>Department of Electrical Engineering</b> <b>California Polytechnic State University, California</b> Faculty in power systems group with focus on power electronics, renewable energy technologies and policy.
<b>2013-Present</b>	<b>Sustainable Energy and Infrastructure Initiative Coordinator</b> <b>College of Engineering</b> <b>California Polytechnic State University, California</b> Led and developed college wide focusing initiative on Sustainable Energy and Infrastructure.
<b>2010-2014</b>	<b>Hood Assistant Professor</b> <b>Department of Electrical Engineering</b> <b>California Polytechnic State University, California</b> Faculty in power systems group with focus on power electronics, renewable energy technologies and policy.
<b>2013</b>	<b>Instructor – Cal Poly Epic Program</b> <b>College of Engineering</b> <b>California Polytechnic State University, California</b> Developed and delivered “Understanding Solar” laboratory experiments for high school students in EPIC summer program.
<b>2011-2012</b>	<b>Stem Diversity FLC (Faculty Learning Community)</b> <b>Center for Teaching and Learning (CTL)</b> <b>California Polytechnic State University, California</b> A full year training and mentorship program run by the CTL to develop the skills of faculty and expose them to diversity issues with the STEM fields.

- 2009-2010**      **Assistant Professor**  
**Department of Electrical Engineering**  
**California Polytechnic State University, California**  
Faculty in power systems group with focus on power electronics, renewable energy technologies and policy.
- 2009-2010**      **JFLC (Junior Faculty Learning Community)**  
**Center for Teaching and Learning (CTL)**  
**California Polytechnic State University, California**  
A full year training and mentorship program run by the CTL to develop the skills of junior faculty and expose them to colleagues from other colleges and departments.
- June 2010**      **Train the Trainer in Inclusive Excellence**  
**California Polytechnic State University, California**  
A 3 day workshop designed to train Cal Poly trainers in diversity awareness and inclusive excellence.
- 2003-2008**      **Research Assistant**  
**Faculty of Applied Science and Engineering**  
**University of Toronto**
- 2007**      **PPIT Program (Prospective Professors in Training)**  
A full year training and mentorship program run by the Faculty of Applied Science and Engineering at the University of Toronto that trains future professors in the three main areas of teaching, research and administrative service. Topics covered include teaching, evaluation, research planning, funding proposals, managing time, money and students etc., such that there is an elevation of the level of skill, understanding and engagement in the widest range of academic and teaching issues possible within the time constraints of the program.
- 2007**      **MIE3002 – Engineering, Teaching and Learning**  
A course that examines effective teaching practices and issues in undergraduate engineering education.
- 2007**      **Course Instructor**  
**Faculty of Applied Science and Engineering**  
**University of Toronto**  
Course: *APS 112 - Engineering Strategies and Practices II*  
Monitored students and supervised TAs for 3 sections of co-operative based learning design course
- 2006**      **DEEP Instructor for Engineering for Educators (E4E) program**  
**Faculty of Applied Science and Engineering**  
**University of Toronto**  
Course: *Environmental Engineering*  
Developed and delivered curriculum for da Vinci Engineering Enrichment Program (DEEP). E4E program designed to provide secondary school teachers with activities and techniques to promote and bring aspects of engineering into their classrooms.
- 2004-2008**      **Teaching Assistant**  
**Department of Electrical and Computer Engineering**  
**University of Toronto**  
Courses:  
ECE463 – *Electric Drives* (Prof. P.W. Lehn) 2008  
ECE315 – *Electromechanical Energy Conversion* (Prof. F.P. Dawson) 2007  
ECE212 – *Circuit Theory* (Prof. A. Prodic and L. DeWindt) 2007  
ECE315 – *Electromechanical Energy Conversion* (Prof. F.P. Dawson) 2006

ECE413 – *Energy Systems and Distributed Generation* (Prof. R. Iravani) 2006  
 ECE315 – *Electromechanical Energy Conversion* (Prof. F.P. Dawson) 2005  
 ECE212 – *Circuit Theory* (Prof. R. Iravani and L. DeWindt) 2005  
 ECE315 – *Electromechanical Energy Conversion* (Prof. F.P. Dawson) 2004  
 ECE315 – *Electromechanical Energy Conversion* (Prof. F.P. Dawson and Prof. J.D. Lavers) 2004

- July 2006**                      **DEEP Course Instructor**  
**Faculty of Applied Science and Engineering**  
**University of Toronto**  
 Course: *Alternative Power Generation*  
 Developed and delivered curriculum for da Vinci Engineering Enrichment Program (DEEP) summer program course to gifted senior high school students.
- 1999-2009**                      **Secondary School Occasional Teacher**  
**Dufferin Peel Catholic District School Board**  
 Taught and monitored grade 9-OAC classes in various subjects.
- 1998-2002**                      **Summer School and Night School Teacher**  
**Father Michael Goetz S.S., Phillip Pocock S.S.**  
**Dufferin Peel Catholic District School Board**  
 Prepared, taught and evaluated OAC Calculus and Finite Mathematics classes.
- 1997-1999**                      **Secondary School Science and Mathematics Teacher**  
**Dufferin Peel Catholic District School Board**  
 Prepared, taught and evaluated classes in Science & Math at the grade 10-OAC levels.

#### **ACADEMIC AWARDS & ACHIEVEMENTS**

- **Lockheed Martin Endowed Professorship** (2014-2016), College of Engineering, California Polytechnic State University, San Luis Obispo
- **CIE Fellow** (2014-Present), Cal Poly Center for Innovation and Entrepreneurship, California Polytechnic State University, San Luis Obispo
- **IATPP Faculty Scholar** (2013-Present), Cal Poly Institute for Advanced Technology and Public Policy, California Polytechnic State University, San Luis Obispo
- **CFA Distinguished Educator** (2013), California Polytechnic State University, San Luis Obispo
- **Electrical Engineering Department Solar Award** (2012), California Polytechnic State University, San Luis Obispo
- **IEEE Power and Energy Society Central Coast Chapter, High Performing Chapter Award**, (2012), California Polytechnic State University, San Luis Obispo – received 1<sup>st</sup> ever high performing chapter award as Chair of the Chapter (only 45 of ~225 worldwide chapters received this award)
- **IEEE Region 6 Outstanding Student Branch** (2012), California Polytechnic State University, San Luis Obispo – as advisor won outstanding student branch award for region 6 (Region 6 has nearly 50,000 members and ~100 student branches)
- **Outstanding Engineer Award** (2011), IEEE Power and Energy Society, Central Coast Chapter
- **Sustainability Advisory Committee** (2011-2013), Appoint by College of Engineering, California Polytechnic State University, San Luis Obispo
- **CFA Distinguished Educator Nominee** (2011), California Polytechnic State University, San Luis Obispo
- **Hood Endowed Professor – Electrical Engineering** (2010-2015), California Polytechnic State University, San Luis Obispo
- **OGSST Postgraduate Scholarship** (2007), Government of Ontario/University of Toronto

- **Gordon R. Slemon Scholarship** (2007), University of Toronto
- **NSERC Postgraduate Scholarship D2 (PGS D2)** (2005), NSERC/University of Toronto
- **NSERC Postgraduate Scholarship A (PGS A)** (2003), NSERC/University of Toronto
- **Dietmar Koslowski Bursary in Electrical Engineering** (2002), University of Toronto
- **NSERC Undergraduate Student Research Award** (2002) NSERC/University of Toronto
- **Dean's Honour List** (2000, 2001, 2002, 2003), University of Toronto
- **Dean's Honour List** (1991, 1997), University of Western Ontario
- **CIAU Academic All Canadian** (1997) – Recognition for athletes obtaining overall “A” averages.
- **Canada Scholar** (1990 - 1992) - Government of Canada for excellence in the field of Science.
- **Faculty of Science Admission Scholarship** (1990 - 1992) - University of Western Ontario.

### **RESEARCH GRANTS HELD**

2014-2017	<b>California Energy Commission: Alternative and Renewable Fuel and Vehicle Technology Program</b> <b><i>“Cal Poly Electric Vehicle Charging Infrastructure Initiative”</i></b> <b>Investigators: D. Dolan (PI), Cindy Campbell, Dennis Elliot</b> <b>Amount: \$185,182</b>
2014-2015	<b>U.S. Department of Energy: Marine and Hydrokinetic Testing Infrastructure Development</b> <b><i>“California Wave Energy Test Center (CalWave)”</i></b> <b>Investigators: Sam Blakeslee (PI), D. Dolan (Cal Poly Technical Lead), and others</b> <b>Amount: \$1,151,408</b>
2014-2015	<b>Western Digital Sponsored Research Grant</b> <b><i>“Data Acquisition Board – Phase II”</i></b> <b>Investigators: D. Dolan (PI), V. Prodanov</b> <b>Amount: \$40,000</b>
2013-2015	<b>Airbus Defense and Space, Inc. Sponsored Research Grant</b> <b><i>“AIRBUS DSI-CP-01: MEA (More Electric Aircraft) Failure Simulations”</i></b> <b>Investigators: D. Dolan (PI), Vladimir Prodanov (Co-PI)</b> <b>Amount: \$20,000</b>
2014	<b>Electricore, Inc. Sponsored Research Grant</b> <b><i>“EADS Battery Technology Review”</i></b> <b>Investigators: D. Dolan (PI), J. Dunning</b> <b>Amount: \$9,000</b>
2013-2014	<b>Chevron Student Project/Lab Development Grant</b> <b><i>“Novel Dual Axis Tracking Mobile Solar PV Trainer”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$2,300</b>
2013-2014	<b>Chevron Student Project/Activity Grant</b> <b><i>“Cal Poly Solar Decathlon 2015”</i></b> <b>Investigators: D. Dolan (PI), Kim Shollenberger (Co-PI)</b> <b>Amount: \$5,000</b>
2013-2014	<b>Western Digital Sponsored Research Grant</b> <b><i>“Negative Transient Tester”</i></b>



	<b>Investigators: D. Dolan (PI)</b> <b>Amount: \$46,000</b>
<b>2013-2014</b>	<b>Western Digital Sponsored Research Grant</b> <b><i>“Torture Stand Data Acquisition Board”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$40,000</b>
<b>2013-2014</b>	<b>University of California, Lawrence Berkeley National Laboratory, Max Tech and Beyond Appliance Design Competition for Ultra-Low Energy Use Appliances</b> <b><i>“High Efficiency Portable Air Conditioner (with 3 phase motor)”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$22,242</b>
<b>2013-2014</b>	<b>University of California, Lawrence Berkeley National Laboratory, Max Tech and Beyond Appliance Design Competition for Ultra-Low Energy Use Appliances</b> <b><i>“Smart Strip: Smart Sensing Power Bar”</i></b> <b>Investigators: Vladimir Prodanov (PI), D. Dolan (Co PI)</b> <b>Amount: \$15,000</b>
<b>2012-2013</b>	<b>Northrup Grumman -</b> <b><i>“Cold Capable Electronics Project”</i></b> <b>Investigators: D. Dolan (Co PI), Vladimir Prodanov (Co PI)</b> <b>Amount: \$5,000</b>
<b>2012-2013</b>	<b>Cal Poly College of Engineering R-IDC Funding</b> <b><i>“Electric Vehicle Research Infrastructure Development”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$3,915</b>
<b>2012-2013</b>	<b>Cal Poly College of Engineering R-IDC Funding</b> <b><i>“Cold Capable Electronics Project”</i></b> <b>Investigators: D. Dolan (Co PI), Vladimir Prodanov (Co PI)</b> <b>Amount: \$4,500</b>
<b>2012-2013</b>	<b>National Fire Protection Association, Fire Protection Research Foundation</b> <b><i>“Photovoltaic Panel Installation Best Practices Review and All Hazards Assessment”</i></b> <b>Investigators: Frederick Mowrer (PI), D. Dolan, Kevin Dong, Thomas Korman</b> <b>Amount: \$30,000</b>
<b>2011-2013</b>	<b>C<sup>3</sup>RP – California Central Coast Research Partnership</b> <b><i>“Hybrid Electric Vehicle Grid Connectivity – Phase I Supplement”</i></b> <b>Investigators: D. Dolan (PI), J. Dunning</b> <b>Amount: \$16,240</b>
<b>2012-2013</b>	<b>Western Digital Sponsored Research Grant</b> <b><i>“Load Transient Response and Efficiency Test Automation”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$37,200</b>
<b>2011-2012</b>	<b>Extramural Funding Initiative, Research and Graduate Programs, California Polytechnic State University</b> <b><i>“Electric Vehicle Evaluation and Education Project (EVEEP)”</i></b> <b>Investigators: D. Dolan (PI), John Dunning, Bridget Benson</b> <b>Amount: \$14,971</b>

2011-2012	<b>University of California, Lawrence Berkeley National Laboratory</b> <b><i>“Hybrid Solar Photovoltaic Panel for Pool Heating”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$19,973</b>
2011-2012	<b>Chevron Lab Development Grant</b> <b><i>“Cal Poly Sustainable Energy Lab”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$10,000</b>
2011-2012	<b>Western Digital Sponsored Research Grant</b> <b><i>“Load Transient Response Project”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$30,000</b>
2011-2012	<b>Lockheed Martin Space Systems Company</b> <b><i>“Cal Poly Sustainable Power for Electrical Resources (SuPER) Project”</i></b> <b>Investigators: D. Dolan (PI), J. Harris, A. Shaban</b> <b>Amount: \$2,000</b>
2011-2013	<b>C<sup>3</sup>RP – California Central Coast Research Partnership</b> <b><i>“Hybrid Electric Vehicle Grid Connectivity – Phase I”</i></b> <b>Investigators: D. Dolan (PI), J. Dunning</b> <b>Amount: \$58,240</b>
2010-2011	<b>Western Digital Sponsored Research Grant</b> <b><i>“Slew Rate Test Methodology and Tool Design”</i></b> <b>Investigators: D. Dolan (PI)</b> <b>Amount: \$40,000</b>
2010-2011	<b>Chevron Sponsored Research Grant</b> <b><i>“Three-Phase Ground-Fault Circuit-Interrupter System”</i></b> <b>Investigators: D. Dolan (PI), J. Oliver, Taufik, A. Shaban, A. Nafisi</b> <b>Amount: \$116, 922</b>

## **PUBLICATIONS**

### **Refereed Journal Papers (accepted or published)**

- [J3] T . **Taufik**, R. Prasetyo, D. Dolan, D. Garinto, “A Cell-Based Multiphase Interleaving Buck Converter with Bypass Capacitors”, Journal of World Academy of Science, Engineering, and Technology, Issue 43, pp699-703, July 2010.
- [J2] T . **Taufik**, T. Gunawan, D. Dolan, M. Anwari, "Design and Analysis of Two-Phase Boost DC-DC Converter", Journal of World Academy of Science, Engineering, and Technology, Issue 43, pp703-708, July 2010
- [J1] **D. S.L. Dolan**, P.W. Lehn, “Simulation model of wind turbine 3p torque oscillations due to wind shear and tower shadow”, IEEE Transactions on Energy Conversion, vol. 21, no. 3, pp. 717-724, September 2006.

**Refereed Conference Papers (published) (presenting author bolded)**  
**student co-authorship indicated with \***

- [C39] **D. Dolan**, M. Ducasse\*, Taufik, “Variability in Detailed Energy Usage on Repeated Trips in the Chevrolet Volt”, EVS27 27th International Electric Vehicle Symposium, Barcelona, Spain, November 2013.
- [C38] **D. Dolan**, J. Dunning, Taufik, “Analysis of Detailed Electric Vehicle Data in Electrical Engineering Education”, EVS27 27th International Electric Vehicle Symposium, Barcelona, Spain, November 2013.
- [C37] **D. Dolan**, M. Ducasse\*, Taufik, “*Characterizing Energy Usage of Chevrolet Volt Versus Speed*”, 2013 IEEE Conference on Technologies for Sustainability (SusTech), Portland, OR, August 2013
- [C36] **Taufik**, D. Dolan, "WIP: Enhancing Students' Learning in Introductory Power Electronic Course Using an LED Driver Project", Proc. of 2013 ASEE-PSW Conference, April 2013.
- [C35] **D. Dolan**, A. Palchak\*, N. Greene\*, S. Roy, “Hybrid Solar Photovoltaic panel for Pool Heating” University of California, Lawrence Berkeley National Laboratory, Maxtech Ultra Low Energy Use Design Competition, 2011/2012.
- [C34] **D. Dolan**, L. Friedman\*, J. Huff\*, and Taufik, "Solar Trainer for Photovoltaic Systems Education", Proc.of 2012 North American Power Symposium, September 2012.
- [C33] Taufik, S. McClusky\*, J. Paolucci\*, and **D. Dolan**, "A Robust PWM Inverter for DC Power Supply", Proc.of 2012 North American Power Symposium, September 2012.
- [C32] C. Grasberger\*, **D. Dolan**, and Taufik, "Development of an Open-Source High-Performance Battery Management System", Proc.of 2012 North American Power Symposium, September 2012.
- [C31] **S. Leonard\***, D. Dolan, K. Zombro\*, and Taufik, "A Low Cost Portable Parabolic Solar Concentrator for Combined Heat and Power", Proc.of 2012 North American Power Symposium, September 2012.
- [C30] **D. Dolan**, V. Le\*, Taufik, “Geographic Variation in Environmental Benefits Achieved by Plug in Electric Vehicles and Electric Vehicles”, EVS26 26th International Electric Vehicle Symposium, Los Angeles, CA, May 2012.
- [C29] **D. Dolan**, Taufik, "Use of Online Review to Increase Student Performance on Online and In-Class Evaluations in Power Electronics", 2012 ASEE PSW Conference, April 2012.
- [C28] **D. Dolan**, P. Lehn, Taufik, "Harmonics and Dynamic Response of a Virtual Air Gap Variable Reactor", Conference on Information Technology: New Generations, April 2012.
- [C27] Taufik, T. Wong\*, **O. Jong\***, and D. Dolan, “Design and Simulation of Multiple-Input Single-Output DC-DC Converter”, Conference on Information Technology: New Generations, April 2012.
- [C26] Taufik, J. Thornton\*, and **D. Dolan**, “Piezoelectric Converter for Wind Energy Harvesting”, Conference on Information Technology: New Generations, April 2012.

- [C25] **D. S.L. Dolan**, D. Zepeda\*, Taufik, “Development of Wind Tunnel for Laboratory Wind Turbine Testing”, Proc. of 2011 North American Power Symposium (NAPS 2011), Boston, Massachusetts, August 2011.
- [C24] Taufik, S. McClusky\*, J. Paolucci\* and **D. S.L. Dolan**, “A New Undergraduate Laboratory Course in Magnetic Design”, Proc. of 2011 North American Power Symposium (NAPS 2011), Boston, Massachusetts, August 2011.
- [C23] J. Harris, A. Shaban, and **D. S.L. Dolan**, “Cal Poly Sustainable Power for Electrical Resources (SuPER) Project”, Proc. of 2011 North American Power Symposium (NAPS 2011), Boston, Massachusetts, August 2011.
- [C22] **D. S.L. Dolan**, and Taufik “An Active Power Factor Correction Laboratory Experiment for Power Electronics Course”, Proc. of 118<sup>th</sup> ASEE Annual Conference and Exposition, Vancouver, Canada, June 2011.
- [C21] Taufik, and **D. S.L. Dolan**, “Web Based Magnetic Design”, Proc. of 118<sup>th</sup> ASEE Annual Conference and Exposition, Vancouver, Canada, June 2011.
- [C20] **D. S.L. Dolan**, V. Prodanov, and Taufik “Student Perception of Lecture Video Use as a Means to Increase Time for in Class Problem Solving”, Proc. of 118<sup>th</sup> ASEE Annual Conference and Exposition, Vancouver, Canada, June 2011.
- [C19] **D. S.L. Dolan**, Joseph Durago\*, and Taufik, “Development of a Photovoltaic Emulator using Labview”, Proc. of 37<sup>th</sup> IEEE Photovoltaic Specialists Conference, Seattle, Washington, June 2011.
- [C18] Taufik, D. Forbes\*, D. S.L. Dolan and R. Putri, “Digital Control of Parallel-Connected DC-DC Converters”, Proc. of the 8th International Conference on Information Technology, April 2011.
- [C17] Taufik, J. Arakaki, D.S.L. Dolan, M. Anwari, and M. Hamid, “Comparative Study of 4-Switch Buck-Boost Controller and Regular Buck-Boost”, Proc. of the International Conference on Advanced Science, Engineering and Information Technology, January 2011.
- [C16] Taufik, R. Prasetyo\*, D.S.L. Dolan, D. Garinto “A New Multiphase Multi-Interleaving Buck Converter With Bypass LC”, Proc. of the 36th Annual Conference of the IEEE Industrial Electronics Society, Phoenix, November 2010.
- [C15] **D. S.L. Dolan**, Joseph Durago\*, Joe Crowfoot\*, Taufik, “Simulation of A Photovoltaic Emulator”, Proc. of 2010 North American Power Symposium (NAPS 2010), Arlington, Texas, September 2010.
- [C14] M.McCarty\*, Taufik, and **D. S.L. Dolan**, “Determining the Optimum Operating Parameters of a Unipolar PWM Inverter Using Experimental Approach”, Proc. of 2010 North American Power Symposium (NAPS 2010), Arlington, Texas, September 2010.
- [C13] Taufik, R. Prasetyo\*, **D. S.L. Dolan** and D. Garinto, “A New Multiphase Interleaving Buck Converter With Bypass Cell Capacitor and Inductor”, Proc. of the 53rd IEEE Int'l Midwest Symposium on Circuits & Systems, Seattle, Washington, August 2010.
- [C12] Taufik, J. Ruckdaschel\*, **D. S.L. Dolan** and M. Anwari, “Modeling and Analysis of a Static VAR Compensated Mixed Load System”, Proc. of IASTED International Conference on Modeling and Simulation, Banff, Alberta, July 2010.

- [C11] **Taufik**, R. Prasetyo\*, D. S.L. Dolan and D. Garinto, "A Cell-Based Multiphase Interleaving Buck Converter with Bypass Capacitors", Proc. of International Conference on Computer, Electrical, and Systems Science, and Engineering, July 2010.
- [C10] **Taufik**, T. Gunawan, D. S.L. Dolan and M. Anwari, "Design and Analysis of Two-Phase Boost DC-DC Converter", Proc. of International Conference on Computer, Electrical, and Systems Science, and Engineering, July 2010.
- [C9] **D. S.L. Dolan**, P.W. Lehn, "Harmonic Mitigation in a Virtual Air Gap Variable Reactor via Control Current Modulation", submitted to IEEE 2008 PES General meeting, Pittsburgh, Pennsylvania, July 2008, 5 pages.
- [C8] **D. S.L. Dolan**, P.W. Lehn, "Finite Element Analysis of a Virtual Air Gap Variable Transformer", 2008 IEEE Canadian Conference on Electrical and Computer Engineering, CCECE2008, Niagara Falls, Ontario, May 2008, 6 pages.
- [C7] **D. S.L. Dolan**, P.W. Lehn, "Analysis of a Virtual Air Gap Variable Reactor", Power Electronics Specialists Conference, PESC2007, IEEE, pp. 1182-1187, Orlando, Florida, June 2007.
- [C6] **D. S.L. Dolan**, "Economic Cost Model for Wind Energy Generation", AWEA WINDPower2007, Los Angeles, California, June 2007, 6 pages.
- [C5] **D. S.L. Dolan**, "Cost Benefit Analysis of an Ontario Community Wind Energy Project", AWEA WINDPower2007, Los Angeles, California, June 2007, 21 pages.
- [C4] **D. S.L. Dolan**, P.W. Lehn, "Simulation model of wind turbine 3p torque oscillations due to wind shear and tower shadow", Power Systems Conference and Exposition, PSCE'06, 2006 IEEE PES, pp. 2050-2057, Atlanta, Georgia, November 2006.
- [C3] C. Sao, **D. S.L. Dolan**, P.W. Lehn, "Voltage Flicker Model of Wind Turbine Generators due to Windshear and Tower Shadows", CIGRE Canada Conference on Power Systems, Montreal, Quebec, October 2006, 4 pages.
- [C2] **D. S.L. Dolan**, C. Sao, P.W. Lehn, "Lightning Exposure of Wind Turbines", 2006 Canadian Conference on Electrical and Computer Engineering, pp. 717-724, Ottawa, Ontario, May 2006.
- [C1] **D. S.L. Dolan**, P.W. Lehn, "Real-Time Wind Turbine Emulator Suitable for Power Quality and Dynamic Control Studies", International Conference on Power System Transients, IPST05-074-26a, Montreal, Quebec, June 2005, 6 pages.

### **Theses**

- [T3] D. S.L. Dolan, "Modelling and Performance Evaluation of the Virtual Air Gap Variable Reactor", Ph.D. Thesis, University of Toronto, 2009.
- [T2] D. S.L. Dolan, "Real time wind turbine emulator suitable for power quality and dynamic control studies", M.A.Sc. Thesis, University of Toronto, 2005.
- [T1] D. S.L. Dolan, S. Figel, P. Zyla, "High Current Switch-Mode Power Supply for Low Voltage Microelectronics", B.A.Sc. Thesis, University of Toronto, 2003.

### **MEDIA ATTENTION AND NEWS ARTICLES**

October 21, 2014	College of Engineering News October 2014 - article titled “Dale Dolan Selected for New Interdisciplinary Faculty Program to Promote University Entrepreneurship”
August 27, 2014	College of Engineering News August 2014 - article titled “Cal Poly Drives Electric Car Use with Fleet of Charging Stations”
August 14, 2014	The Tribune - article titled “Cal Poly to Install Electric Vehicle Charging Stations on Campus”
Spring, 2014	College of Engineering, Engineering Advantage article titled “SunPower Gift Promotes Sustainability in the Classroom”
Spring, 2014	College of Engineering, Engineering Advantage article titled “A Wave of Sustainability”
Spring, 2014	College of Engineering, Engineering Advantage article titled “Here comes the Sun (Again)”
March 6, 2014	Mustang News - article titled “Cal Poly to Compete in 2015 Solar Decathlon”
February 18, 2014	College of Engineering News February 2014 - article titled “Cal Poly To Compete in U.S. Department of Energy Solar Decathlon 2015”
January 13, 2014	The Tribune - article titled “Cal Poly Institute to Explore Sites for Wave Energy Testing Facility”
December 11, 2013	Mustang News - article titled “Cal Poly Wins Department of Energy Grant, Will Research Ocean Wave Power”
December 9, 2013	Cal Poly News - article titled “Cal Poly Institute for Advanced Technology and Public Policy’s Wave Energy Project Nets \$750,000 Dept. of Energy Research Grant”
October 25, 2007	Caledon Enterprise article titled “Windy Hills Gathers Momentum”
September 5, 2007	Huntsville Forester article titled “A New Energy Source for Muskokans”

### **PROFESSIONAL AFFILIATIONS**

- Chair, IEEE Power Engineering Society – Central Coast Chapter (May 2011 - Present)
- Member, IEEE Central Coast Section Executive Committee (May 2011 - Present)
- Member, IEEE
- Member, IEEE Power Engineering Society
- Member, IEEE Power Electronics Society
- Member, Ontario College of Teachers
- Member, Ontario English Catholic Teachers Association
- Reviewer, **IEEE Transaction on Energy Conversions** (May 2006 - Present)
- Reviewer, **IEEE Transaction on Power Systems** (May 2006 - Present)
- Reviewer, **IEEE Power Engineering Society Letters** (August 2007 - Present)
- Reviewer, **IEEE Transaction on Power Delivery** (September 2008 - Present)
- Reviewer, **Applied Energy** (July 2009 - Present)
- Reviewer, DOE's ARPA-E Initiative ( July 2009)
- Reviewer, DOE's Smart Grid Investment Grant Program ( August 2009)

## Adrienne I. Greve

### *Associate Professor*

City and Regional Planning Department  
California Polytechnic State University  
San Luis Obispo, CA 93407

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### **Fields of Interest**

Climate change adaptation  
Greenhouse gas reduction  
Natural hazards mitigation

Watershed management  
Urban hydrology  
Urban ecology

### **Education**

*University of Washington, Seattle, WA, 2002-2007*

Ph.D. Interdisciplinary PhD Program in Urban Design and Planning, Urban Ecology Program

*Colorado State University, Fort Collins, CO, 1997-1999*

M.S., Bioresource Engineering, Environmental Engineering Option

*Cornell University, Ithaca, NY, 1992-1996*

B.S., Biological and Agricultural Engineering

### **Academic Experience**

*Associate Professor, City and Regional Planning Department, California Polytechnic State University, San Luis Obispo, CA, September 2012 – present, Assistant Professor September 2006 – ongoing.*

*Visiting Professor, Research Center for Disaster Reduction Systems, Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto, Japan, September 2013 – August 2014.*

*Doctoral Fellow, Interdisciplinary PhD Program in Urban Design and Planning, Urban Ecology IGERT, University of Washington, Seattle, WA, September 2002 – August 2005.*

*Research Staff, Urban Ecology Research Laboratory, Land Cover Impacts on Hydrologic Time of Concentration, Seattle, WA, Summer 2004*

*Teaching and Research Assistant, Bioresource Engineering Department, Colorado State University, Fort Collins, CA, August 1997 – August 1999.*

### **Professional Experience**

*Aquatic Ecology Staff, Seattle Public Utilities, Science, Sustainability, and Watershed Group, Seattle, WA, 2005-2006*

*Surface-Water Hydrologist, U.S. Geological Survey, National Water Quality Assessment Program, Upper Colorado River and South Platte River Study Unit Teams, Denver, CO, 1999-2002*

*Biologist, U.S. Forest Service, Marbled Murrelet Team, Darrington, WA, 1993*

## Publications

- Greve, AI, and Boswell, MR. (2014). Climate Change Adaptation. In Blanco, H and Mazmanian, D. (eds.). *Elgar Companion to Sustainable Cities – Strategies, Methods and Outlook*. Northampton, MA: Edward Elgar Publishing Ltd.
- Boswell, MR, Greve, AI, and Seale, TL. (2014). Climate Action Planning. In Blanco, H and Mazmanian, D. (eds.). *Elgar Companion to Sustainable Cities – Strategies, Methods and Outlook*. Northampton, MA: Edward Elgar Publishing Ltd.
- Greve, AI. (2012). Linking urban form, land cover pattern, and hydrologic flow regime in the Puget Sound Lowland. *Urban Ecosystems* 15: 437-450.
- Boswell, MR, Greve, AI, and Seale, TL. (2012). *Local Climate Action Planning*. Washington DC: Island Press, 304 p.
- Boswell, MR, Greve, AI, and Seale, TL. (2010). An Assessment of the Link Between Greenhouse Gas Emissions Inventories and Climate Action Plans. *Journal of the American Planning Association*, 76(4): 451-462.
- Oleyar MD, Greve AI, Withey JC, and Bjorn AM. (2008). Evaluating Urban Forest Functionality: An Interdisciplinary Approach. *Urban Ecosystems* 11: 289-308.
- Dooling, S., Graybill J.K., Greve, A.I. (2007). Response to Young and Wolf: Goal attainment in urban ecology research 1975-2000. *Urban Ecosystems* 10: 339-347.
- Graybill, J.K., Dooling, S., Shandas, V., Withey, J., Greve, A., Simon, G.L. (2006). A Rough Guide to Interdisciplinarity: Graduate Student Perspectives. *Bioscience* 56: 757-763
- Greve, A.I., Loftis, J.C., Brown, J.B., Buirgy, R.R., Alexander, B. (2003). Design and Implementation of a Cooperative Water Quality Monitoring Program in Colorado's Big Thompson Watershed. *Journal of the American Water Resources Association* 39: 1409-1418.
- Sprague, L.A., & Greve, A.I. (2003). Changes in Nutrient and Pesticide Concentrations in Urban and Agricultural Areas of the South Platte River Basin, Colorado, Wyoming, and Nebraska, 1994–2000: *U.S. Geological Survey Water-Resources Investigations Report* 02-4270, 12 p.
- Greve, A.I. (2002). Data-Quality Measures for Stakeholder-Implemented Watershed-Monitoring Programs. *U.S. Geological Survey Open File Report* 02-141, 19 p.
- Gurdak, J.J., Greve, A.I., & Spahr, N.E. (2002). Water-quality Data Analysis of the Upper Gunnison River Watershed, Colorado, 1969-99. *U.S. Geological Survey Water-Resources Investigations Report* 02-4001, 61 p.
- Greve, A.I., Spahr, N.E., Van Metre, P.C., & Wilson, J.T. (2001). Identification of Water-Quality Trends Using Sediment Cores from Dillon Reservoir, Summit County, Colorado. *U.S. Geological Survey Water-Resources Investigations Report* 01-4022, 33 p.
- Greve, Adrienne, Loftis, Jim, Alexander, Ben, & Buirgy, Rob. (1999). Design of a Cooperatively Implemented Monitoring System: The Big Thompson Watershed Forum. *Water Resources Impact* 1: 18-22.
- Greve, A.I., & Ward, R.C. (1998). Gaining Public Support for Urban Water Quality Management via Monitoring. *Proceedings National Water Quality Monitoring Council*, National Monitoring Conference, Las Vegas, NV, 1998.



## Funded Projects

- Co-Principal Investigator, Used Oil and Filter Curbside Collection Research, June 2014 – March 2016, California Department of Recycling and Recovery.
- Co-Principal Investigator, Local Policy Scan on Climate Change Adaptation and Food Systems in the San Francisco Bay Area, October 2013 – February 2014, ChangeLab Solutions.
- Co-Principal Investigator, Local Policy Scan on Climate Change Adaptation, October 2012 – June 2013, ChangeLab Solutions, <http://changelabsolutions.org/publications/policy-scan-climate-change>.
- Co-Principal Investigator, Rapid Climate Action Planning Process and Pilot Program, September 2012 – December 2013, Navigant Consulting and Southern California Gas Company.
- Co-Principal Investigator, Project Director, State of California Climate Change Adaptation Planning Guide, January 2011 – August 2012, California Emergency Management Agency and California Natural Resources Agency, [http://resources.ca.gov/climate\\_adaptation/local\\_government/adaptation\\_policy\\_guide.html](http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html).
- Principal Investigator, Climate Action Plan Implementation Pilot Study, June 2011 – January 2012, Planning, Design and Construction Institute - Seed Grant Program.
- Project Director, City of San Luis Obispo Climate Action Plan, August 2009-April 2010, City of San Luis Obispo, CA, <http://www.slocity.org/communitydevelopment/CAP/CAP%20Final%20Web.pdf>.
- Project Director, City of Benicia Climate Action Plan, August 2008 – May 2009, City of Benicia, CA, [http://www.ca-ilg.org/sites/main/files/file-attachments/resources\\_\\_finalcap.pdf](http://www.ca-ilg.org/sites/main/files/file-attachments/resources__finalcap.pdf).

## Selected Presentations

- “Applying Resilience Goals – Integrating Resilience into Local Planning, Lessons from the Tohoku Region.” Association of Collegiate Schools of Planning Conference, Philadelphia, PA, October 2014.
- “Planning for the Public Health Impacts of Climate Change: Identifying Best Practice.” Greve, AI and MR Boswell. Association of Collegiate Schools of Planning Conference, Philadelphia, PA, October 2014.
- “Resilience and Local Planning - Evaluating activities in Japan, Canada, and the US.” Greve, AI. Disaster Prevention Research Institute Symposium, Kyoto University, Uji, Japan, July 2014.
- “Local Adaptation Planning: Making Decisions in an Uncertain Context.” Greve, AI. Environmental Innovators Symposium IV - Embracing Change: Building Resilience with Communities, Keio University, Hiyoshi Campus, Yokohama, Japan, January 2014.
- “Climate Change and Local Planning.” Greve, AI. Environmental Innovators Special Lecture, Keio University, Fujisawa, Japan, December 2013.
- “Mainstreaming Climate Adaptation Planning.” Greve, AI, JP Lowe, B Reed, and C Alling. California Climate Action Planning Conference, San Luis Obispo, CA, February 2013.
- “Flooding, Storm Surges—What’s Next? Our Regional Response to a Warming Climate.” Greve, AI, B Williams, & KC Golden. Town Hall, Seattle, WA, December 2012.
- “Meeting Local Needs – The Challenge of Climate Adaptation Planning on a Local Scale.” Greve, AI, K Main, & M Boswell. Association of Collegiate Schools of Planning Conference, Cincinnati, OH, November 2012.
- “Local Climate Action Planning.” Greve, AI, M Boswell, T Seale. San Francisco Planning and Urban Research Association (SPUR), October 2012.
- “Adapting Cities to Climate Change.” Greve, AI, M Culver, S Shuford. American Planning Association Web Conference, June 2012.

- "Low Cost Ways to Reduce Energy and GHG Emissions." Greve, AI, K Brubaker, S Freedman. Local Government Commission Webinar, June 2012.
- "Climate Adaptation Planning Tools for California Local Governments." McCormick, M, K Malchow, A Greve. Institute for Local Government Webinar, May 2012.
- "Adapting to Climate Change - California Resources for Local Governments." Greve, AI. 2012 National American Planning Association Conference, Los Angeles, CA April 2012.
- "Urban Ecology and Planning for Climate Change." Greve, A.I. MIT Department of Urban Studies and Planning Symposia – Reinventing the City: Urban Ecology and the City. Cambridge, MA, December 16, 2011.
- "Local Climate Adaptation Planning in California." Greve, AI, M Boswell. Association of Collegiate Schools of Planning Conference, Salt Lake City, UT, October 2011.
- "Climate Adaptation - Acting In the Face of Uncertainty". Holland, B., AI Greve, K Meis, M Boswell. Roundtable Session. American Planning Association California Conference, Santa Barbara, CA, September 2011.
- "Climate Change Adaptation and Mitigation". Greve, AI, AG Young, C Martinez, R Loures. Roundtable Session. Energy and Climate Partnership of the Americas (ECPA), Sustainable Urban Planning and Energy Efficient Construction for Low-income Areas of the Americas, November 2010, Rio de Janeiro, Brazil.
- "Translating Climate Predictions into Adaptation Decisions." Greve, A, E Holdeman, K Trenberth, B Binder. Panel Discussion. Natural Hazards Research and Application Workshop, Broomfield, CO, July 2010.
- "Climate Action Plans and Emissions Inventories: Strengthening The Foundations of Policy Development." Boswell, M, A Greve, T Seale. Association of Collegiate Schools of Planning Conference, Minneapolis, MN, October 2010.
- "Theories and Application of Sustainable Development." Greve, AI, L Vanasupa, P Schwartz, S Alptekin, R. Rutherford, N Zhang, B Qu. Sino-U.S. Collaborative Workshop, Huan County, China, July 2010.
- "Assessing Interdisciplinary Learning Styles." Greve, AI, A Leithner, M Neveu, S Rahman. CSU Regional Symposium on University Teaching, San Luis Obispo, CA, May 2009.
- "Mixed-Method Assessment of Stream Function in a Human-Dominated Setting." Greve, AI. Association of Collegiate Schools of Planning and the Association of European Schools of Planning, Joint Conference, Chicago, IL, July 2008.
- "Linking Urban Form and Land Cover Pattern to Hydrologic Flow Regime: an alternative to imperviousness." Greve, AI. Associated Collegiate Schools of Planning, Annual Conference, Fort Worth, TX, November 2006.
- "Streams in an Urban Context—Accounting for Settlement Pattern and History." Greve, AI. Associated Collegiate Schools of Planning, Annual Conference, Kansas City, MO, October 2005.
- "Evaluating Urban Forest Functionality: A Three-dimensional Approach." AM Bjorn, AI Greve, MD Oleyar, JC Withey. Poster Presentation, 2<sup>nd</sup> International Congress of the Postgraduate Research and Study Programme on Urban Ecology, Berlin, October 2004.
- "Design of a Cooperatively Implemented Monitoring System: The Big Thompson Watershed Forum." Greve, AI J Loftis. AWRA Annual Summer Specialty Conference, Science into Policy: Water in the Public Realm, Bozeman, MT, 1999.

**Yarrow M. Nelson**  
Professor

Department of Civil and Environmental Engineering  
California Polytechnic State University  
San Luis Obispo, CA, 93407  
805-756-1347 ynelson@calpoly.edu

**Education**

**Ph.D. 1997 Environmental Engineering, Cornell University**  
**M.S. 1992 Agricultural and Biological Engineering, Cornell University**  
**B.S. 1979 Chemical Engineering, University of California, Berkeley**

**Academic Experience**

**Professor, Department of Civil and Environmental Engineering, California Polytechnic State University, 2006 to present.**

Teaching environmental engineering and biochemical engineering courses. Research on biodegradation and phytoremediation of hydrocarbons and chlorinated compounds, toxic metal biogeochemistry, and algae-based wastewater treatment.

**Associate and Assistant Professor, Department of Civil and Environmental Engineering, California Polytechnic State University, 1999 to 2005.**

Taught mass transport, environmental engineering unit operations, wastewater treatment and biochemical engineering. Research areas included microbial interactions affecting toxic trace metals in aquatic environments, bioremediation of hydrocarbon-contaminated sites, and nitrate transport in soils.

**Visiting Assistant Professor, School of Civil and Environmental Engineering, Cornell University, Summer 2000**

Conducted a research project on toxic trace metal adsorption to biogenic Mn oxides.

**Research Associate and Lecturer, School of Civil and Environmental Engineering, Cornell University, 1997-1999**

Supervised and conducted NSF-sponsored research on biological interactions with Mn and Fe oxides that affect toxic trace metal fate, transport and bioavailability. Taught undergraduate courses in environmental engineering.

**Graduate Research Assistant/ EPA Fellow /, School of Civil and Environmental Engineering, Cornell University, 1992-1997.**

Completed doctoral research under a fellowship from the U.S. Environmental Protection Agency. Developed integrated models for toxic trace metal fate and transport in natural and engineered aquatic systems. Conducted an ecotoxicological investigation of polluted sediments in an alkaline lake in Kenya and developed a toxic release inventory for the lake watershed (with the World Wildlife Fund). Also taught and assisted teaching of undergraduate environmental engineering courses.

## **Related Professional Experience**

**Research Support Specialist**, Department of Agricultural and Biological Engineering, Cornell University, 1989-1992.

Designed bench and pilot-scale reactor systems for coupled anaerobic and methanotrophic processes for degradation of chlorinated groundwater contaminants.

**Research Support Specialist**, Chemical Engineering, Cornell University, 1981-1989

Conducted research on detergents, flame retardants, polymeric materials for electron beam lithography, diffusion in polymers, and recycling of polymers.

**Chemical Design Engineer**, Photon Power, Inc., El Paso, TX, 1980 - 1981.

Designed the chemical unit processes and pollution control systems for a photovoltaic solar cell manufacturing plant in El Paso, Texas.

**Process Engineer**, Lion Oil Company / TOSCO, 1978 - 1979

Designed air pollution control systems and developed a computer model for use in optimization of refinery processes.

## **Awards**

- Cal Poly Distinguished Teaching Award 2005-2006
- Northrup Grumman Excellence in Research and Development Award 2004.
- Raytheon Excellence in Teaching and Applied Research Award, 2003.
- Environmental Protection Agency 1995-1997 STAR Graduate Student Fellowship.

## **Professional Organizations**

- American Chemical Society - Division of Environmental Chemistry.
- American Association of Environmental Engineering and Science Professors
- Water Environment Federation

## **Publications and Presentations**

Manheim, D. and Y. Nelson. 2013. "Settling and bioflocculation of two species of algae used in wastewater treatment and algae biomass production" *Environmental Progress & Sustainable Energy*, Vol 32, No. 4, pp. 946–954

Shihady, S., Nelson, Y, et al. 2012 "Bench-scale testing: Transfer of NO<sub>x</sub> from artificial flue gas to *Chlorella* algae grown in photobioreactors." Presented at the annual meeting of the National Algae Association, Nov. 2012

Kline, K., D. Mackay, L. Rastegarzadeh, Y. Nelson and J. Clark. 2011. "Importance of exposure history when using single well push pull tests to quantify in situ ethanol biodegradation rates." *Ground Water Monitoring & Remediation.*, Vol 31, pp 103-110.

Woertz, I., A. Feffer, T. Lundquist and Y. Nelson. 2009. "Algae grown on dairy and municipal wastewater for simultaneous nutrient removal and lipid production for biofuel feedstock." *J. Environ. Engin. (ASCE)*. Vol 135, No 11, pp 1115-1122.

- Nelson, Y.M., S. Bragg-Flavan, L. Rastegarzadeh, M. Chell, K. Crossley, and E. Mick. "Assessment of Alternative Modes of Biodegradation for Natural Attenuation of Weathered Petroleum." Presented at the 10th International Conference on In-situ and On-site Bioremediation." Baltimore, MD, May, 2009.
- Mick, E., K. Crossley, and Y. M. Nelson, 2007. " Chemical Composition of Groundwater Hydrocarbon Mixtures Before and After Aerobic Biodegradation." Platform presentation at the 9th International Conference on in-situ and on-site Bioremediation." Baltimore, MD, May 7-10, 2007.
- Dreyer, M.G., Y.M. Nelson, C. Kitts, P. Lundegard and G. Garcia, 2005. "Weathering effects on biodegradation and toxicity of hydrocarbons in groundwater." Presented at the 8th International Conference on In Situ and On-Site Bioremediation, Battelle, Baltimore, MD, June 5, 2005.
- Cunningham, C.R., Y.M. Nelson, C. Kitts, P. Lundegard, 2005. "Biodegradation of weathered hydrocarbons in soil columns and laboratory microcosms simulating natural attenuation field conditions. Presented at the 8th International Conference on In Situ and On-Site Bioremediation, Battelle, Baltimore, MD, June 5, 2005.
- Orchard, B. Y.M. Nelson, L. Maloney, C. Kitts, and P. Lundegard, 2005 "Microbial activity of soil following steam treatment." Presented at the 8th International Conference on In Situ and On-Site Bioremediation, Battelle, Baltimore, MD, June 5, 2005.
- Martin, W., Y.M. Nelson and K. Hoffman, 2004."Investigation of hydrocarbon phytoremediation potential of *Lupinus chamissonis* in laboratory microcosms. Platform presentation at the Water Environment Federation Conference, October, 2004, New Orleans.
- Maloney, L., Y.M. Nelson and C.L. Kitts, 2004. "Characterization of aerobic and anaerobic microbial activity in hydrocarbon-contaminated soil." in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds*. Battelle Press, Columbus, OH, 2004
- Waudby, J. and Y.M. Nelson, 2004. "Biological feasibility and optimization of biosparging at a hydrocarbon-contaminated site," in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds*. Battelle Press, Columbus, OH, 2004
- Scott, S., and Y.M. Nelson, 2004. "Biodegradability and toxicity of hydrocarbon leachate from land treatment units." in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds*. Battelle Press, Columbus, OH, 2004
- Nelson, Y.M. and L. W. Lion (2003) "Formation of biogenic manganese oxides and their influence on the scavenging of toxic trace metals." Book Chapter in Geochemical and Hydrological Reactivity of Heavy Metals in Soils, H.M. Selim and W.L. Kingerly, Eds., CRC Press.
- Hoffman, K.M. and Y. M. Nelson (2003) "Phytostimulation of hydrocarbon biodegradation by Arroyo willows in laboratory microcosms," In Phytoremediation of Petroleum-contaminated Sites, Battelle Press, Columbus, OH.

- Chokshi, B. G. and Y. M. Nelson (2003) "Optimization of high-strength hydrocarbon biodegradation using respirometry." In *Landfarming of Contaminants, Seventh International Conference on In Situ and On-Site Bioremediation*, Battelle.
- Nelson, Y.M., L. W. Lion, M.L. Shuler, and W. C. Ghiorse (2002) "Lead adsorption to mixtures of biogenic Mn oxides and Fe oxides." *Environ. Sci. Technol.*: **36**, 421-425.
- Green, C.E., A. Stansberry, J. Szechowski and Y.M. Nelson (2001) "Enhanced biodegradation of hydrocarbon contaminants using photocatalytic pretreatment." In *In Situ Aeration and Aerobic Remediation, Physical or Chemical Pretreatment Approaches*, A. Leeson et al., Ed. Vol. 6, pp 311-318.
- Wilson, A. R., L.W. Lion, Y.M. Nelson, M.L. Shuler, and W.C. Ghiorse (2001) "The effects of pH and composition on Pb adsorption to natural freshwater biofilms." *Environmental Science and Technology*: **35** (15) pp 3182-3189
- Nelson, Y.M., L.W. Lion, W.C. Ghiorse, and M.L. Shuler (1999) "Lead binding to metal oxide and organic phases of natural aquatic biofilms." *Limnology and Oceanography*, **44**, 1715-1729.
- Nelson, Y.M., L.W. Lion, W.C. Ghiorse, and M.L. Shuler (1999) "Production of biogenic Mn oxides by *Leptothrix discophora* SS-1 in a chemically defined growth medium and evaluation of their Pb adsorption characteristics." *Appl. Environ. Microbiol.*, Vol. 65, pp 175-180.
- Nelson, Y. M. (1999) "Modeling toxic metal adsorption in aquatic environments." Presented to the Chinese Academy of Sciences, Institute of Geochemistry, Guangzhou, China, and at Jilin University Dept. of Environmental Science, Changchun, China. Sept. 1999
- Nelson, Y.M., R.J. Thampy, Motelin, G.K., J.A. Raini, C.J. DiSante, L.W. Lion (1998) "Model for toxic metal exposure to filter-feeding flamingos at a polluted alkaline Rift Valley lake." *Environ. Toxicol. Chem.*, Vol. 17, No. 11, pp 2302-2309.
- Nelson, Y.M., L.W. Lion, W.C. Ghiorse, and M.L. Shuler (1998) "Pb adsorption and surface area of bacterially oxidized Mn." Presented at the 8th Annual V.M. Goldschmidt Conference, Toulouse, France, Aug. 30 - Sept. 3, 1998.
- Nelson, Y.M., L.W. Lion, W.C. Ghiorse, and M.L. Shuler (1998) "New evidence for a greater role of biogenic manganese oxides in controlling trace metal transport and bioavailability in aquatic environments." Gordon Research Conference, Environmental Sciences: Water, June 14-19, 1998, Henniker, NH.
- Nelson, Y. M. (1997). "Formulation, verification and application of integrated models for trace metal phase distribution in laboratory microcosms and aquatic environments." Ph.D. Thesis, Cornell University, August, 1997.

- Nelson, Y.M., L.W. Lion, M.L. Shuler, and W.C. Ghiorse (1997), "Modeling lead binding to biological metal oxide components of surface coatings from freshwater environments." Presented at the Amer. Soc. of Limnology and Oceanography, Aquatic Sciences Meeting, Santa Fe, NM, February 10-14, 1997, Session # S41.
- Nelson, Y.M., L.W. Lion, M.L. Shuler, and W.C. Ghiorse (1996), "Modeling oligotrophic biofilm formation and lead adsorption to biofilm components." *Environmental Science and Technology*, Vol. 30, No. 6, pp 2027-2035.
- Nelson, Y.M., L.W. Lion, M.L. Shuler and W.C. Ghiorse (1996). "Lead binding to surface coatings from natural and engineered environments." American Chemical Society, Division of Colloid and Surface Chemistry, 70th Colloid and Surface Science Symposium., Clarkson University, June, 1996, Potsdam, NY.
- Nelson, Y.M., L.W. Lion, M.L. Shuler and W.C. Ghiorse (1996). "Modeling the roles of metal oxides and biogenic materials in controlling lead binding to freshwater surface coatings." Gordon Research Conference, Environmental Sciences: Water, June 23-28, 1996, New Hampton, NH.
- Nelson, Y.M., L.W. Lion, M.L. Shuler, and W.C. Ghiorse (1996), "Modeling oligotrophic biofilm formation and lead adsorption to biofilm components." Presented at the 212th Annual Meeting of the American Chemical Society, Division of Environmental Chemistry Student Awards, Aug. 25-29, 1996.
- Nelson, Y. M., W. Lo, L. W. Lion, M. L. Shuler and W. C. Ghiorse (1995) "Lead distribution in a simulated aquatic environment: Effects of bacterial biofilms and iron oxide." *Water Research*. Vol. 29, pps. 1934-1944.
- Nelson, Y. M. and W. J. Jewell (1993) "Vinyl chloride biodegradation with methanotrophic attached films." *ASCE Journal of Environmental Engineering*, Vol. 119, No. 5.
- Fennell, D. E., Y. M. Nelson, S. E. Underhill, T. E. White and W. J. Jewell (1993) "TCE degradation in a methanotrophic attached-film bioreactor." *Biotechnology and Bioengineering*, Vol. 42, pp 859-872.
- Nelson, Y. M., M. S. Wilson and W. J. Jewell (1992) "Methanotrophic bacteria for nutrient removal from wastewater: attached film system." *Water Environment Research*, Vol. 64, No. 6, pp 756-765.
- Nelson, Y. M. (1992) "Methanotrophic vinyl chloride biodegradation." MS Thesis, Cornell University, August, 1992.
- Nelson, Y. M. and W. J. Jewell (1992) "Methanotrophic vinyl chloride biodegradation kinetics: methane inhibition and vinyl chloride toxicity." Presented at the Water Environment Federation Conference.

## **A n u r a g P a n d e , P h . D .**

<http://works.bepress.com/apande/>

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### **OFFICE**

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### **RESEARCH INTERESTS**

Traffic Safety, Traffic Simulation, Statistical Analysis of Transportation Data, Public Transportation, Intelligent Transportation Systems, Service Learning, Scholarship of Teaching.

### **EDUCATION**

Ph.D. in Civil Engineering (Transportation), 2005, University of Central Florida  
M.S. in Civil Engineering (Transportation), 2003, University of Central Florida  
B.Tech. in Civil Engineering, 2002, Indian Institute of Technology Bombay, Mumbai (India)

### **ADDITIONAL QUALIFICATION**

**Graduate Certificate in Data Mining:** SAS Institute/Department of Statistics, University of Central Florida.

### **THESES**

Pande, A. (2005) *Estimation of Hybrid Models for Real-Time Crash Risk Assessment on Freeways*, Doctoral Dissertation, University of Central Florida.

Pande, A. (2003) *Classification of Traffic Speed Patterns to Predict Crashes on Freeways*, M.S. Thesis, University of Central Florida.

Pande, A. (2002) *Travel Demand Forecasting for a Transportation Project*, Undergraduate Thesis, Indian Institute of Technology, Bombay.

### **EMPLOYMENT**

*Assistant Professor* (08/08 – Present): Department of Civil & Environmental Engineering, Cal Poly State University.

*Post-doctoral Research Associate* (12/05 – 07/08): Department of Civil & Environmental Engineering, University of Central Florida.

*Engineering Intern* (03/04 – 08/04): GMB Engineers and Planners Inc.



## HONORS AND AWARDS

Faculty Advisor for the Cal Poly ITE student chapter *Recipient of the Best Student Chapter Award (2013-14)* from Institute of Transportation Engineers.

Recipient of the *ASCE ExCEED Fellowship (2009)* – One of the 48 faculty members selected to attend the ExCEED workshop from a nationwide pool of applicants

Recipient of the *Young Researcher Award (2007)* —TRB Committee on *Safety Data, Analysis, and Evaluation* (Selected based on the paper presented at 85<sup>th</sup> annual meeting of the Transportation Research Board)

Recipient of the University-level *Outstanding Dissertation Award (2006)* (Selected from all doctoral dissertations produced at UCF in 2005)

Recipient of the *Presidential Doctoral Fellowship (2003)* as a Doctoral student at UCF (Fall'03 through the completion of degree program)

Recipient of the *Provost's Fellowship (2002)* as a Masters student at UCF (Fall'02 through the completion of degree program)

Recipient of the *CATSS Scholarship (2004)* as a graduate student in Transportation Engineering program at UCF

Recipient of the *Best Office Bearer (2001)* award at IIT Bombay for outstanding organizational skills as the General Secretary—Hall of Residence

Recipient of the *National Scholarship Scheme - Merit Scholarship (1996)* by Government of India for exceptional performance in Secondary School Examination

## RESEARCH PROJECTS

### California Polytechnic State University

University of California Transportation Center (UCTC) Technology Transfer and Educational Outreach (Co-Principal Investigator), Funded by UCTC at University of California Berkeley (2013-2015).

Collaborative Research: New Methods for Measuring, Evaluating and Predicting the Safety Impact of Road Infrastructure Systems on Driver Behavior (Principal Investigator), Funded by National Science Foundation (2009-2014).

Proactive assessment of accident risk to improve safety on a system of freeways (Principal Investigator), Funded by Mineta Transportation Institute at San José State University (2010-2011).

Assessment of public perception of user-based fees and tolls to finance transportation infrastructure improvements (Principal Investigator), Funded by Leonard University Transportation Center at California State University, San Bernardino (2010-2011).

A Framework for Developing and Integrating Effective Routing Strategies within the Emergency Management Decision Support System for Transit Centers (Principal Investigator), Funded by Mineta Transportation Institute at San José State University (2009-2010).

Guidelines for Transit Bus Stop Spacing: Improving Accessibility and Performance (Co-Principal Investigator), Funded by Leonard University Transportation Center at California State University, San Bernardino (2010-2011).

### **University of Central Florida**

Reducing Fatalities and Severe Injuries on Florida's High-speed Multi-lane Arterial Corridors, Funded by Florida Department of Transportation (2007-2008).

Linking Crash Patterns to ITS-Related Archived Data (PHASE I & II): Developing a Hybrid Detailed Crash Prediction System using ITS Data on I-4 and Evaluating the Application Strategies, Funded by Florida Department of Transportation (2002-2008).

Frequency Analysis Technique Applied to Transportation Freight, Goods, and Services Data, Funded by Florida Department of Transportation (2004-2006).

Identification of Intersections' Crash Profiles/Patterns, Funded by Florida Department of Transportation (2002-2008).

Using the UCF Driving Simulator as a Test Bed for High Risk Locations: Signalized Intersections and Toll Plazas, Funded by Florida Department of Transportation (2003-2004).

The Impact of Real-time and Predictive Information on I-4 Travelers, Funded by Florida Department of Transportation (2002-2003).

### **COURSE DEVELOPMENT GRANTS**

CTL Technology Grant Program Phase II — Principles of Enhancing Teaching and Learning with Technology: *Cal Poly Center for Teaching and Learning (CTL)* – Redesigning Traffic Engineering class in the hybrid mode – Spring '09.

CTL Grant Program —*Cal Poly Center for Teaching and Learning (CTL)* – Developing a Course on Evolution of Standards for Highway Design and Transportation Planning – Summer '09.

## **TEACHING EXPERIENCE**

### **California Polytechnic State University**

**Fundamentals of Transportation Engineering** (CE-321 — Fall '08, Winter '09, Spring '09, Winter '10, Spring '11, Winter '12, Winter '13, Fall '13, Winter '14)

**Fundamentals of Transportation Engineering Lab** (CE-322 — Spring '11; Fall '11; Winter '12; Spring '12; Fall '12)

**Traffic Engineering** (CE-421 — Fall '08, Fall '09, Spring '10, Spring '13, Spring '14)

**Public Transportation** (CE-424—Winter '14)

**Transportation Analysis** (CE-528 — Fall '09, Fall '10, Fall '11, Fall '12, Fall '13)

**Numerical Methods in Civil Engineering** (CE-251— Winter '10; Winter '11)

**Modeling and Simulation in Transportation Engineering** (CE-529— Spring '10, Spring '11, Spring '12, Spring '13, Spring '14)

**Advanced Civil Engineering Topics: Transportation Safety and Highway Design Standards** (CE-570—Fall '13)

### **University of Central Florida**

**Geometric Design of Highways** (TTE 5805 — Fall '07)

## **SUPERVISION OF GRADUATE RESEARCH**

Major Advisor for the following MS Theses:

- Mr. Sean Carney (Spring 2014, expected) Analysis of Latent Classes Hidden in the Pedestrian Crash Data
- Mr. Nate Johnston (Winter 2014) A methodology for Estimating Bicyclist LOS at TWSC Intersections
- Mr. James Loy (Summer 2013) Methods for Measuring, Evaluating and Predicting the Safety Impact of Road Infrastructure Systems on Driver Behavior
- Mr. Cameron Shew (Fall 2012) Transferability of Real-time Crash Risk Estimators for Freeways
- Mr. Joseph Yu (Fall 2011) Developing and Integrating Effective Routing Strategies for Emergency Evacuation through Traffic Simulation
- Mr. Steve Kilbert (Winter 2010) Microscopic Simulation Modeling of Traffic, Parking, and Emissions at California Polytechnic State University-San Luis Obispo

- Mr. Jake Hudson (Fall 2010) Traffic Safety Investigations For Local Agencies

Doctoral Dissertation Advisory Committee member for the following students:

- Mr. Scott Parr (Fall 2014) Analysis and Modeling of Manual Traffic Control for Signalized Intersections, Louisiana State University, Baton Rouge, LA.
- Mr. Mohamed M. Ahmed (Spring 2012) Multi-Level Safety Performance Functions for High Speed Facilities, University of Central Florida, Orlando, FL.
- Mr. Md. Kamrul Islam (Fall 2013) Stochastic Modeling for Evaluation of Impacts of Headway Variability on Public Transit Performance, University of New South Wales, Australia.

Committee member for the following MS Theses:

- Ms. Mikki McDaniel (Spring 2013) Auto-Motives: Unraveling the Riddle of Alternative Transportation to School
- Ms. Audrey Desmuke (Spring 2013) Effects of Transit-Oriented Development on Affordable Housing, Job Accessibility, and Affordability of Transportation in the Metro Green Line Corridor of Los Angeles (CA)
- Ms. April Hickey (Spring 2013) Utilizing ACTS Data To Inform a Dynamic Reassignment System for Muni Metro Light Rail Vehicles Departing Embarcadero Station
- Mr. Wesley Catanzaro (Spring 2013) The Development of an Electronic Data Collection Tool and Comparison of the Electronic and Manual Methods of Land Use Inventory
- Mr. Christopher Hoover (Spring 2013) MANTIS: A Predictive Driving Directions Recommendation System
- Mr. Justin Shiu (Fall 2012) Circulator Shuttle Implementation Plan for the City of Pittsburg
- Mr. James Hinkamp (Spring 2011) Freight Truck Traffic Associated With the Port Of Oakland: A Case Study of Roadway Impacts
- Mr. Reed Calkins (Spring 2011) Performance of the Crack, Seal, and Overlay Rehabilitation Technique for Concrete Pavements In California

- Ms. Natalie L. Stiffler (Spring 2011) The Effect of Transit-Oriented Development on Vehicle Miles Traveled: A comparison of case studies in Carlsbad, CA
- Mr. Tyler Langley (Fall 2010) Transportation Energy Analysis for Single-Family Residential Construction in California
- Ms. Erin Cooper (Spring 2010) Planning for Stop Spacing Under the San Francisco Municipal Transportation Agency Bus Stop Consolidation Proposal
- Mr. Kevin Fang (Summer 2009) Accessibility of Bay Area Rail Transit Stations: An Evaluation of Opportunities for Transit Oriented Development
- Mr. Prem C. Devarasetty (Winter 2009) Safety Improvements on Multilane Arterials - A Before and After Evaluation Using the Empirical Bayes Method
- Mr. Vasu T. Persaud (Fall 2007) Dynamic Speed Monitoring System Effectiveness on Sharp Curves
- Mr. Ryan Cunningham (Summer 2007) Examining Dynamic Variable Speed Limit Strategies for the Reduction of Real-Time Crash Risk on Freeways
- Mr. Hari Salkapuram (Summer 2006) A New Approach to Identify the Expected Crash Patterns based on Signalized Intersection Size and Analysis of Vehicle Movements

### **PROFESSIONAL ACTIVITIES**

Editor, *Traffic Engineering Handbook, 7<sup>th</sup> Edition*, Published by Institute of Transportation Engineers (2013-2014).

Member of the Transportation Research Board Committee (Since April 2014) on *Safety Data, Analysis, and Evaluation (ANB20)*

*Faculty Liaison for Community Based Learning* at Cal Poly San Luis Obispo (Since March 2014)

Invited Speaker on Traffic Safety Policies: An International Comparison of Policy Changes from USA at **IATSS 2012 International Workshop**, Tokyo, Japan, September 2012.

Invited **NSF Panel Reviewer** for Division of Civil, Mechanical and Manufacturing Innovation (CMMI), May 2012 and May 2013.

Appointment as a ***Graduate Faculty Scholar*** by University of Central Florida as a person with special expertise and privileges to participate as member or co-chair of doctoral dissertation advisory committees.

Appointment as a ***Graduate Faculty*** by Louisiana State University as a person with special expertise and privileges to participate as member or co-chair of doctoral dissertation advisory committees.

Associate Editor for **MERLOT (Engineering)** an international initiative for peer reviewed learning materials for higher education supported by National Science Foundation

Invited Reviewer for the Transportation Research Board Committee on ***Statistical Methodology and Statistical Computer Software in Transportation Research (ABJ80)***

Invited Reviewer for the Transportation Research Board Task Force on ***Emergency Evacuation (ANB80T)***

Invited Reviewer for the Transportation Research Board Committee on ***Freeway Operations (AHB20)***

Invited Reviewer for the Transportation Research Board Committee on ***Roundabouts (ANB75)***

Faculty Adjudicator for the Oral Presentation and Research Poster Competition at the ***Annual Graduate Research Forum-2006*** at UCF

Paper reviewer for ***Accident Analysis and Prevention, IEEE Transactions on Intelligent Transportation Systems, and Journal of Safety and Security***

Faculty Advisor for ***Institute of Transportation Engineers (ITE)*** Chapter at Cal Poly

Session Chair for Writing (and Reading) for the Internet at **13<sup>th</sup> CSU Symposium on Teaching and Learning**, San Bernardino, CA, April 2010.

Paper reviewer for the **9<sup>th</sup> International IEEE Conference on Intelligent Transportation Systems**, Toronto, Canada, September 2006.

Paper reviewer for the **8<sup>th</sup> International IEEE Conference on Intelligent Transportation Systems**, Vienna, Austria, September 2005.

Session Chair for Data Mining and Analysis at **8<sup>th</sup> International IEEE Conference on Intelligent Transportation Systems**, Vienna, September 2005.

## **COMPUTER SKILLS**

**Programming Languages:** Visual BASIC

**Transportation/Simulation Packages:** VISSIM

**Statistics/Analysis Software:** SAS, MATLAB, R

### **CONTINUING EDUCATION (WORKSHOPS)**

Transportation Engineering Educators Conference/Workshop: *The National Transportation Curriculum Project*, Seattle, WA, July, 2012.

14<sup>th</sup> CSU Regional Symposium on University Teaching: Organized by *CSU Channel Islands* – May, 2011.

Teaching and Affective Domain: *Cal Poly Center for Teaching and Learning (CTL)* – April, 2010.

Interdisciplinary Teaching and Research: *Cal Poly Center for Teaching and Learning (CTL)* – February, 2010.

Effective Teaching and Learning FLC (Faculty Learning Community): *Cal Poly Center for Teaching and Learning (CTL)* – Winter '10.

13<sup>th</sup> CSU Regional Symposium on University Teaching: Organized by *CSU San Bernardino* – May, 2010.

ASCE — ExCEED: Excellence in Civil Engineering Workshop, Flagstaff, AZ, July, 2009.

12<sup>th</sup> CSU Regional Symposium on University Teaching: Organized by *Cal Poly Center for Teaching and Learning (CTL)* – May, 2009.

CTL Technology Grant Program Phase I — Principles of Enhancing Teaching and Learning with Technology: *Cal Poly Center for Teaching and Learning (CTL)* – Fall '08.

Newer Faculty Orientation: How to have a rewarding first quarter at Cal Poly: *Cal Poly Center for Teaching and Learning (CTL)* – September, 2008.

Technology at UCF: How Do We Teach Effectively Online: *UCF Faculty Center for Teaching and Learning (FCTL)* – January, 2008.

Preventing Plagiarism with Turnitin.com: *UCF Faculty Center for Teaching and Learning (FCTL)* – August, 2007.

101 Tips for Teaching Large Classes: *UCF Faculty Center for Teaching and Learning (FCTL)* – January, 2006.

Training sessions for adjunct faculty, covering both nuts-and-bolts (rosters, legal matters, syllabi) and more general pedagogy (how to hold effective and interesting lectures, increase student engagement, and build courses that are balanced and aligned between goals, objectives, assignments, and teaching practice): *UCF Faculty Center for Teaching and Learning (FCTL)* – August, 2005.

## JOURNAL PUBLICATIONS

**Pande, A.**, Loy, J., Dixit, V., Spansel, K. and Wolshon, B. (2014) Integrity of Estimates of the Two-Fluid Model and Gender Impacts. Forthcoming in *Transportation Research Part C: Emerging Technologies*.

Yu J. , **Pande A.**, Ali N., Edwards F., and Dixit, V. (2014) Routing Strategies for Emergency Management Decision Support Systems during Evacuation. *Journal of Transportation Safety and Security*, Vol. 6, Issue 3, pp. 257-273.

Shew C., **Pande A.** and Nuworsoo C. (2013) Transferability and Robustness of Real-Time Freeway Crash Risk Assessment, *Journal of Safety Research*, Vol. 46, Issue 5, pp. 83-90.

**Pande A.**, Das A., Abdel-Aty M., and Hassan, H. (2011) Real-Time Crash Risk Estimation: Are All Freeways Created Equal?, *Journal of the Transportation Research Board*, No. 2237, pp. 60-66.

**Pande A.** and Grimes J. (2011) Traffic Engineering in a ‘Hybrid’ Format: More Learning With Less Meeting, *Journal of the Transportation Research Board*, No. 2211, pp. 18-26.

Dixit V., **Pande A.**, Abdel-Aty M., Das A., and Radwan E. (2011) Quality of traffic flow on urban arterial streets and its relationship with safety, *Accident Analysis and Prevention*, Vol. 43, Issue 5, pp. 1610-1616.

**Pande A.** Abdel-Aty M. and Das A. (2010) A Classification Tree Based Modeling Approach for Segment Related Crashes on Multilane Highways, *Journal of Safety Research*, Vol. 41, Issue 5, pp. 391-397.

Das A., Abdel-Aty M., and **Pande A.**, (2010) Using Genetic Programming to Investigate the Design Parameters Contributing to Crash occurrence on Urban Arterials, *Journal of the Transportation Research Board*, No. 2147, pp. 25-32.

Abdel-Aty M., **Pande A.**, Hsia L. (2010) The Concept of Proactive Traffic Management for Enhancing Freeway Safety and Operation, *ITE Journal*, Vol. 80 Issue 3, pp. 34-41.

**Pande A.** and Abdel-Aty M. (2009) A novel approach for analyzing severe crash patterns on multilane highways, *Accident Analysis & Prevention*, Volume 41, Issue 5, pp. 985-994.

Das A., Abdel-Aty M., **Pande A.** (2009) Using conditional inference forests to identify the factors affecting crash severity on arterial corridors, *Journal of Safety Research*, Vol. 40, Issue 4, pp. 317-327.



**Pande A.** and Abdel-Aty M. (2009) Market basket analysis of crash data from large jurisdictions and its potential as a decision support tool, *Safety Science*, Vol. 47 Issue 1, pp. 145-154.

Abdel-Aty M., Devarasetty P., **Pande A.**, and Santos J. (2009) Safety Evaluation of Multilane Arterials in Florida, *Accident Analysis and Prevention*, Vol. 41 Issue 4, pp. 777-788.

Das A., **Pande A.**, Abdel-Aty M. and Santos J. (2008) Urban Arterial Crash Characteristics related with Proximity to Intersections and Injury Severity, *Journal of the Transportation Research Board*, No. 2083, pp. 137-144.

Abdel-Aty M., **Pande A.**, Das A., and Knibbe, W. (2008) Analysis of Infrastructure Based ITS Data for Assessing Safety on Freeways in the Netherlands, *Journal of the Transportation Research Board*, No. 2083, pp. 153-161.

**Pande A.** and Abdel-Aty M. (2008) Discovering Indirect Associations using Probe Attributes in Crash Data from a Principal Arterial, *Journal of the Transportation Research Board*, No. 2083, pp. 170-179.

Dixit V., **Pande A.**, Radwan E., and Abdel-Aty M. (2008) Understanding the Impact of a Recent Hurricane on Mobilization Time during a Subsequent Hurricane, *Journal of the Transportation Research Board*, No. 2041, pp. 49-57.

**Pande A.** and Abdel-Aty M. (2007) A multi-model framework for real-time crash risk assessment, *Journal of the Transportation Research Board*, No. 2019, pp. 99-107.

Harb R., Radwan E., Yan X., **Pande A.** and Abdel-Aty M. (2007) Freeway work-zone crash analysis and risk Identification using multiple and conditional logistic regression, *Journal of Transportation Engineering*, Vol. 134 Issue 5, pp. 203-214

Abdel-Aty M. and **Pande A.** (2007) Crash data analysis: collective vs. individual crash level approach, *Journal of Safety Research*, Vol. 38 Issue 5, pp. 97-108.

**Pande A.** and Abdel-Aty M. (2006) Assessment of freeway traffic parameters leading to lane-change related collisions, *Accident Analysis and Prevention*, Vol. 38 Issue 5, pp. 936-948.

**Pande A.** and Abdel-Aty M. (2006)<sup>1</sup> A comprehensive analysis of the relationship between real-time traffic surveillance data and rear-end crashes on freeways, *Journal of the Transportation Research Board*, No. 1953, pp. 31-40.

<sup>1</sup> Received Young Researcher Award from TRB Committee on Safety Data, Analysis, and Evaluation for this paper.

Abdel-Aty M. and **Pande A.** (2006) ATMS implementation system for identifying traffic conditions leading to potential crashes, *IEEE Transactions on Intelligent Transportation Systems*, Vol. 7 Issue 1, pp. 78-91.

**Pande A.** and Abdel-Aty M. (2005) A freeway safety strategy for advanced proactive traffic management, *Journal of Intelligent Transportation Systems*, Vol. 9 Issue 3, pp. 145-158.

**Pande A.**, Abdel-Aty M. and Hsia L. (2005) Spatio-temporal variation of risk preceding crash occurrence on freeways, *Journal of the Transportation Research Board*, No. 1908, pp. 26-36.

Abdel-Aty M., Uddin N. and **Pande A.** (2005) Split models for predicting multi-vehicle crashes during high-speed and low-speed operating conditions on freeways, *Journal of the Transportation Research Board*, No. 1908, pp. 51-58.

Abdel-Aty M. and **Pande A.** (2005) Identifying crash propensity using specific traffic speed conditions, *Journal of Safety Research*, Vol. 36 Issue 1, pp. 97-108.

Abdel-Aty M., **Pande A.**, Hsia L. and Abdalla F. (2005) The potential for real-time traffic crash prediction, *ITE Journal*, Vol. 75 Issue 12.

Abdel-Aty M., Uddin N., **Pande A.**, Abdalla F. and Hsia L. (2004). Predicting freeway crashes based on loop detector data using matched case-control logistic regression, *Journal of the Transportation Research Board*, No. 1897, pp. 88-95.

#### **REFEREED CONFERENCE PROCEEDINGS**

Shaaban, K., and **Pande, A.** (2015) Where did you Park?: Revealed Preference Analysis of Factors Affecting Parking Choices in Qatar, Preprint No. TRB 15-2139, Presented at 94<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2015.

Mousavi, M., Parr, S., Kent, J., **Pande, A.**, Wolshon, B. and Dixit, V. (2015) Forecasting Long-Term Crash Patterns on Interrupted-Flow Roadways Using Naturalistic Driving Data, Preprint No. TRB 15-4431, Presented at 94<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2015.

Johnston, N., and **Pande, A.** (2015) Analysis of Approach Features from a Bicyclist Perspective to Estimate Performance Functions for Two-Way Stop-Controlled (TWSC) Intersections, Preprint No. TRB 15-1389, Presented at 94<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2015.

Nezamuddin, N., **Pande, A.**, and Nuworsoo, C. (2014) Workforce of the Future: Ideas for Improving K-12 Outreach by Transportation Engineering Educators through Near-Peer Involvement and Leveraging Contextual Exposure, Presented at 121<sup>st</sup> Annual Conference

and Exposition of American Society of Engineering Education (ASEE), Indianapolis, IN, June 2014.

**Pande, A.,** Loy, J., Dixit, V., Kent, J., Spansel, K. and Wolshon, B. (2014) Exploration of Naturalistic Driving Data for Identifying High Crash Risk Highway Locations, Preprint No. TRB 14-5291, Presented at 93<sup>rd</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2014.

**Pande, A.,** Nezamuddin, N., Loy, J., and Das, A. (2014) Understanding Characteristics of Severe Crashes by Examining Patterns in Latent Classes, Preprint No. TRB 14-3228, Accepted for presentation at 93<sup>rd</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2014.

**Pande, A.,** Loy, J., Dixit, V., Spansel, K. and Wolshon, B. (2013) Application of Naturalistic Driving Data for Two-Fluid Model Estimation, Accepted for Presentation at 4<sup>th</sup> International Conference on Road Safety and Simulation (RSS), Rome, Italy, October 2013.

**Pande, A.** (2013) Identifying Unsafe Drivers: Explorations of Attributes in the Naturalistic Driving Data, Preprint No. TRB 13-3447, Presented at 92<sup>nd</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2013.

Dixit V. and **Pande A.** (2012) Choice of Time Spent Accelerating as Drivers' State based Utility Maximization Mechanism, Preprint No. TRB 12-2089, Presented at 91<sup>st</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2012.

Harb R., Radwan E., Ramasamy S., Abdel-Aty M., **Pande A.,** Shaaban K., and Putcha S. (2009) Two Simplified Dynamic Lane Merging Systems for Short-Term Work Zones, Preprint No. TRB 09-1668, 88<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2009.

Abdel-Aty M. and **Pande A.** (2008) The Viability of Real-time Prediction and Prevention of Traffic Accidents, the Fourth International Gulf Conference on Roads, Doha, November 2008.

Gayah V., Abdel-Aty M. and **Pande A.** (2008) Evaluating Route Diversion as a Strategy for Reduction of Real-Time Crash Risk on Freeways Using Microscopic Simulation, 10th International Conference on Applications of Advanced Technologies in Transportation (AATT), Athens, May 2008.

Abdel-Aty M., **Pande A.,** Das A. and Knibbe W. (2008) Exploration of Crash Prone Traffic Conditions on Freeways in the Netherlands using Random Forests, 10th International Conference on Applications of Advanced Technologies in Transportation (AATT), Athens, May 2008.

Abdel-Aty M. and **Pande A.** (2008) Proactive Traffic Management using ITS data from Uninterrupted Flow Facilities, Transportation Planning and Implementation Methodologies for Developing Countries, IIT Bombay, Dec. 3-6, 2008.

Abdel-Aty M. and **Pande A.** (2008) Severity Analysis of Crashes on Multilane Arterials Using Conditional Inference Forests, Transportation Planning and Implementation Methodologies for Developing Countries, IIT Bombay, Dec. 3-6, 2008.

**Pande A.** and Abdel-Aty M. (2006) Application of Data Mining Techniques for Real-Time Crash Risk Assessment on Freeways, 9<sup>th</sup> International Conference on Applications of Advanced Technology in Transportation (AATT) Chicago, IL, September 2006.

**Pande A.** and Abdel-Aty M. (2005) Identification of Rear-end Crash Patterns on Instrumented Freeways: A Data Mining Approach, 8<sup>th</sup> International IEEE Conference on Intelligent Transportation Systems (ITSC2005), Vienna, Austria, September 2005.

Abdel-Aty M., **Pande A.** and Uddin N. (2005) Traffic Surveillance from a Safety Perspective: An ITS Data Application, 8<sup>th</sup> International IEEE Conference on Intelligent Transportation Systems (ITSC2005), Vienna, Austria, September 2005.

Abdel-Aty M., Uddin N. and **Pande A.** (2005) Improving Safety and Security by Developing a Traffic Accident Prevention System, Proceedings of the First International Conference on Safety and Security Engineering, Rome, Italy, June 2005.

Abdel-Aty M., **Pande A.** and Uddin N. (2005) Proactive Real-Time Safety Implementation Strategy on Freeways, 13<sup>th</sup> International Conference, Road Safety on Four Continents, Warsaw, Poland, October 2005.

Abdel-Aty M. and **Pande A.** (2004) Predicting Traffic Crashes using Real-Time Traffic Speed Patterns, 10<sup>th</sup> World Conference on Transport Research, Istanbul, Turkey, July 2004.

Abdel-Aty M. and **Pande A.** (2004) Classification of Real-Time Traffic Speed Patterns to Predict Crashes on Freeways, Preprint No. TRB 04-2635, 83<sup>rd</sup> Annual Meeting of the Transportation Research Board, Washington D.C., January 2004.

## Steffen Peuker

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Contact Information	California Polytechnic State University Mechanical Engineering College of Engineering San Luis Obispo, CA 93407-0358	<i>Voice:</i> (805) 756-1353 <i>Fax:</i> (805) 756-1137 <i>E-mail:</i> speuker@calpoly.edu
Citizenship	Germany, Permanent Resident of the USA	
Research Interests	HVAC applications, thermal systems, engineering education, flipped class room, Team-Based Learning	
Education	<b>University of Illinois at Urbana-Champaign</b> , Urbana, Illinois USA  Ph.D., Department of Mechanical Science and Engineering <b>December 2010</b> <ul style="list-style-type: none"> <li>• Thesis Title: Experimental and Analytical Investigation of Refrigerant and Oil Migration</li> <li>• Advisor: Professor Predrag S. Hrnjak</li> <li>• Area of Study: Refrigeration</li> </ul> M.S., Department of Mechanical Science and Engineering <b>December 2006</b> <ul style="list-style-type: none"> <li>• Thesis Title: Experimental and Modeling Investigation of Two Evaporator Automotive Air Conditioning Systems</li> <li>• Advisor: Professor Predrag S. Hrnjak</li> <li>• Area of Study: Refrigeration</li> </ul> <b>Hochschule Mannheim - University of Applied Sciences</b> , Mannheim, Germany  Dipl.-Ing. (FH), Department of Mechanical Engineering <b>September 2002</b> <ul style="list-style-type: none"> <li>• Thesis Title: Transient Simulation of Heat Pump Processes with the Alternative Refrigerant Carbon Dioxide (R744)</li> </ul>	
Experience	<b>California Polytechnic State University</b> , San Luis Obispo, California USA  Assistant Professor, Mechanical Engineering <b>since January 2014</b>  <b>Teaching</b> <ul style="list-style-type: none"> <li>• ME 457/Lab Refrigeration Principles and Design</li> <li>• ME 460/Lab HVAC Senior Design Project II</li> <li>• ME 359/Lab Fundamentals of HVAC Systems</li> <li>• ME 459/Lab HVAC Senior Design Project I</li> </ul> <b>Current Research</b> <ul style="list-style-type: none"> <li>• Development of an Active Fog Catcher</li> <li>• Team Based Learning in Mechanical Engineering Courses</li> <li>• Enhancement of Freshman Engineering Student Success, Retention and Time to Graduation</li> <li>• Implementing Team Based Learning in Freshmen Engineering Courses</li> </ul> <b>Current Service</b> <ul style="list-style-type: none"> <li>• Member-At-Large, Executive Committee SLO Chapter of the California Faculty Association</li> </ul>	

**University of Alaska Anchorage**, Anchorage, Alaska USAAssistant Professor, Mechanical Engineering **January 2011 to December 2013****Courses taught**

- ENGR A151 Introduction to Engineering
- ENGR A161 Engineering Practices II
- ME A414 Thermal System Design
- ME A414L Thermal System Design Laboratory
- ME A455/655 HVAC Systems Optimization
- ME A497 Modular Heat Exchanger Design (Independent Study)

**Service**

- Director of the Thermal System Design Laboratory
- ASHRAE Student Chapter Advisor
- Academic Integrity Committee member
- Center for Advancing Faculty Excellence (CAFE) Advisory Council member
- UAA School of Engineering faculty liaison for Project Lead the Way and the Engineering Academies of the Anchorage School District
- School of Engineering Design Competition Ad-hoc Committee
- Senior design advisor for five projects related to HVAC&R

**University of Illinois at Urbana-Champaign**, Urbana, Illinois USA*Graduate Research Assistant* **January 2003 to August 2010***Instructor* **Fall 2009, Fall 2010**

- Taught the undergraduate thermodynamics course (ME300)

*Teaching Assistant* **September 2008 to May 2009**

- Head teaching assistant for laboratory fluid mechanics class
- Taught and graded fluid mechanics laboratory class

*Mentoring* **2007 to 2010**

- Invited and mentored several international undergraduate students
- Trained graduate and undergraduate students on scientific research and methodology

*Grader* **September 2008 to May 2009**

- Graded homework, midterm and final exams of fluid mechanics course

Completed  
Research**Projects completed since 2002**

- Implementing Team Based Learning in first-year engineering courses
- Student industry cooperation for the development of thermal system design teaching laboratory equipment
- Incorporating active learning into thermal system design lecture
- Effect of multiple choice testing on student performance in an introductory engineering course
- Cool-down (Start-up) Transients in A/C Systems
- Experimental and Modeling Investigation of Two Evaporator Systems
- R134a/R744 HMMWV Dual Evaporator System Phase II
- R134a/R744 HMMWV Dual Evaporator System Phase I
- SAE Enhanced R744 Pilot 2002

## Professional Development

### Since January 2014

- Completed 5-625 APOGEE Advanced Operations, August 12-15, San Luis Obispo, CA
- Attended the 6th Annual First Year Engineering Experience Conference (FYEE), August 7-8, College Station, TX
- Completed 5-615 APOGEE Field Panel and FLN Operations, June 24-27, San Luis Obispo, CA
- Completed 5-620 APOGEE Workstation Operations, June 3-6, San Luis Obispo, CA
- Attended ASHRAE's High Performance Buildings Conference, April 7-8, San Francisco, CA
- Attended 33rd Annual Conference on The First-Year Experience (FYE), San Diego, CA, USA, February 15-18, 2014

### Before January 2014

- Attended Fifth Annual First Year Engineering Experience Conference (FYEE), Pittsburgh, PA, USA, August 8-9, 2013
- Attended 120th Annual ASEE conference in Atlanta, GA, June 23-26, 2013
- Building Student Capacity for High Performance Teamwork, workshop at 120th Annual ASEE conference in Atlanta, GA, June 23, 2013
- Student Conduct Workshop, May 23, 2013
- ASHRAE Webcast, Assessing Building Energy Performance, from Principles to Practice, April 18, 2013
- Attended Online RosEvaluation Conference, April 1-2, 2013
- Banner Navigation Training, January 29, 2013
- Banner Basic Student Information and Academic History Training, January 31, 2013
- ASME webinar, Looking for Better Energy Storage: Think Thermal, March 5, 2013
- NAFSA's Webinar: International Student Adjustment: Patterns & Tips for Student Success, July 11, 2012
- Enhancing Student Success Through a Model Introduction to Engineering Course, Raymond B. Landis, held at the California State University, Dominguez Hills, Los Angeles, May 23-25, 2012
- 2012 Tech Summit, Anchorage, AK, GEA PHE Systems Plate Heat Exchanger Seminar and Industrial Turbine Applications, May 8 2012

### On Campus seminars/workshops at Cal Poly:

- CENG Sustainable Energy and Infrastructure - Final Stakeholder Meeting, July 30, 2014
- CENG Sustainable Energy and Infrastructure workshop, May 17, 2014
- PolyPlanner Demos for Faculty/Staff, February 28, 2014

### Seminars/workshops 2011-2013 at UAA:

- Retention, Promotion & Tenure File Preparation, March 29, 2013
- Using Small Groups to Improve Learning - Faculty Report on Team-Based Learning, March 29, 2013
- Writing Meaningful Objectives and Effective Multiple Choice Questions, January 11, 2013
- Team-Based Learning How and Why It Works, 2-day workshop, January 10-11, 2013
- What You Should Know Before Submitting Faculty Development Grant Applications, September 14, 2012
- Blackboard 9.1 workshop, January 6, 2012
- Faculty Advising with Associate Registrar Lora Volden, November 3, 2011
- Dealing with Disruptive Students in the Classroom, September 30, 2011

## Industry Experience

### **Daimler AG, Stuttgart, Germany**

#### *Research student*

**April 2002 to September 2002**

- Analyzed experimental data and improved model for transient simulation of R744 automotive A/C system

#### *R&D Internship*

**September 2000 to February 2001**

- Built test stand for automotive prototype R744 A/C system; Implemented test stand experiments; Technical report included evaluation of experiments and theoretical views of R744 refrigerant cycle

### **Feinmechanik Joos GmbH, Mannheim, Germany**

#### *Mechanical Engineering Internship*

**September 1998 to February 1999**

- Operated and programmed CNC milling machine; Received training and worked on all standard machine tools

### **Energy Consulting Heidelberg GmbH, Heidelberg, Germany**

#### *Mechanical Engineering Internship*

**May 1997 to September 1997**

- Assisted project manager in a power plant project

## Honors, Awards and Certificates

APOGEE Master Operator	<b>August 2014</b>
ASHRAE E.K. Campbell Award Nominee	<b>2014</b>
The James L. Bartlett, Jr. Asst. Prof.	<b>since January 2014</b>
Secretary of ASHRAE Alaska Chapter	<b>July 2013 to December 2013</b>
UAA Faculty Development Grant	<b>April 2013</b>
UNAC Travel Award	<b>October 2012</b>
FERPA Training Certificate	<b>Fall 2011, 2012</b>
Treasurer of ASHRAE Alaska Chapter	<b>July 2012 to July 2013</b>
ASHRAE Senior Undergraduate Project Grant	<b>February 2012</b>
EPA Section 608 Type I Certification	<b>October 2011</b>
IRB Training Certificate	<b>September 2011</b>
Fundamentals of Arctic Engineering Certificate	<b>June 2011</b>
Teacher Scholar Certificate	<b>April 2010</b>
Ranked as excellent instructor by students	<b>Fall 2009, 2010</b>
Graduate Teacher Certificate	<b>October 2009</b>
Departmental Teaching Fellowship Award	<b>Fall 2009, 2010</b>
Outstanding (top 10%) teaching assistant based on student feedback	<b>Spring 2009</b>
Outstanding (top 10%) teaching assistant based on student feedback	<b>Fall 2008</b>
SAE Recognition Award - SAE 2009 World Congress	<b>April 2009</b>
SAE Recognition Award - SAE 2008 World Congress	<b>April 2008</b>
SAE Recognition Award - VTMS Conference	<b>May 2005</b>
FY05 Secretary of the Army Environmental Award	<b>2005</b>

## Computer Skills

EES, EnergyPlus, DesignBuilder, APOGEE, MatLab–Simulink, Dymola–Modelica, FLUENT, ANSYS, PRO–E, AutoCAD, Agilent VEE Pro, LabVIEW, Mathcad, RefWorks, Adobe Acrobat Professional, Adobe Premiere Elements, T<sub>E</sub>X, L<sup>A</sup>T<sub>E</sub>X, BibT<sub>E</sub>X  
 Microsoft: Excel, Outlook, Powerpoint, Project, Visio, Windows, Word



Professional Memberships	<p>American Society for Engineering Education  American Society of Heating, Refrigerating and Air-Conditioning Engineers  American Society of Mechanical Engineers  Society of Automotive Engineers</p>
Reviewer	<p><b>Journal and Conference Proceedings</b></p> <ul style="list-style-type: none"> <li>• Sixth Annual First Year Engineering Experience Conference 2014</li> <li>• ASEE 2014 Annual Conference - The First-Year Programs Division</li> <li>• Fifth Annual First Year Engineering Experience Conference 2013</li> <li>• ASEE 2013 Annual Conference - Mechanical Engineering Division</li> <li>• ASHRAE HVAC&amp;R Research</li> <li>• ASME 2011 International Mechanical Engineering Congress &amp; Exposition – Heat Pump, CHP &amp; CCHP Technology</li> </ul>
Workshops	<p>Peuker, S., Landis, R., Design Your Process of Becoming a World-Class Engineering Student—A Powerful Project for Enhancing Student Success, presented at the Sixth Annual First Year Engineering Experience Conference (FYEE), College Station, TX, USA, August 7-8, 2014</p> <p>Peuker, S., Implementing the Design Your Process of Becoming a World Class Engineering Student Project, presented at the Enhancing Student Success Through a Model Introduction to Engineering Course, Raymond B. Landis, held at the California State University, Dominguez Hills, Los Angeles, January 8-10, 2014</p> <p>Peuker, S., Landis, R., Implementing the Design Your Process of Becoming a World Class Engineering Student Project, presented at the Fifth Annual First Year Engineering Experience Conference (FYEE), Pittsburgh, PA, USA, August 8-9, 2013</p>
Selected Peer-Reviewed Publications	<p>Peuker, S., Schauss, A.G., Improving Student Success and Retention Rates in Engineering: One Year after Implementation, Sixth Annual First Year Engineering Experience Conference (FYEE), College Station, TX, USA, August 7-8, 2014</p> <p>Peuker, J.M., Peuker, S., Implementing Team Based Learning in Freshmen Engineering Courses, Sixth Annual First Year Engineering Experience Conference (FYEE), College Station, TX, USA, August 7-8, 2014</p> <p>Peuker, S., Student Industry Cooperation for the Development of Thermal System Design Teaching Laboratory Equipment, Conference Proceedings of the 120th ASEE Annual Conference and Exposition, June 23-26, Atlanta, Georgia, USA, 2013, Paper ID #6313</p> <p>Peuker, J.M., Peuker, S., Incorporating Active Learning into a Thermal System Design Lecture, Conference Proceedings of the 120th ASEE Annual Conference and Exposition, June 23-26, Atlanta, Georgia, USA, 2013, Paper ID #5893</p> <p>Li, B., Peuker, S., Hrnjak, P. S., Alleyne, A. G., Refrigerant Mass Migration Modeling and Simulation for Air Conditioning Systems, Applied Thermal Engineering Vol. 31, no. 10: 1770-1779, 2011</p>

**Sandy Stannard**  
**Professor of Architecture | Registered Architect | LEED AP**  
**Department of Architecture**  
**Cal Poly San Luis Obispo, CA 93407**  
**Tel. 805-756-2076**                      **Email: stannard@calpoly.edu**

**Education**

**Master of Architecture**  
 University of Washington, 1992  
 Master's Thesis: "Boføelleskaber vs. Cohousing" [commendation award for thesis work, awarded by the faculty]  
  
**Research fellowship** [competitive award from the Valle Scholarship program]  
 Copenhagen, Denmark, 1990  
  
**Bachelor of Arts in Architecture** [high honors]  
 University of California, Berkeley, 1987  
  
**Study Abroad**  
 Florence, Italy, 1985 [through Syracuse University]

**Registrations**

Licensed Architect, California (#25596) (1995- present); Idaho (1996-2005)  
 Leadership in Energy + Environmental Design Accredited Professional (LEED AP), 2005 - present

**Academic Experience**

**California Polytechnic State University, San Luis Obispo, California**  
**College of Architecture and Environmental Design [CAED]**  
 Architecture Department  
 Professor [fall 2009 – present], *Associate Professor* (with tenure), 2005-2009, *Assistant Professor*, 2001-2005  
  
**Università degli Studi di Camerino, Ascoli Piceno**  
**Scuola di Architettura e Design**  
 Professoressa di Architettura, [2010]  
  
**Sede di Roma in Roma, Italia** (*combined University of Idaho and Pennsylvania State program*)  
 Assistant Professor, 2000, 2001, 2002 [summer session]  
  
**University of Washington, Seattle, Washington**  
**Department of Architecture**  
 Visiting Assistant Professor, 2000; Teaching Assistant, Department of Architecture, 1989-91  
  
**University of Idaho, Moscow, Idaho**  
**Department of Architecture**  
 Assistant Professor (1996-2000), Adjunct Assistant Professor (1993-1996)

**Awards**

**2015 Cal Poly Distinguished Teaching Award** [nominee], fall 2014. Process in progress.  
  
**Green Innovation Award (honorable mention)**, Bishop Peak/Teach Outdoor Classroom, USGBC C4 chapter, 2012  
 Design award for design/build intervention project, completed with Cal Poly architecture students.  
  
**Solar Decathlon 2005.** Department of Energy sponsored design/build competition for up to 20 groups of faculty and students to design, build and compete with a fully solar powered residence. *Overall third place* winner with specific contest placings: *First place*: Lighting, Appliances. *Second Place*: Architecture, Dwelling, Comfort Zone, 2005  
  
**ACSA/AIA New Faculty Teaching Award.** National award given by the Association of the Collegiate Schools of Architecture and the American Institute of Architecture Students (National Chapter) for excellence in teaching, 2000

**Professional Experience**

**Architectural Design**  
**Private Practice | Licensed Architect** [1995 – present]  
**Jonathan Reich Architects** [Berkeley, California; Seattle, Washington; Moscow, Idaho], 1991-1996  
**Mithun Architects + Designers + Planners**; Seattle, Washington, 1990-1991  
**Roger Williams Architects**; Seattle, Washington, 1989  
**Dahlin Group Architecture | Planning**; Pleasanton, California, 1988-1989  
**Peters Clayberg Caulfield**; San Francisco, California, 1987  
  
**Lighting Consultant**  
**Pacific Energy Center**; San Francisco, California, 2000

<b>Grants and Fellowships</b>	<b>CAED Teacher/Scholar Support Program “Testing the Core: Solar Decathlon,”</b> [\$3800], 2015
	<b>U.S. Department of Energy, “Solar Decathlon 2015,”</b> [\$50,000], 2014 <i>Principal Investigator</i>
	<b>California Polytechnic State University Instructional Related Activity Grant for Solar Decathlon 2015 (joint proposal between CAED and CENG, in conjunction with the Renewable Energy Club)</b> [\$17,500] With Professor Kim Shollenberger, M.E., 2014.
	<b>Seeds of Change “Share the Good” Grant</b> [\$10,000], 2013
	<b>PGE “Bright Ideas” Grant</b> [\$5,000], 2010
<b>Current Research</b>	<b>Lowe’s “School box for Education” Grant.</b> [\$6,000], 2010
	<b>U.S. Green Building Council (USGBC) Excellence in Green Building Education Incentive Grant</b> [finalist], 2009
	<b>American Institute of Architects (AIA) support for the Carbon Neutral Design (CND) Project,</b> 2008 A Society of Building Science Educators collaborative project (Jim Wasley, University of Wisconsin-Milwaukee, Principal Investigator).
	<i>Book proposal/consultation, Routledge Publishers</i>
	Consult to discuss a potential manuscript project related to the topic of “architecture + nature,” 2015
	<i>Habitat Temporanei: Proposals for Post-Disaster Provisional Housing</i> Architects Research Centers Consortium [ARCC] Annual Conference, Chicago, IL [accepted, forthcoming 2015]
	<i>Learn, Explore and Be Inspired By Nature: A Design/Build Case Study</i> Architectural Research Centers Consortium [ARCC] Annual Conference [accepted, forthcoming] 2015
	<i>Climatically Responsive Manufactured Housing</i> International Conference on Sustainable Design, Engineering, and Construction, 2015 [accepted, forthcoming 2015]
	<i>Eco-Fab: A Climatic Responsive Alternative to Manufactured Housing</i> American Solar Energy Society [ASES] Annual Conference, San Francisco, 2014
	<i>A Modular Alternative: Responding to Climate</i> Modular Building Institute “World of Modular” annual conference, Scottsdale, Arizona, 2013
<b>Invited Panels, Presentations, Conferences</b>	<i>Intervista [interview about Italian teaching experience].</i> Appearing in <i>Learning By....An Exchange Experience Between UNICAM and Cal Poly</i> , [Monica Rossi, Editor], AeD Press, 2012
	<i>Autodesk “Train the Trainer” event</i> San Francisco, CA [August 2014]
	<i>Measuring Effectiveness: ECS Teaching Methodology</i> Society of Building Science Educators Annual Retreat: “Measuring Design: Models and Metrics,” Mt. Baldy, California, June 2013
	<i>AIA + 2030 Professional Series</i> Year long professional workshop targeting strategies for designing energy efficient buildings [participant], 2012-2013
<b>Recognition of Student Work</b>	<i>Solar Cal Poly 2015</i> Schematic design of an interdisciplinary design/build solar house for the U.S. DOE Solar Decathlon 2015 competition. Published in Cal Poly’s CAED Journal [fall 2014]
	American Institute of Architects Central Coast (AIACC) student design awards Recognition awards given every spring for design excellence to 5 <sup>th</sup> year students; my students recognized since 2009: Cameron Hempstead, Jessica Labac, 2013; Matt Heiss, 2012 Carissa Nakano, Keith Rowe, Joanne Hong and Caleb Chen, 2010; Tracy Wang, 2009
<b>Exhibits</b>	<i>Architecture Department Fifth Year “Chumash Show,”</i> 2007 – present
	<i>Annual Stannard Studio fifth year final show,</i> 2007 - present <i>Annual fall all-fifth year “Abstract,” “Section” and “Details” shows,</i> 2007 - present
<b>Professional Memberships</b>	U.S. Green Building Council [USGBC – C4, San Luis Obispo], American Solar Energy Society [ASES] Society of Building Science Educators (SBSE)

## Curriculum Vitae

**Samuel A. Vigil, Professor Emeritus**  
**Civil and Environmental Engineering Department**  
**California Polytechnic State University**  
**San Luis Obispo, California 93407**  
**svigil@calpoly.edu**

### Education:

Ph.D. University of California, Davis, Engineering, 1981  
 M.S. Texas A & M University, College Station, Civil Engineering, 1974  
 B.S. University of California, Berkeley, Civil Engineering, 1969

### Registration And Certifications:

Registered Civil Engineer, No. 35624, California.  
 Board Certified Environmental Engineer, American Academy of Environmental Engineers (Solid Waste Management Specialization)  
 LEED Accredited Professional, U.S. Green Building Council

### Experience:

1982 - Present Professor, Civil and Environmental Engineering, California Polytechnic State University, San Luis Obispo, California. Teaching and research assignments in sustainability, solid waste management, water and wastewater treatment, and environmental engineering design. (Emeritus from 2009)

1980 - 1982 Principal Engineer, Brown and Caldwell Consulting Engineers, Walnut Creek, California. Project manager assignments on solid waste and energy recovery projects including recycling, gasification, landfill gas utilization.

1978 - 1980 Research Engineer, Civil Engineering Department, University of California, Davis. Duties included the design, construction, and operation of a pilot scale co-gasification system for sludge and source separated solid waste.

1975 - 1978 Teaching Assistant, Civil Engineering Department, University of California, Davis.

1973 - 1974 Research Assistant, Civil Engineering Department, Texas A&M University College Station.

1973-1995 Commissioned Officer, U.S. Navy Civil Engineer Corps (reserve duty), Construction, and environmental engineering projects on U.S. Navy bases in the U.S., Europe, and South East Asia. Retired in 1995 with the rank of Commander.

1969 - 1973 Commissioned Officer, U.S. Navy (active duty). Electronics and communications assignments in Washington, D.C. and Puerto Rico.

**Membership In Professional Societies:**

Air and Waste Management Association  
 American Academy of Environmental Engineers  
 American Geophysical Union  
 Solid Waste Association of North America  
 U.S. Green Building Council

**Honors And Awards:**

The Richard I. Stessel Waste Management Award, Air & Waste Management Association, "Awarded for distinguished achievement as an educator in the field of waste management," January 2015.

Elected as a Fellow of the Air & Waste Management Association, January, 2012.

Iraj Zandi Award, Journal of Solid Waste Management and Technology, Philadelphia, PA, "The award is given annually to an individual who has inspired and led students in their careers in the field of solid waste. Dr. Vigil is certainly such an inspiration. His textbook has been used by thousands of students worldwide and is generally considered the standard text in the field." March 2011

Keynote Speaker, First International Symposium on Advanced Waste and Emission Management, Nagoya University, Nagoya, Japan, December 2000.

Best Air Quality Paper, TAPPI 1998 Environmental Conference, "Evaluation of the EPA Recommended Approach to Predicting Air Emissions from Pulp and Paper Industry Landfills," (with R. Lang, et al)

Best Architectural Research Project in 1998, "Energy Efficient Resource Recovery Project for Cal Poly State University", Architecture Magazine, April 1998 (with D. Panetta, D. Williams, R. Lang, et al).

Navy Commendation Medal, for meritorious service while serving as Environmental Program Manager of the Reserve Division, Naval Facilities Engineering Command. Established two Reserve Environmental Engineering Units which provided over \$1 million dollars of engineering services to the Atlantic and Pacific Fleets in their first year of operation. Awarded December 1993.

**Book:**

Tchobanoglous G., H.M. Theisen, and **S.A. Vigil**, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993, 978 pages. (Spanish translation published in 1995 by McGraw-Hill de Espana, Madrid; Japanese, Chinese, and Korean translations published in 1998 by McGraw-Hill International.)

## Engineering Reports

Brewer, W., G. Hoffman, E. Silver, C. DiLeonardo, J. R. Henderson, and **S. Vigil**, “Evaluating Use of Satellite Observations for Detecting Large CO<sub>2</sub> Leaks and Carbon Sequestration Monitoring,” Lawrence Livermore National Laboratory, LLNL-TR-568072, August 1, 2012.

**Vigil, S.A.** and H.M. Theisen, “Review Of Leachate Treatment Technologies”, World Bank, Washington, D.C., August 27, 2012 (in press).

**Vigil, S. A.**, R. M. Roberts and D. E. Brunner, Solid Waste Resource Recovery Alternatives, U.S. Facility, Subic Bay, Philippines, Naval Civil Engineering Laboratory Technical Note TN-1721, 1985.

Sorbo, N. W., G. Tchobanoglous, **S. A. Vigil**, and J. R. Goss, [Performance and Economic Feasibility of a Sludge/Wastepaper Gasifier System](#), EPA Project Summary - EPA-600/S2-84-063, 1984.

## Publications

(Many are available for downloading at <http://works.bepress.com/svigil/> )

Tratt, D.M., K. N. Buckland, J.L. Hall, S.J. Young, I. Leifer, and **S. A. Vigil**, “Identification and Source Attribution of Gaseous Effluents using High-Resolution Airborne Thermal-Infrared Imaging Spectrometry,” Presented at the Air and Waste Management Association, Air Quality Measurement Methods and Technology Conference, Sacramento, California, November 19-21, 2013.

**Vigil, S.A.** and I. Leifer, “Remote Sensing of Greenhouse Gases from Landfills,” Presented at Air and Waste Management Association Regional Specialty Conference on Sustainable Resources and Air Quality Management, Yilan, Taiwan, October 23 - 25, 2013.

**Vigil, S.A.**, “Gasification of Solid Waste Residuals as Part of A Zero Waste Strategy,” Presented at Air and Waste Management Association Regional Specialty Conference on Sustainable Resources and Air Quality Management, Yilan, Taiwan, October 23 - 25, 2013.

Leifer, I. D. Tratt, E. T. Eglund, K. Gerilowski, **S. A. Vigil**, M. Buchwitz, T. Krings, H. Bovensmann, S. Krautwurst, and J. P. Burrows, “Investigation of Greenhouse Gas Emissions by Surface, Airborne, and Satellite on Local to Continental Scale,” Presented at the 2013 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 9 - 13, 2013.

**Vigil, S. A.** , “Satellite Remote Sensing of Landfill Gas in Developing Countries,” Proceedings of The Twenty-Sixth International Conference On Solid Waste Technology and Management, Philadelphia, PA, March 27-30, 2011.

Brewer, B., Hoffmann, G., Silver, E., DiLeonardo, C., **Vigil, S.A.**, and Henderson, J., “CO<sub>2</sub> Sequestration Leak Detection Using Satellite-Based Sensors,” Presented at the 2011 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 5 - 9, 2011.

**Vigil, S. A.** , “Satellite Remote Sensing of Landfill Gas in Developing Countries,” Proceedings of The Twenty-Sixth International Conference On Solid Waste Technology and Management, Philadelphia, PA, March 27-30, 2011.

**Yesiller, N. Vigil, S. A.,** and Hansen, J.L., “Assessment of State Composting Regulations in the United States,” Proceedings of The Twenty-Sixth International Conference On Solid Waste Technology and Management, Philadelphia, PA, March 27-30, 2011.

**Vigil, S. A.** and Bovensmann, H., “The Measurement of Landfill Gas Emissions with the Orbiting Carbon Observatory and CarbonSAT Satellites,” Poster Presented at the 2010 Fall Meeting of the American Geophysical Union, San Francisco, CA, December 13 – 17, 2010.

**Vigil, S. A.,** “Solid Waste and Biomass Gasification,” Proceedings of the 103rd Annual Meeting and Exhibition of the Air and Waste Management Association, Calgary, Alberta, Canada, June 2010.

**Vigil, S. A.** and Crisp, D., “The Use of Data from the Orbiting Carbon Observatory to Measure Greenhouse Gas Emissions from Landfills,” Proceedings of the 103rd Annual Meeting and Exhibition of the Air and Waste Management Association, Calgary, Alberta, Canada, June 2010.

Yesiller, N., Hansen, J.L., and **Vigil, S.A.,** Assessment of State Recycling Regulations in the United States, Global Waste Management Symposium Proceedings: San Antonio, TX, October 3, 2010, pages 1-8.

Heinrichs, G, **Vigil, S. A.,** et al, “Handbook of Guidelines : Ecology Meets Technology, Sustainable Technology Park”, College of Architecture and Environmental Design, California Polytechnic State University, San Luis Obispo, 2006. (Chapters on Renewable Energy, Water Conservation and Wastewater Treatment, and Renewable Materials and Construction Waste Management)

Tsuji, A, Nelson, Y., Kean, A, and **Vigil, S. A.,** “Recyclability Index for Automobiles,” Proceedings of the 99th Annual Meeting and Exhibition of the Air and Waste Management Association, New Orleans, LA, June 2006.

**Vigil, S. A.,** and D. Zueck, "Environmental Applications of the Global Positioning System," Proceedings of the 92nd Annual Meeting and Exhibition of the Air and Waste Management Association, St. Louis, Missouri, June 1999.

Lang, R.J., **Vigil, S. A.,** and Melcer, H, "Techniques for Modeling Hazardous Air Pollution Emissions from Landfills," Proceedings of the 91<sup>st</sup> Annual Meeting and Exhibition of the Air and Waste Management Association, San Diego, California, June 14-18, 1998.

Melcher, H., R. Lang, **S. A. Vigil,** and C. Maltby, "Evaluation of the EPA Recommended Approach to Predicting Air Emissions from Pulp and Paper Industry Landfills," presented at the 1998 TAPPI Environmental Conference, May 1998.

"Energy Efficient Resource Recovery Project for Cal Poly State University", Architecture Magazine, April 1998 (**Vigil, S. A.** with D. Panetta, D. Williams, R. Lang, et al).

Cota, H.M., and **Vigil, S. A.**, "Environmental Engineering Design," Proceedings of the 90<sup>th</sup> Annual Meeting and Exhibition of the Air and Waste Management Association, Toronto, Canada, June 8-13, 1997.

**Vigil, S. A.**, S. Rupp, "Recycling and Pollution Prevention Programs at New United Motors Manufacturing, Inc., Fremont, California," Proceedings of the 89th Annual Meeting and Exhibition of the Air and Waste Management Association, Nashville Tennessee, June 23 - 28, 1996.

Mull, S. R., R. J. Lang, **S. A. Vigil**, H. Cota, "PC Windows Finite Element Modeling of Landfill Gas Flow, Proceedings of the 1996 National Waste Processing and NAWTEC-IV Waste-to-Energy Conference, American Society of Mechanical Engineers, New York, New York, 1996.

**Vigil, S. A.**, "Development of a Graduate Integrated Waste Management Course Using the Case Study Approach," Proceedings of the 88th Annual Meeting and Exhibition of the Air and Waste Management Association, San Antonio, Texas, June 18-23, 1995.

**Vigil, S. A.**, and G.M. Holter, "Application of Macro Material Flow Modeling to the Decision Making Process for Integrated Waste Management Systems," Proceedings of the 1995 International Conference on Solid Waste Management: Thermal Treatment and Waste-to-Energy Technologies, Washington, D.C., April 18-21, 1995.

**Vigil, S. A.**, and G. Tchobanoglous, "Comparison of the Environmental Effects of Aerobic and Anaerobic Composting Technologies," Proceedings of the 87th Annual Meeting and Exhibition of the Air and Waste Management Association, Cincinnati, Ohio, June 19-24, 1994.

**Vigil, S. A.**, and H. Thiesen, "Graphical Integrated Waste Management Model for Puerto Rico," Proceedings of the 1992 National Waste Processing Conference, American Society of Mechanical Engineers, New York, New York, 1992.

**Vigil, S. A.**, and G. Tchobanoglous, "Development of Solid Waste Courses at the Undergraduate and Graduate Level," Proceedings of the 1992 National Waste Processing Conference, American Society of Mechanical Engineers, New York, New York, 1992.

**Vigil, S. A.**, "Surabaya, Indonesia : Options in Solid Waste Management". Proceedings of the Second European Conference on Environmental Technology, Amsterdam, The Netherlands, June 22 – 26, 1987.

**Vigil, S. A.**, and Zevely, J.A., "Microcomputer Solid Waste Financial Model," Proceedings of the 1986 National Waste Processing Conference, American Society of Mechanical Engineers, New York City, New York, 1986.



Ortiz-Canavate, J., **S. A. Vigil**, J. Goss, and G. Tchobanoglous, "Comparison of Operating Characteristics of 35 - kw Diesel Engine Fueled With Low Energy Gas, Biogas, and Diesel Fuel," Proceedings of the Third Symposium on Biotechnology in Energy Production and Conservation, John Wiley & Sons, Inc., New York, 1981.

Davis, D.A., S.A. Vigil, and G. Tchobanoglous, "Evaluation of Residual Char from the Gasification of Solid Wastes as a Substitute for Powdered Activated Carbon," Proceedings of the Third Symposium on Biotechnology in Energy Production and Conservation, John Wiley & Sons, Inc. New York, 1981.

Vigil, S.A., D.A. Bartley, R. Healy, and G. Tchobanoglous: "Operation of Packed Bed Gasifiers Fueled with Source Separated Solid Waste," Thermal Conversion of Solid Wastes and Biomass, American Chemical Society, Washington, D.C., 1980.

Bartley, D.A., **S. A. Vigil**, and G. Tchobanoglous: "The Use of Source Separated Paper as a Biomass Fuel," Proceedings of the Second Symposium on Biotechnology in Energy Production and Conservation, John Wiley & Sons, Inc., New York, 1980.

## **Research and Education Projects**

Review of Waste and Material Handling Regulations for California. Funded by the California Integrated Waste Management Board. (2009 to 2010) Co-PI.

Development of a "Handbook of Performance Driven Guidelines" for a Sustainable Technology Park for the Cal Poly Campus, San Luis Obispo. Responsible for Chapters on Renewable Energy, Water Conservation and Wastewater Treatment, and Renewable Materials and Construction Waste Management. (2004 to 2005). Co-PI.

Development of a Composting Best Practices Manual for California. Funded by the California Integrated Waste Management Board. (1999 to 2000) Co-PI.

Energy Efficient Resource Recovery Project for Cal Poly State University. Funded by the Renewable Energy Institute, California Polytechnic State University. (1997) Co-PI.

"Planning and Management For Municipal Solid Waste", Symposium and Professional Development Course, University College, Dublin, Ireland (May 12-14, 1997) Co-PI.

Solid Waste Management Problem Solving: Materials Recovery and Recycling Systems. A short course for California Integrated Waste Management Board Staff. (December 1995) Co-PI

Science and Technology Research Priorities for Waste Management in California, Funded by the California Council on Science and Technology for the California Integrated Waste Management Board. (1991 to 1992) Co-PI.

Development of a Microcomputer Model for Integrated Solid Waste Management. Funded by the California Integrated Waste Management Board. (1985 to 1986) PI.

## Project Schedule

Task 1: Identification of Leading-Edge GHG Reduction Strategies

Task 2: Building System Simulation and Integration

Task 3: Data Analysis and Reporting

	Year 1												Year 2											
Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1																								
2																								
3			Q			Q			Q			DF						F						

For Task 3: Q denotes a quarterly report, DF denotes a draft final report, and F denotes a final report

Note: Month designations based on contract start date.

## Estimated Cost by Task

Task	Labor	Fringe Benefits and Employer Payroll Taxes	Consultants	Equipment	Travel Subsist	Supplies	Data Storage	Data Acquisition	Coding Support	Copy Editing	Publication Fees	Indirect Costs	TOTAL
1	\$78,580	\$10,268	\$0	\$0	\$1,600	\$0	\$0	\$0	\$0	\$0	\$0	\$9,045	\$99,493
2	\$147,404	\$27,938	\$0	\$0	\$4,000	\$4,000	\$0	\$0	\$0	\$0	\$0	\$18,334	\$201,676
3	\$79,829	\$8,970	\$0	\$0	\$1,000	\$0	\$0	\$0	\$0	\$0	\$0	\$8,980	\$98,779
	<b>\$305,813</b>	<b>\$47,176</b>	<b>\$0</b>	<b>\$0</b>	<b>\$6,600</b>	<b>\$4,000</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$36,359</b>	<b>\$399,948</b>

**Co-Funding: Unrecovered Indirect Costs \$103,622**

**SALARIES AND WAGES:** The salary rates are based on the California State University and Cal Poly Corporation established salary rate paid during the 2014-2015 Academic year (July 1 – June 30). The salary and wage rates for all employees include a projected 4.5% salary increase per year. The rates shown are for budgetary purposes; the actual rates in effect at the time the work is performed will be charged to the project.

**FRINGE BENEFITS AND EMPLOYER PAYROLL TAXES:** Full time benefits for Release time include a benefit package consisting of FICA, State Unemployment Insurance (SUI), Worker's Compensation, non-industrial leave including vacation and sick leave, medical, dental, and life insurance benefits, and retirement benefits (PERS) and are calculated at 48.03%. Benefits for Faculty summer and overload work and Intermittent employees include FICA, SUI and Workers Compensation and are calculated at 10.9%. Student benefits include FICA (when applicable), SUI, and Worker's Compensation and are calculated at 4.9% and 10.9% if FICA is charged. Only rates in effect at the time the work is performed will be charged to the sponsor.

**DOMESTIC TRAVEL:** Funds in the amount of \$6,600 for the project are requested for roundtrip travel to Sacramento (1 trip in both year 1 and year 2) for the PI to meet with the sponsor.

At least one trip per collaborator (11 faculty) to complete data collection and/or a site visit. Trips will be within California, and approximately 1-2 days in duration.

**MATERIALS AND SUPPLIES:**

Funds are requested in Task 2 to support the purchase of a computer to be used in simulations, simulation software, and memory backup.

**INDIRECT COSTS:** Cal Poly State University's Federal negotiated indirect rate is 38.5% of modified total direct costs, effective July 1, 2015. Modified total direct costs exclude equipment, capital expenditures, charges for patient care, tuition remission, rental costs of off-site facilities, scholarships, and fellowships as well as that portion of each subgrant and subcontract in excess of \$25,000. However, the sponsor limits indirect costs to 10% of Modified Total Direct Costs. Unrecovered indirect costs are contributed to the project by the University.

**CO-FUNDING: UNRECOVERED INDIRECT COSTS:** Unrecovered Indirect Costs are shown as Co-funding. At this time Cal Poly co-funding for this project is limited to unrecovered Indirect Costs.