

BRYAN PALMINTIER

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Education

Massachusetts Institute of Technology, PhD, Engineering Systems Completed Oct 2012

Dissertation: *Incorporating Operational Flexibility into Electric Generation Planning: Impacts and Methods for System Design and Policy Analysis*

Stanford University, Engineer's Degree, Mechanical Engineering -Design Division 2004

Thesis: *The Emerald Protocol Suite: Design and Implementation of a Modular, Distributed Architecture for Small Satellite Command, Telemetry, and Power Systems*

Stanford University, M.S., Aeronautics & Astronautics Engineering 1999

Georgia Institute of Technology, B. S., Aerospace Engineering, with Highest Honor 1996

Research and Engineering Experience

National Renewable Energy Lab (NREL), EERE/Sunshot Postdoctoral Fellow 2013-Present

- Cyber-Physical-Energy Theory and Testbed. Co-PI for internal R&D grant (\$300k). Developing a super-computer based ISO-to-appliance scale simulation platform to assess the value and operational impacts of distributed intelligent resources including smart inverters and demand response.
- Testbed for Distributed Energy Integration. Co-author for internal R&D grant (\$400k). Developed a co-simulation environment that enables actual hardware under test (e.g. PV inverters) with Power-Hardware-in-the-Loop to interact with an external feeder-scale simulation using existing modeling tools.
- Energy Systems Integration. Working with another researcher to refine the concept and potential of ESI. We identified example opportunities, created a categorization framework, and estimated impacts in energy, expenditures, carbon emissions, and less tangible "-ilities" such as reliability, flexibility, etc.
- Arizona Public Service High-Penetration Study. Reviewed OpenDSS-based tool chain for PV integration analysis. Assisted with optimal clustering for representative feeder identification.
- Efficient, open methods for assessing high penetration solar photovoltaic as (re)active participants in electric distribution systems. Wrote successful fellowship grant (\$180k). Developing methods to capture interactions among advanced inverters, existing controls, anticipated technologies (e.g. electric vehicles, storage), and the bulk power system. Efforts include integrate existing simulation tools, power-hardware-in-the-loop testing, development of screening methodologies, and European collaboration.

MIT Engineering Systems Division, Graduate Research Assistant 2009-2012

- Decision making under coupled multi-timescale uncertainty: Co-wrote successful NSF grant (\$330k). Research combined stochastic multi-decade electricity generation planning with sophisticated hourly power systems models to assess operational flexibility for renewables and other advanced technologies. I developed novel approaches to power systems models and approximate dynamic programming (ADP).
- Advanced electric power systems models: Developed new power systems operations and expansion approaches to estimate unit commitment constraints many times faster than conventional methods.
- Power system expansion models: Designed & built model used by collaborators to investigate investment trade-offs under carbon and water restrictions. Extended analytic model for renewable policy insights
- ADP Toolbox: Developed a set of modular tools for dynamic and approximate dynamic programming. Incorporated into others' research and an MIT graduate-level class assignment on ADP.

University of Washington, Electrical Engineering, Visiting Lecturer 2010-2012

Informal research collaboration: Power & Energy Systems Analysis, and Wind Integration Research labs.

MIT|Portugal Program, Graduate Research Assistant 2008-2009

Green Islands Project: Built models of energy balance and power-flow for high renewable scenarios with storage & demand response on São Miguel & Flores Islands. Analyzed correlation of wind vs. demand.

Rocky Mountain Institute, Research and Consulting Fellow 2007-2008

- Next Generation Utility (NGU): Conceptual architect and founding programmer for large renewable efficient power system model. Studied optimal mix of wind and solar for variability reduction.
- Smart Garage: Conducted systems design and economic analysis for vehicle-grid (V2G) integration.
- Energy Efficient Datacenters: Worked with design team to identify 50-90% energy savings for IT equipment at a large datacenter being built in the UK for a world-leading managed hosting provider.
- Other projects: Office energy monitoring system. Building energy modeling.

Energy Solutions, Oakland, CA, Project Manager 2006-2007

- Coordinated emerging technology (ET) demonstration of ventilation controls efficiency retrofit for PG&E.
- Codes and standards development for lighting, signage, & streetlights, for Pacific Gas & Electric (PG&E).
- Specification and support for California Solar Initiative (CSI) web interface.

Robotics System Lab (RSL), Santa Clara University, Staff Research Associate 2001-2007

- Emerald Protocol Suite: Developed plug-and-play architecture used by 5 universities for 7+ satellites.
- Emerald/ONYX/Obsidian Nanosatellite Project: Led/managed multi-disciplinary team of students & staff to meet electrical, mechanical & mission requirements. Mentored over 20 BS and MS students.
- Emerald/ONYX Modular Sub-systems: Developed 6+ plug-and-play embedded microcontroller based subsystems: hardware & software. Designed, assembled, & tested majority of satellite electronic systems.

Stanford University Civil & Env. Engineering, Energy Research Associate 2003-2005

- Reviewed and edited manuscript for *Renewable and Efficient Electric Power Systems* with Gil Masters.
- Researched material for future course: "Renewable and Efficient Energy in SE Asia." (in Singapore)
- Analyzed telephone datacenter energy usage for AT&T to establish baseline for VoIP transition.
- Participated in conceptual design of Stanford Green Dorm with a focus on advanced building monitoring.

Crary Lab, McMurdo Station, Antarctica, Field Researcher (University of Illinois) 2004-2005

- Antifreeze Adaptations of Antarctic Nototheonoid Fish (B-005): Designed & built real-time temperature control system for 150,000-gallon research aquarium. Designed, deployed, and analyzed data from custom ice sensor and off-the-shelf precision instruments for oceanographic environment analysis.

Jasper Ridge Biological Preserve, Stanford University, Graduate Research Assistant 2003

Leslie Shao-ming Sun Field Station Energy Monitoring System: Designed, built, programmed, and installed energy monitoring system and WWW kiosk for field station building and its 20kW solar array.

Space Systems Development Lab (SSDL), Stanford, Graduate Research Assistant 1997- 2001

- Emerald/Orion Command and Data Handling Team Lead (1999-2001) Managed students and consultants in the design, construction, programming and testing for central control and data unit. Designed and built embedded motherboards for distributed satellite architecture, including associated software libraries.
- OPAL Satellite, 100% mission success on orbit (2000). Solar assembly, machining, post-launch operation.
- Sapphire Satellite, 100% mission success on orbit (2001). Electronics, mechanism design, systems test.

Naval Research Laboratory (NRL), Washington, DC, Engineering Technician 1994-1996

Naval Center for Space Technology: Developed computer simulations of hybrid rockets and satellites.

Leadership Experience (See also Teaching Experience)**Co-Founder/Past-President, Electricity Student Research Group (ESRG), MIT** 2009-2012

Brought together power system researchers scattered across campus. The group has grown to two-dozen active grad students from 5 departments plus many faculty/staff and affiliates.

Staff Project Leader, Emerald Nanosatellite, RSL, Santa Clara University 2001-2005

Coordinated, mentored, and managed a multi-disciplinary team of 20+ BS/MS students and staff in the design and prototyping of a small (20kg) satellite. (See also Research Experience)

Founder, President, & Instructor, (new) Stanford Alpine Club 2002-2007

Spearheaded a group of 5-8 students to re-build the long defunct Stanford Alpine Club, including: extensive risk management, discussions of club goals/structure, etc. Grew membership to 100+, organized meetings, slideshows, 15+ instructional trips, and \$50+k of equipment.

- Science Co-director**, Cosmos Education Science & Sustainability Conference 2002
Worked with the other directors to organize a 1-day science education conference for 400 secondary children and 30 teachers at United Nations Environment Program Headquarters in Nairobi, Kenya.
- Assistant Field Coordinator**, Cosmos Education 2002
Coordinated and managed two multi-week science education expeditions in Africa: UAS2002 - Under African Skies (Kenya, Tanzania legs) and Eclipse Watch 2002: (South Africa, Swaziland). Both involved teams of 20 young international scientists traveling from village to village as a traveling science show.
- Team Lead**, Emerald Command and Data Handling Subsystem, SSDL, Stanford, 1999- 2001
Managed team of 10 fellow students and outside consultants in the design, construction, programming and testing for command and data handling sub-system for the three-satellite Emerald-Orion mission.

Teaching Experience *(See also Guest Lectures under Publications and Presentations)*

- Instructor and Co-Coordinator**, Renewable Integration Short Course, NREL 2013
Coordinated and taught half of the material for a full day class on Distributed Energy/Solar Grid Integration as part of a week-long short course on Renewable Integration with 60 students.
- Mountaineering Course Leader**, National Outdoor Leadership School (NOLS) 2002-Present
Lead or co-lead 8 two- to four-week-long wilderness expeditions in Alaska, Washington, British Columbia, & Wyoming. With team of 1-3 instructors lead 10-15 students through uniquely intense situations in remote environments involving physically demanding travel, technical terrain, weather, etc. In addition to wilderness travel and technical climbing skills, we focus on leadership and group dynamics.
- Teaching Assistant**, *Massachusetts Institute of Technology*
Engineering, Economics, & Regulation of Electric Power Systems (ESD.934/6.974) 2009 & 2010
Recitations, teaching support, & grading for large (75 participants) inter-disciplinary courses.
- Adjunct Professor**, *Santa Clara University*
Graduate Mechatronics Sequence (Mech 207-9) 2002 & 2006
Introduction to Mechatronics (Mech 143/Elen 123) 2002
Co-taught 4 quarter-long courses each with lecture, lab, and extensive project components.
- Instructor and Coordinator**, Outdoor Education Program, Stanford University 1997-2007
As an instructor co-taught 20 quarter-long classroom & field courses (for credit) and organized and taught 15 skill specific workshops (half as first offerings). As coordinator, oversaw 20-25 instructors, hiring/admission, university interactions, \$100+k of equipment, 200+ classes, and 40+ trips.
- Teaching Assistant**, *Stanford University*
Spacecraft Design (AA 236a) 1998
Expanded and taught the electronics component (ten lectures). Organized lab & design projects.
- Trip Leader and sub-group chair**, *Outdoor Recreation at Georgia Tech (ORGT)* 1993-1996
As a trip leader, organized & taught dozens of multi-weekend seminars on backpacking, climbing & caving.
As chair, coordinated 10-20 instructors, managed equipment and contributed to the long-term visioning.

Honors & Awards

- EERE/SunShot Postdoctoral Research Fellowship**, Department of Energy 2012-Present
- Martin Family Sustainability Fellowship**, MIT Energy Initiative 2010
- Department Fellowship**, Stanford Aero/Astro Engineering 1997
- President's Scholar** (full scholarship), Georgia Tech 1992-1996
- 1st place team senior design competition**, Georgia Tech Aerospace Engineering 1996
- Tau Beta Pi** 1993
- Sigma Gamma Tau** 1993
- Eagle Scout** 1991

Technical Skills

Programming Languages: Python, MATLAB, GAMS/CPLEX, R, C, C++, and 10+ others

Modeling Tools: GridLAB-D, OpenDSS, Opal-RT, Simulink, RNM, etc.

Development Tools: GIT, SVN, Eclipse, etc.

Operating Systems: OSX, Windows, Linux

Productivity Tools: Microsoft Office, LyX, Zotero, OmniGraffle, LaTeX, Visio, etc.

Hardware: Electric (100-600+V AC/DC) and Electronic (3-24V DC) design, assembly & test

Short Courses Attended

NREL Training, Golden, CO

Qualified Electric Worker (2013), Lock-out/Tag-out (2013), etc.

Pacific Energy Center, San Francisco, CA

HVAC: Fundamentals of the field (2007), Manual and Automated Demand Response and Critical Peak Pricing Strategies (2006), Retro-commissioning (2006), Building Modeling with eQuest (2004)

Professional Activities

Reviewer for:

National Science Foundation, Electrical, Communications and Cyber Systems (ECCS)

IEEE Transactions on Power Systems

Journal of the Operations Research Society

Energy Systems (Journal)

Interdisciplinary Research Groups:

Electricity Student Research Group, MIT 2009-2012

Co-founder, 2009. Co-president, 2009-2010. Journal club organizer, 2010-2011

Stochastic Optimization Reading Group, MIT 2010-2011

Wind Energy Interest Group, MIT 2008-2010

Conference Support:

MIT Energy Conference, *Audio/Visual Coordinator*, Cambridge, MA 2010

MIT Wind Week, *Webmaster*, Cambridge, MA 2009

MIT Energy Conference, *Responsive Demand Panel Team*, Cambridge, MA 2009

Cosmos Education Science & Sustainability Conference: Science co-director 2002

United Nations Environment Program Headquarters, Nairobi, Kenya

Professional Memberships:

IEEE (Power & Energy Society) 2007-Present

INFORMS 2011-Present

Volunteer Experiences

Grid Alternatives, San Francisco, CA, *PV installation and home energy audits* 2006-2007

Cosmos Education, *Assistant Coordinator and Science Teacher* 2002

UAS2002 - Under African Skies Expedition: Kenya, Tanzania

Eclipse Watch Expedition 2002: South Africa, Swaziland

Jasper Ridge Biological Preserve, Stanford University, *Ranger* 2000-2004

Publications and Presentations

Refereed Journal Articles

- Palmintier, B.**, Lundstrom, B., Chakraborty, S., & Williams, T. (In Preparation). A Power-Hardware-in-the-Loop Platform with Remote Distribution Circuit Co-simulation for Advanced Photovoltaic Inverter Testing. Target: *IEEE Transactions on Industrial Electronics*.
- Palmintier, B.**, & Webster, M. (In Review). Impact of Operational Flexibility on Generation Planning. *IEEE Transactions in Power Systems*.
- Palmintier, B.**, & Webster, M. (To Appear 2014). Unit Clustering for Efficient Operational Flexibility Modeling. *IEEE Transactions in Power Systems*.
- Webster, M., Donohoo, P., & **Palmintier, B.** (2013). Water-CO2 trade-offs in electricity generation planning. *Nature Climate Change*, 3(12), 1029–1032.

Refereed Conference Papers

- Palmintier, B.** (In preparation, abstract accepted). Flexibility in Generation Planning: Identifying Key Operating Constraints. To be presented at the *18th Power Systems Computation Conference (PSCC'14)*, Wroclaw, Poland, August 2014.
- Palmintier, B.**, & Webster, M. (2011) Impact of Unit Commitment Constraints on Generation Expansion Planning with Renewables. In *Proceedings of the 2011 IEEE Power and Energy Society General Meeting*.
- Lee, R., Watson, R., Kitts, C., Stang, P., & **Palmintier, B.** (2004). On-Board Expert System for the Emerald Nanosatellites. In *Proceedings of the 2004 IEEE Aerospace Conference*. Big Sky, MT.
- Lee, R. K., Watson, R., Kitts, C., Stang, P., & **Palmintier, B.** (2004). Anomaly detection using the Emerald nanosatellite on board expert system. In *Proceedings of the 2004 IEEE Aerospace Conference*. Big Sky, MT.
- Palmintier, B.**, Twigg, R., & Kitts, C. (2000). Distributed computing on Emerald: a modular approach for robust distributed space systems. In *Proceedings of the IEEE 2000 Aerospace Conference*. Big Sky, MT.
- Kitts, C., Twigg, R., Pranajaya, F., **Palmintier, B.**, & How, J. (1999). Emerald: A low-cost spacecraft mission for validating formation flying technologies. In *Proceedings of the 1999 IEEE Aerospace Conference*. Snowmass, CO.

Other Conference Papers (abstract review)

- Traube, J., Hansen, L., **Palmintier, B.**, & Levine, J. (2008). Spatial and Temporal Interactions of Wind and Solar Resources in the Next Generation Utility - An Update. In *Proceedings of WindPower 2008*. Houston, TX.
- Palmintier, B.**, Hansen, L., & Levine, J. (2008). Spatial and Temporal Interactions of Wind and Solar Resources in the Next Generation Utility. In *Proceedings of the American Solar Energy Society (ASES) Solar2008 Conference*. San Diego, CA.
- Kitts, C., Quinn, N., Ota, J., Stang, P., & **Palmintier, B.** (2003). Development and Teleoperation of Robotic Vehicles. In *AIAA Unmanned Unlimited Systems, Technologies and Operations Conference*. San Diego, CA.
- Palmintier, B.**, Kitts, C., Stang, P., & Swartwout, M. (2002). A Distributed Computing Architecture for Small Satellite and Multi-Spacecraft Missions. In *Proceeding of the 16th Annual AIAA/USU Conference on Small Satellites*. Logan, UT.
- Townsend, J., **Palmintier, B.**, & Allison, E. (2000). Effects of a Distributed Computing Architecture on the Emerald Nanosatellite Development Process. In *Proceedings of the 14th AIAA/USU Conference on Small Satellites*. Logan, UT.
- Kitts, C., Twigg, R., Pranajaya, F., Townsend, J., & **Palmintier, B.** (1999). Experiments in Distributed Microsatellite Space Systems. In *Proceedings of the AIAA Space Technology Conference and Exhibition*. Albuquerque, NM.
- Pranajaya, F. M., Garcia-Sacristan, C., Cutler, J., **Palmintier, B.**, Kitts, C., & Swartwout, M. (1999). Micro-and Nanotechnology Applications at Stanford University. In *Proceedings of the 2nd International Conference on Integrated Micro-Nanotechnology for Space Applications* (pp. 11-15). Pasadena, CA.

Conference presentations (abstract review)

- Palmintier, B.**, & Webster, M. (2011, November). *Electricity Planning with Environmental Policy Uncertainty using ADP: Carbon Policies and Renewables*. INFORMS 2011 Annual Meeting, Charlotte, NC.
- Palmintier, B.** (2010, June). *Incorporating High Dimensional Uncertainty and Operational Constraints Into Long- Term Generation Expansion Models Using Approximate Dynamic Programming*. FERC Conference on Increasing Market and Planning Efficiency Through Improved Software and Hardware - Enhanced wide-area planning models, Washington, D.C.
- Palmintier, B.**, & Newman, S. (2008, August). *Systems Thinking for Radically Efficient and Profitable Datacenter Design*. Next Generation Datacenter Conference, San Francisco, CA.
- Wang, K., & **Palmintier, B.** (2008, April). *Grid Services from Responsive Loads and Electric Drive Vehicles in the Next Generation Utility*. IEEE Power Engineering Society Transmission and Distribution Conference, Chicago, IL.
- Palmintier, B.** (2002, June). *Using Electronics to Sense the World Around Us: From Satellites to the Soil*. Presented at the Under African Skies 2002, Science & Sustainability Conference: Applying Appropriate Solutions for a Global Society, UNEP, Nairobi, Kenya.
- Palmintier, B.**, & Bellini, P. (1995, April). *Design and Testing of the Georgia Tech Hybrid Rocket Motor (GTHYRM)*. Regional AIAA Student Competition, Atlanta, GA.

Guest Lectures and Selected Other Presentations

- Palmintier, B.** (2011, October 13). *Electric Power Planning for Flexibility: Integrating Unit Commitment Constraints into Long-term planning for Renewables*. University of Washington, Energy and Environment Seminar (EE500E), Seattle, WA.
- Palmintier, B.** (2010, September 22). *It's Not Just the Energy: Ancillary Services and a peek behind the scenes for electric power systems*. MIT, Modeling of Electric Power Systems (ESD.865) Guest Lecture, Cambridge, MA.
- Palmintier, B.** (2009, April 16). *Efficiency 101*. MIT Energy Club Lecture Series, MIT, Cambridge, MA.
- Palmintier, B.** (2008, July 10). *Systems Thinking*. University of Colorado. (School of Education, Mathematics Knowing for Equitable Teaching) Guest Lecture. Boulder, CO.
- Palmintier, B.** (2001). *Emerald Nanosatellite Data Architecture*. Stanford University, Aerospace Data Systems Course (AA254) Guest Lecture, Stanford, CA.

Posters

- Palmintier, B.** (2013, April). "Efficient, Open Methods for Assessing High-Penetration Solar Photovoltaic as (Re)Active Participants in Electric Distribution Systems." Presented at the EERE Postdoctoral Research Awards Annual Meeting, Golden, CO.
- Palmintier, B.** (2011, November). "Stochastic Energy Planning with Operations Constraints: Methods for assessing flexibility during advanced electric power design and policy analysis." Engineering Systems Poster Session, Cambridge, MA.
- Palmintier, B.** (2010, November). "Energy Planning Under Multi-timescale Uncertainty: Designing advanced electric power systems with intermittent renewables, storage, and demand-side resources." Engineering Systems Poster Session, Cambridge, MA.
- Palmintier, B.** (2009, November). "Evaluating Resources for Balancing Renewables: A Clean Energy Screening Model for Planning and Operations Under Uncertainty." Engineering Systems Poster Session, Cambridge, MA.
- Palmintier, B.** (2009, October). "Integrating Large Quantities of Renewables: How Can Demand Help?" MIT Energy Night 2009, Cambridge, MA.
- Palmintier, B.** (2009, May). "Demand Options for Ensuring Electric Power System Performance with Very High Levels of Renewables." Second Transatlantic Renewable Energy Conference, Angra do Heroísmo, Terceira, Açores, Portugal.
- Suomalainen, K., **Palmintier, B.**, Connors, S., & Silva, C. (2009, January). "Azores Green Islands: Looking at Demand." Alliance for Global Sustainability Conference, Zürich, Switzerland.

Amorim, F., **Palmintier, B.**, & Pina, A. (2009, January). "Renewables for Azores Green Islands - how big can we go?" Alliance for Global Sustainability Conference, Zürich, Switzerland.

Selected Other Publications

Schewel, L., Brylawski, M., Wang, K., Simpson, M., Gately, M., Senft-Grupp, S., **Palmintier, B.**, et al. (2008). *Smart Garage Charrette Pre-Read*. Rocky Mountain Institute.

Buhayar, N., & **Palmintier, B.** (2008, May 30). Rethinking the cost of hybrid cars. *Yahoo! Green | Environmental Lovins*. On-line at <http://green.yahoo.com/blog/amorylovins/43/rethinking-the-cost-of-hybrid-cars.html>.

Palmintier, B. (2007, November 15). How your future car could help add power back to the grid. *Yahoo! Green | Environmental Lovins*. On-line at <http://green.yahoo.com/blog/amorylovins/16/how-your-future-car-could-help-add-power-back-to-the-grid.html>.

Swartwout, M., Twigg, R., Kenny, T., Kitts, C., Batra, R., **Palmintier, B.**, et al. (1998). *The Sapphire Project: Mission Overview, Design Description, Launch and Orbit Information*.