ARTHUR K. BARNES

123 Grand Canyon Dr
White Rock NM, 87547

Mobile: 479-530-8117
artbarnes@ieee.org

SUMMARY

- Ph.D., electrical engineering
- Created a probabilistic model for PV intermittency
- Developed a computationally efficient method for placing energy storage or other shunt-connected devices on an electrical distribution system
- Introduced methods to integrate local voltage regulators into a distribution system
- Designed and tested a novel switched-capacitor topology in hardware
- Experience with C/C++, GNU Toolchain, Java, TI Code Composer, TI C2000/C6000
- Skilled in Matlab/Simulink, CYMDIST, OpenDSS, Gridlab-D, C/C++, Visual Studio 2013/C#

EDUCATION

Ph.D., Electrical Engineering, University of Arkansas at Fayetteville
- Graduated: December 2014, GPA, 3.6
- Degree focus: Power electronics/power systems
- Research focus: Energy storage, microgrids, distributed generation, renewables integration
- Advisor: Dr. Juan Carlos Balda

M.S., Electrical and Computer Engineering, University of Florida at Gainesville
- Graduated: May 2007, GPA: 3.84
- Degree focus: Signal processing/machine learning
- Advisor: Dr. Paul D. Gader

B.S., Electrical and Computer Engineering, University of Colorado at Boulder
- Graduated: May 2003, GPA: 3.32
- Degree focus: Embedded systems

RESEARCH EXPERIENCE

Effects of Geomagnetic Disturbances on Transformer Heating
Los Alamos National Laboratory, October 2016 to present

- Objective is to create analysis in order to quantify the effects of space weather events on the North American electrical grid
- Developed quasi-dynamic coupled ac and dc optimal power flow model in Julia with line and generator breaker tripping
- Model accepts as input induced line voltages from a nonlinear magnetic field and breaker failures resulting from high-frequency electromagnetic pulses
- Developed dynamic transformer heating model is coupled to optimal power flow results to predict transformer damage

Cyber-Physical Security of Building Automation Systems
Los Alamos National Laboratory, March 2016 to August 2017

- Objective is to detect actions of an intruder in a cyber-physical system during the exploratory phase of attack in order to secure the system before the attack occurs
- Applies time-series correlation methods to avoid having the detection method strongly coupled to properties of the controlled physical plant
- Developed Python-based intrusion software framework to operate via BACNET with the heating ventilation and air-conditioning (HVAC) system of a large office building

Resilient Microgrid Design
Los Alamos National Laboratory, January 2016 to January 2017

- Objective is to create a tool to design microgrids by selecting from a portfolio of generation sources, storage and line options
- Developed a single-phase test network based on the electrical model of a small Northern New Mexico town
- Developed a Python-based framework for calculating component impedances given an electrical model with line geometries, conductor types and transformer types specified

Resilient Distribution System Design
Los Alamos National Laboratory, January 2016 to present

- Objective is to create a tool to upgrade a distribution system to improve resilience to severe weather events by investing in an optimal combination of line hardening and microgrid installations
- Constructed a 1200-node test network from the electrical model of a physical Northeast distribution system
- Modified existing C++-based resilient design tool to accept input from physical, unbalanced distribution systems

Outage Forecasting
Los Alamos National Laboratory, November 2016 to present

- Objective is to create a tool to predict peak customer outages on a distribution system given aggregate information about the distribution system, region and storm parameters
- Developed tool to extract outaged transformer raster given the electrical model of physical Northeast distribution system and outage records

Integrating Energy Storage into a Future Distribution System
Department of Electrical Engineering, University of Arkansas, November 2010 to December 2014

- Objective is to integrate energy storage into a distribution system in the most-cost effective manner to maintain voltage regulation within limits and reduce conduction losses
- Considering ability of photovoltaic inverters and energy storage to coordinate with each other
- Using both linear and mixed-integer nonlinear optimization, optimal power flow, nonlinear regression, dimensionality reduction, and clustering methods

Modeling of Cloud-Induced Photovoltaic Intermittency
Department of Electrical Engineering, University of Arkansas, November 2010 to August 2014

- Objective is to develop a probabilistic model of photovoltaic intermittency suitable for use in simulation, forecasting, and stochastic optimization problems
- Using both unsupervised and Bayesian classification to predict the clear-sky irradiance profile and detect clouding events
- Represents intermittency with a discrete-time semi-Markov random process model

Integrating Local Voltage Regulators into a Distribution System
Gridco, spring 2013 to spring 2014

- Objective is to place local voltage regulators in a distribution system to maximize power savings gained by conservation voltage reduction
- Developed an application in Matlab and Gridlab-D to place the local voltage regulators using a greedy heuristic and evaluate the savings gained under peak and nominal conditions

Evaluating the Impact of Distributed Photovoltaic Generation

Gridco, spring 2012 to spring 2013

- Objective is to quantify secondary voltage rise caused by distributed photovoltaic generation
- Developed an application in Matlab based on analytical formulas
- Applied the Matlab application to identify problem scenarios

Coordination of Energy Storage with Diesel Synchronous Generation
Department of Electrical Engineering, University of Arkansas, November 2009 to November 2010

- Objective is to coordinate energy storage with an existing backup diesel genset in order to improve voltage and frequency regulation on a tightly-coupled microgrid
- Diesel genset is normally used for backup purposes, but can be used grid-paralleled, potentially with the energy storage for peak shaving and improving power quality
- Focused on modeling of electrical machinery and development of control algorithms

Smoothing of Photovoltaic Generation Power Ramp-Rates with Energy Storage
Sandia National Laboratories, June 2009 to August 2009

- Objective is to develop a model of an energy storage system and use it to maintain power ramp-rates within those specified by interconnect requirements
- Focused on modeling and control of an energy storage system

Multilevel Switched-Capacitor Boosting Inverter
Department of Electrical Engineering, University of Arkansas, August 2008 to August 2010

- Objective is to eliminate bulky magnetics in the dc-dc converter or transformer of the power electronics interface for an electric vehicle or grid-connected energy storage system
- Developed and tested a novel switched-capacitor topology in hardware

Testing of Silicon Carbide Integrated Power Modules
Department of Electrical Engineering, University of Arkansas, May 2008 to August 2008

- Objective is to characterize SiC integrated power modules
- Performed data collection and produced a datasheet

Classification with Sparsity-Promoting Hierarchical Probit Models
Department of Computer Science, University of Florida, May 2006 to December 2006

- Objective is to classify data with a high-dimensional feature space such as ground-penetrating radar or microarray data
- Developed a classifier using Markov-chain Monte Carlo training, requiring efficient software implementation due to the high number of iterations used

PROFESSIONAL EXPERIENCE

Power Systems Engineer, Los Alamos National Laboratory, spring 2016 to present

- Developed coupled ac optimal power flow and geomagetically induced current solver for steady-state and quasi-steady-state analysis
- Developed Python-based self-hosted framework for performing demand response and cyber-physical security tests

Proprietor, Ozark Electric Design, spring 2014 to present
Developing IoT-based system for closed-loop irrigation of commercial substrate agriculture

Power Systems Engineer, Gridco, Boston, spring 2012 to spring 2014

- Developed methods to integrate local voltage regulators into a distribution system to maximize savings from conservation voltage reduction
- Analyzed voltage rise resulting from "smart" distributed photovoltaic generation in the OpenDSS software environment
- Developed a detailed, stateful load-flow model of a local voltage regulator for the Gridlab-D software package
- Designed an analog interface board for a hardware-in-the-loop simulation
- Analyzed secondary voltage rise resulting from distributed photovoltaic generation

RA, National Center for Reliable Electric Power Transmission, University of Arkansas, spring 2008 to spring 2012

- Constructed and tested a prototype for a novel multilevel inverter topology

- Developed methods to integrate energy storage into a distribution system with high photovoltaic penetration

Intern, Sandia National Laboratories, Albuquerque, summer 2009

- Simulated the impact of energy storage for mitigating the effects on intermittent generation on power quality on an islanded electrical grid
- Designed an output filter for a high-temperature single-phase inverter

RA, Landmines Lab, University of Florida, fall 2004 to fall 2006

- Designed a sparsity-promoting algorithm for landmine detection using edge histograms with 3D ground-penetrating radar data
- Designed a multiclass classifier using dynamic time warping and resonant ultrasound spectroscopy

Grader, Discrete-Time Signals and Systems, University of Florida, spring, summer semesters 2004
Grader, Electromagnetic Fields and Waves, University of Florida, fall 2003

SUPERVISING EXPERIENCE

Evaluating the Performance of Maximum Power-Point Tracking (MPPT)

- Supervised two students for Freshman Engineering Program Honors Research Symposium
- Objectives are to learn about the concepts behind photovoltaic cells and inverters, data acquisition systems, and maximum power-point tracking
- Designed an experiment using captured irradiance data and photovoltaic panel data-sheet parameters to compare the energy captured with a constant-voltage MPPT vs. energy captured using suboptimal voltages in addition to an ideal MPPT

Analytical Methods for Placement of Energy Storage

- Supervised a Research Experience for Undergraduates (REU) student for the fall 2011 semester developing analytical methods to place energy storage for voltage regulation
- Objective is to determine the optimal location to minimize voltage drop on a single feeder given either uniform or centralized load distributions.

Deterministic Methods for Placement of Energy Storage

- Supervised a Research Experience for Undergraduates (REU) student for the fall 2011 semester investigating methods to place energy storage without requiring the use of random search
- Produced a literature review of methods employed, including dynamic programming, linear programming, sequential quadratic programming, clustering, and multidimensional scaling
- Conclusion is that clustering methods can offer a good sub-optimal solution at a much lower computational cost

Photovoltaic Data Collection

- Supervised a Research Experience for Undergraduates (REU) student over the spring 2011 and summer 2011 semesters developing a data acquisition system for photovoltaic installations
- Produced specifications and schedule for the development of a Labview-based data logging system
- Designed and supervised testing of an Enphase microinverter
- Supervised installation of irradiance and temperature sensors for a roof-mounted photovoltaic array

Photovoltaic Generation for Grid-Connected Applications

- Supervised a Research Experience for Undergraduates (REU) over the summer 2011 semester studying grid-connected photovoltaics
- Produced schedule for reports, procured supplies, and assisted with construction of a solar robot

Website Design

- Supervised an hourly student to develop a website for the Sustainable Smart Electrical Energy Systems research group over the spring 2011 and summer 2011 semesters
- Coordinated with the website developer and students to develop specifications and collect content for the website

Real-Time Hardware Platform

- Supervised a Research Experience for Undergraduates (REU) student over the fall 2010 semester assembling a Mathworks xPC Target-based real-time hardware platform
- Provided specifications, schedule and technical assistance

LEADERSHIP AND AWARDS

Vice President of IEEE Student Chapter, fall 2008 to fall 2009
Bradley Fellow
Secretary of CU Robotics Club, fall 2001 to spring 2003
High School Honors Institute group leader, summers of 2001 and 2002
Engineering Ambassadors, spring 2002 to spring 2003
Recipient of Gladys and Francis O'Kelly senior merit scholarship
Softpro scholarship recipient

PROFESSIONAL ORGANIZATIONS

IEEE, 2004 to present
IEEE Power & Energy Society, 2011 to present
IEEE Power Electronics Society, 2007 to present
Utility Arborist Association, 2014 to present

PROFESSION EDUCATION

IEEE Power & Energy Society Boston Chapter, Transformer Course

COMPUTER SKILLS

C/C++, GNU Toolchain, Java, Matlab/Simulink, Python, PSpice, CYMDIST, OpenDSS, Gridlab-D, Javascript/jQuery, Visual Studio 2013/C#

LANGUAGES

English (native speaker)
Spanish (conversational)

PRESENTATIONS AND PUBLICATIONS

Primary Author (reverse chronological order):

[1] A.K. Barnes, J.C. Balda,, and L.A. Garcia Rodriguez, "Complexity analysis and verification of real-time operation for a semi-Markov process model of photovoltaic intermittency," to be presented in *IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, Aachen, Germany, 2015.

[2] A.K. Barnes, J.C. Balda, and A. Escobar Mejía, "A semi-Markov model for control of energy storage in utility grids and microgrids with PV generation," *IEEE Transactions on Sustainable Energy*, vol.6, no.2, pp. 546–556, April 2015.

[3] A.K. Barnes and J.C. Balda, "Placement of distributed energy storage via multidimensional scaling and clustering," in *International Conference on Renewable Energy Research and Applications (ICRERA)*, Milwaukee, WI, 2014.

[4] A.K. Barnes, J.C. Balda, and J.K. Hayes, "Modeling PV clouding effects using a semi-Markov process with application to energy storage," in *International Federation of Automatic Control World Congress (IFAC)*, Cape Town, South Africa, 2014.

[5] A.K. Barnes, J. Simonelli, "Numerical analysis of voltage regulation via smart PV inverters," in *IEEE PES General Meeting (GM)*, Washington, DC, 2014.

[6] A.K. Barnes, V. Martinelli, A. Kam, H. Wrede, J. Simonelli, "Load-flow modeling of a three-phase local voltage regulator" in *International Conference and Exhibition on Electricity Distribution (CIRED)*, Rome, 2014.

[7] A.K. Barnes, V. Martinelli, and J. Simonelli, "A local voltage regulator that improves energy savings under Advanced Volt-Var Control," in *IEEE PES Transmission and Distribution Conference (T&D)*, 2014, pp. 1–5.

[8] A.K. Barnes and J. Simonelli, "Improvement of conservation voltage reduction energy savings via local voltage regulation," in *IEEE Energy Conversion Congress and Exposition (ECCE)*, 2013, pp. 2257–2263.

[9] A.K. Barnes and J.C. Balda, "Sizing and economic assessment of energy storage with real-time pricing and ancillary services," in *IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, Fayetteville, AR, 2013, pp. –7.

[10] A.K. Barnes, J.C. Balda, A. Escobar Mejía, and S.O. Geurin, "Placement of energy storage coordinated with smart PV inverters," in *IEEE PES Innovative Smart Grid Technologies (ISGT)*, 2012, pp. 1–7.

[11] A.K. Barnes, J.C. Balda, and C.M. Stewart, "Selection of converter topologies for distributed energy resources," in *IEEE Applied Power Electronics Conference and Exposition (APEC)*, 2012, pp. 1418–1423.

[12] A.K. Barnes, J.C. Balda, S.O. Geurin, and A. Escobar Mejía, "Optimal battery chemistry, capacity selection, charge/discharge schedule, and lifetime of energy storage under time-of-use pricing," in *IEEE PES Innovative Smart Grid Technologies Europe (ISGT-EU)*, 2011, pp. 1–7.

[13] A.K. Barnes and J.C. Balda, "Implementation of a three-phase multilevel boosting inverter using switched-capacitor converter cells," in *IEEE Energy Conversion Congress and Exposition (ECCE)*, 2010, pp. 2141–2147.

Contributing Author (reverse chronological order):

[14] A. Kam, A. Barnes, V. Martinelli, H. Wrede, J. Simonelli, "Optimal placement of an inline voltage regulator on a secondary distribution system," in *International Conference and Exhibition on Electricity Distribution (CIRED)*, Rome, 2014.

[15] A. Johnson, A. Escobar Mejía, J.C. Balda, and A.K. Barnes, "Wind farm layout for mitigating output power intermittency," in *IEEE International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, 2012, pp. 883–889.

[16] S.O. Geurin, A.K. Barnes, and J.C. Balda, "Smart grid applications of selected energy storage technologies," in *IEEE PES Innovative Smart Grid Technologies (ISGT)*, 2012, pp. 1–8.

[17] A. Escobar Mejía, J.C. Balda, J. Bourne, A.K. Barnes, and R.M. Schupbach, "Enhancing power quality on distribution systems with fault-current limiters," in *IEEE PES Innovative Smart Grid Technologies (ISGT)*, 2012, pp. 1–5.