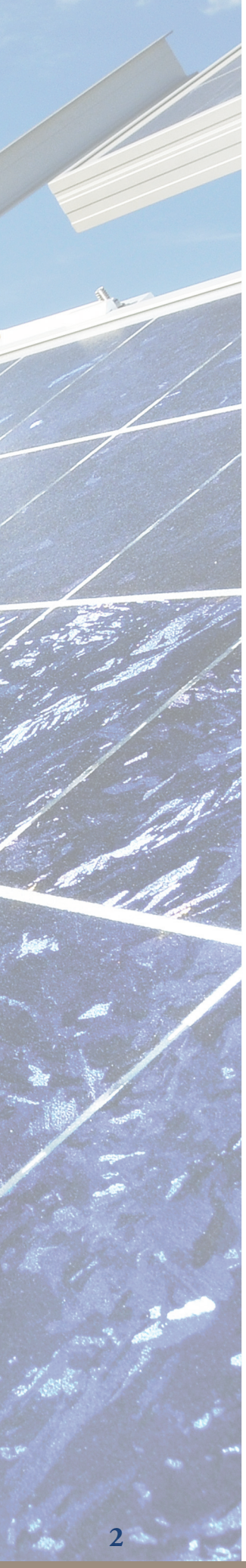
Abraham Ellis

SAND2015-4406C

Sandia National Laboratories

HENAAC 2015 NOMINATION



HENAAC 2015 - Abraham Ellis

NOMINATOR	Dr. Paul J. Hommert
Title	President and Laboratories Director
Organization	Sandia National Laboratories
Email	pjhomme@sandia.gov
Phone	505-844-7261
Fax	505-844-1120
Address	PO Box 5800, MS 0101, Albuquerque, NM 87185-0101
NOMINEE	Dr. Abraham Ellis
Nominee title	Distinguished Member of Technical Staff & Acting Manager
Organization	Photovoltaic and Distributed Systems Department
Award category	Outstanding Technical Achievement
Nominee email	aellis@sandia.gov
Nominee phone	505-844-7717
Nominee fax	505-284-3139
Nominee address	PO Box 5800, MS 1033, Albuquerque, NM 87185-1033
Undergraduate	New Mexico State University
Degree & major	B.S., electrical engineering, power systems
Graduate school	New Mexico State University
Degree earned	M.S., electrical engineering, power systems
Graduate school	New Mexico State University
Degree earned	Ph.D., electrical engineering, power systems
Years of professional experience	19
Ethnicity	Hispanic

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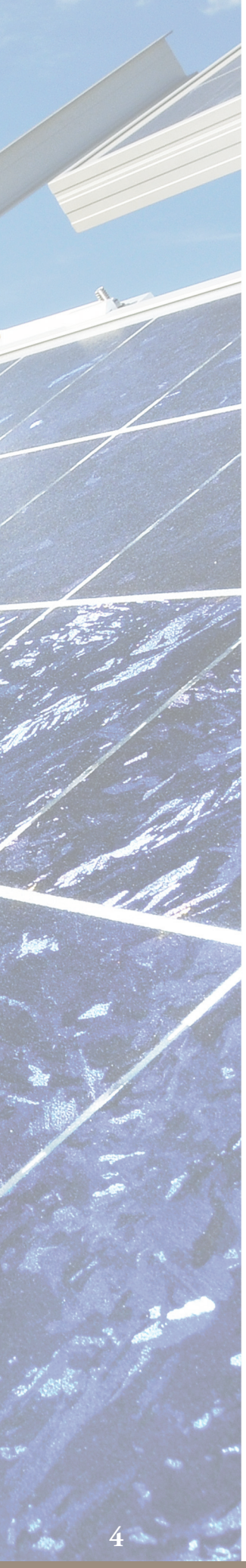

Nomination Letter

Exceptional service in the national interest

Sandia National Laboratories

Operated for the U.S. Department of Energy by **Sandia Corporation**

Dr. Paul J. Hommert
President and Laboratories Director

P.O. Box 5800, Albuquerque, NM 87185-0101
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May 27, 2015

HENAAC Award Selection Committee
Great Minds in STEM
602 Monterey Pass Road
Monterey Park, CA 91754

Dear HENAAC Selection Committee:

Subject: Nomination of Dr. Abraham Ellis for the 2015 HENAAC Outstanding Technical Achievement Award

I am proud to introduce this year's nominee from Sandia National Laboratories for the 2015 HENAAC Outstanding Technical Achievement Award. This nominee stands at the top of his field in both technical excellence and leadership on the job and in the community. He is among the best of the best at a national laboratory that is internationally recognized as being at the forefront of science and engineering.

I am nominating Dr. Abraham Ellis in recognition of his exceptional leadership, distinguished record of technical accomplishment, and personal commitment to Sandia and his community. Dr. Ellis continually demonstrates integrity, technical knowledge, innovative thinking, excellent communication skills, and superb leadership, especially in nurturing the development of scientists and engineers while serving as a role model through his own impressive research accomplishments.

Dr. Ellis is currently a Distinguished Member of Technical Staff, an honor reserved for less than 10% of Sandia's research staff. For the last 12 months, he also has served as acting manager of Sandia's Photovoltaic and Distributed Systems Department. As manager, he leads a $15 million-a-year program to develop advanced solar and wind energy technologies. Over the last six years, he has played a central role in defining this new and critical research program for Sandia while helping to resolve major problems associated with the integration of renewable energy systems into the electric power grid.

His impactful work at Sandia builds on a national reputation he earned while he was assigned to special projects in transmission planning and engineering at the Public Service Company of New Mexico (PNM). Integrating wind and solar power into the existing power grid presented special problems, and Dr. Ellis was among the first to recognize and begin to resolve these problems through both new performance standards and computer modeling approaches to understanding grid performance. His leadership in forming and leading multi-organization problem-solving

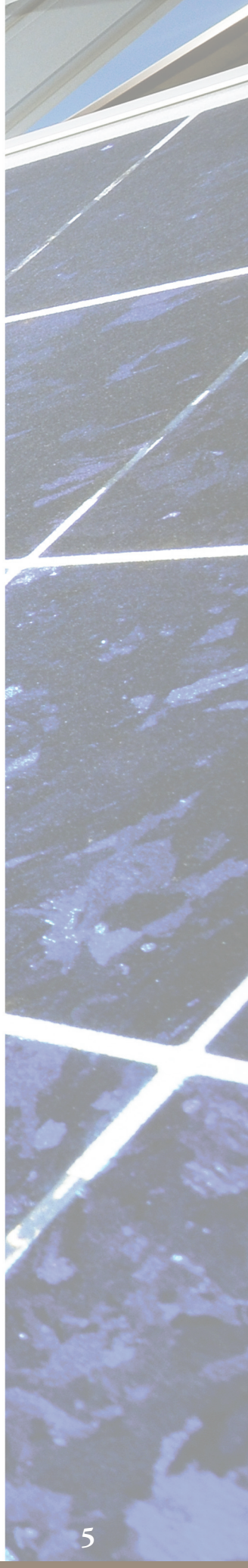
groups thrust him into the national spotlight, and he remains today a national leader in grid integration of renewable energy technologies. In 2003, largely as a result of his work, PNM began operating what was then the largest wind farm in the U.S. and the first directly connected to the ultra-high voltage transmission system.

Dr. Ellis's commitment and service to the community has been a hallmark of his career and began very early, during high school in Panama, when he organized and led school and community groups. During graduate school at New Mexico State University, he worked on a program to address development problems by bringing renewable energy systems to rural areas of Mexico and Central America. Later, while at PNM, he volunteered to serve on the Speakers' Bureau, bringing low-income Spanish-speaking families information about home ownership, working with utilities, and weatherizing homes. He also volunteered for the Junior Achievement Program through the Albuquerque Public Schools, mentoring Hispanic youth. He coached a soccer team and led a Cub Scout troop – both Spanish-speaking. He advised the Northern New Mexico College, a Hispanic-serving institution. At Sandia he helped organize the 2007 International Science and Engineering Fair in Albuquerque and was a judge for the New Mexico Science Fair, striving to give New Mexico youth positive experiences in science and technology. Today he mentors and serves as an exemplary role model for members of his staff and other Sandia employees.

Abraham Ellis is an exceptional candidate for the 2015 HENAAC Outstanding Technical Achievement Award, and it is with great pleasure that I endorse his nomination.

Sincerely,

Dr. Paul Hommert
President and Laboratories Director
Sandia National Laboratories



Résumé

EDUCATION

New Mexico State University, 1987-2000

- Ph.D., Electrical Engineering, Power Systems, 2000
- M.S., Electrical Engineering, Power Systems, 1995
- B.S., Electrical Engineering, Power Systems, 1993

RESEARCH AND PROFESSIONAL EXPERIENCE

2008-Present, Sandia National Laboratories, Albuquerque, NM

- Organization: Photovoltaic and Distributed Systems Department
- Titles: Acting Manager, Distinguished Member of the Technical Staff, and Principal Investigator & Project Manager for renewable energy integration and grid modernization R&D projects
- Research: Technical lead for photovoltaic grid integration, transmission, and distribution; research in wind, hydro, and energy storage; research in distribution and transmission system modeling and simulation; analysis of power systems electrical performance; power systems operations.
- Leadership: Coordination of national efforts on photovoltaics and wind modeling; active participation in standards development within IEEE and NERC (North American Electric Reliability Corporation); engagement with technical activities at the international level, such as International Electrotechnical Commission (IEC) Technical Committee 88 (TC88) Work Group 27 (WG27) (wind plant modeling, chairman of the U.S. delegation) and International Energy Agency (IEA) Task 14 (high penetration photovoltaics).

2000-2008, Public Service Company of New Mexico (PNM), Albuquerque, NM

- Organization: Transmission Planning and Operations Department
- Title: Principal Engineer
- Research: Interconnection studies of proposed large-scale generation, particularly wind and solar; assessment of transmission grid performance for compliance with NERC and WECC (Western Electricity Coordinating Council) reliability standards as part of long-term transmission planning process; special projects such as renewables integration studies, deployment of phasor measurement unit (PMU) networks, analysis of Flexible AC Transmission Systems (FACTS) devices, and advanced load modeling.
- Leadership: Served as representative to WECC Transmission Studies Subcommittee and WECC Modeling and Validation Working Group; member or chairman of several WECC task forces.

1995-2000, Southwest Technology Development Institute, Las Cruces, NM

- Title: Senior Engineer
- Research: Responsible for developing custom hardware and software for monitoring of

off-grid and grid-connected photovoltaic and wind systems; responsible for analysis of photovoltaic and wind plant performance.
- Conducted seminars and demonstrations in several Latin American countries (Mexico, Guatemala, Honduras, Dominican Republic, Panama, Brazil, and Bolivia) on application of renewable energy technologies to rural development, including water pumping for irrigation and drinking and community/village power.

SELECTED LEADERSHIP ACTIVITIES

- Chair and founder, WECC Renewable Energy Modeling Group and Renewable Energy Modeling Task Force, 2005-present
- Chair, WECC Modeling and Validation Working Group, 2005-2009
- Chair and founder, HVDC/SVC Modeling Task Force, 2009
- Chairman, U.S. national delegation to IEC WG27 TF88 (wind models), 2011-present
- Chairman, IEEE Dynamic Performance of Wind Power Generation Working Group, 2009-2011
- Chairman, Utility Variable-generation Integration Group (UVIG) Distributed Generation Users Group, 2011-present (solar generation performance standards, simulation tools, and system impacts studies)
- Editor, *IEEE Transactions on Sustainable Energy*, Vol. 4, No. 2, April 2013, a journal focusing on renewable energy generation and system integration
- Responsible for multiple Cooperative Research and Development Agreements (CRADAs) with various utilities and research organizations
- Coordinator for Sandia's international collaboration with DERlab (European consortium of renewable and smart grid laboratories) and NEDO (Japan)

SELECTED HONORS

- Scientific Committee Chairman, International Conference on Integration of Renewable and Distributed Energy Resources, Albuquerque 2010 and Berlin 2012
- Conference Co-Chair, 5th International Conference on Integration of Renewable and Distributed Resources, Berlin 2012
- Invited author, "Generic Wind Power Plant Models," chapter in *Wind Power in Power Systems*: *Second Edition* (Ackerman, editor), Wiley 2012
- IEEE Power and Energy Society Prized Paper Award, "Blackout Experiences and Lessons, Best Practices for System Dynamic Performance, and the Role of New Technologies," 2009
- UWIG Achievement Award for "Significant Contributions to the Advancement of the State of the Art in Wind Generation Engineering," 2006
- Sandia National Laboratories 2014 Employee Recognition Award for Individual Leadership, for the New Jersey rail project and industry impact in grid modernization
- Finalist, 2014 International Smart Grid Action Network (ISGAN) Award of Excellence, for full-scale field demonstration related to the Mesa del Sol Smart Grid Demonstration Project, 2014
- Distinguished Speaker, New Mexico Academy of Science, 2014
- New Mexico State University Globalization Award, for significant contributions to the international projection of NMSU, 2000

MEMBERSHIPS

- Senior Member, IEEE Power and Energy Society
- Professional Engineer License, State of New Mexico
- Affiliated Faculty and Member of the Graduate Faculty, Klipsch School of Electrical and Computer Engineering, New Mexico State University

SERVICE AND VOLUNTEERISM

- Volunteer Speaker, Speakers Bureau, Public Service Company of New Mexico, provided outreach to low-income, Spanish-speaking community members on topics such as home ownership, working with utilities, and weatherizing homes, 2002-2008
- Volunteer, Junior Achievement Program, Albuquerque Public Schools, provided outreach to Hispanic youths, 2002-2005
- Member, External Advisory Committee, IT/ME Department, Northern New Mexico College, a Hispanic-serving institution, 2012-2013
- Volunteer Member, Organizing Committee, International Science and Engineering Fair, 2007
- Volunteer Judge, New Mexico Science Fair, Central Region, 2002-2008
- Volunteer, New Mexico Solar Fiesta, 2003-2009
- Soccer Coach (Spanish language), for under-represented Hispanic and other minority children, Las Cruces and Albuquerque, NM, 1998-2007
- Cub Scout Troop Leader (Spanish language), for under-represented Hispanic and other minority children, 2002-2006
- Volunteer musician (percussion) and coordinator of the volunteer sound tech team supporting worship services and community events, 2011-present

TUTORIALS & WORKSHOPS CHAIRED

- "Tutorial on Microgrids for Resilience Applications," Kyoto, Japan, November 2014.
- "WECC 2014 Renewable Energy Modeling Workshop," Salt Lake City, UT, June 2014. Conducted by the WECC Renewable Energy Modeling Task Force (REMTF).
- "WECC Renewable Energy Modeling Workshop," Salt Lake City, UT, June 17, 2012. Conducted by the WECC Renewable Energy Modeling Task Force (REMTF) and Modeling and Validation Work Group (MVWG).
- "Fundamentals of Wind Energy," IEEE Power Systems Conference and Exposition, Phoenix, AZ, 2011. Dynamic Performance of Wind Power Generation Working Group.
- "Tutorial on Wind Generator Modeling and Controls," IEEE Dynamic Performance of Wind Power Generation Working Group.
- WECC – 2009 Generator Model Validation Workshop, held at Tristate Generator and Transmission Association, Westminster, CO, May 18-19, 2009. Conducted by the WECC Wind Generator Modeling Group.
- "WECC – 2009 Modeling Workshop for Planning Engineers," San Francisco, CA, April 16–17, 2009. Conducted by the WECC Wind Generator Modeling Group.
- "Wind 101: Tutorial on Fundamentals of Wind Energy," IEEE PES General Meeting, Calgary, Canada, July 26, 2009.
- "Tutorial on Wind Generation Modeling and Controls," IEEE PSCE Conference, Seattle, WA, March 2009. Conducted by the Dynamic Performance of Wind Power Generation Task Force (DPWPGTF).
- "Wind Energy Boot Camp," Albuquerque, NM, Nov. 12-14, 2008. Conducted by New Mexico State University, PNM, and the National Renewable Energy Lab.
- "Tutorial on Wind Generation Modeling and Controls," IEEE PES General Meeting, Pittsburgh, PA, July 2008. Conducted by the IEEE Dynamic Performance of Wind Power Generation Task Force.
- "WECC 2006 Modeling Workshop," Las Vegas, NV, June 14-15, 2006. Conducted by the WECC Modeling and Validation Working Group.
- Organizer of several workshops on grid modernization, microgrids, advanced inverter testing, and renewables grid integration.

PUBLICATIONS

- A. Ellis, R. Jeffers, J. Henry, K. Jones, N. Jaramillo, "NJ TRANSITGRID Feasibility Study Phase 2," Sandia National Laboratories Report SAND2014-TBD (OUO), February 2015.
- K. Jones, A. Ellis, J. Durfee, C. Frazier, L. Nozick, A. Sorensen, R. Jeffers, "Resilience-based Performance Optimization Analysis Capability," Sandia National Laboratories Report SAND2014-TBD (OUO), December 2014.
- R. Elliott, R. Byrne, A. Ellis, L. Grant, "Impact of increased photovoltaic generation on inter-area oscillations in the western North American power system," 2014 IEEE Power and Energy Society (PES) General Meeting, Washington, DC, July 2014.
- E. Muljadi, A. Ellis, "Western Electricity Coordinating Council Wind Model Development," California Energy Commission Report CEC-500-2014-043-AP, May 2014.
- A. Ellis, et al., "WECC Wind Power Plant Dynamic Modeling Guide," prepared by the WECC Renewable Energy Modeling Task Force, April 2014.
- A. Ellis, D. Bhatnagar, R. Guttromson, J. Ellison, D. Robinson, "NJ TRANSITGRID Feasibility Study," Sandia National Laboratories Report SAND2014-1100, February 2014.
- J. Johnson, A. Ellis, Denda, K. Morino, J. Hawkins, B. Arellano, T. Shinji, T. Ogata, M. Tadokoro, "Experimental Comparison of PV-Smoothing Controllers using Distributed Generators," Sandia National Laboratories Report SAND2014-1546, February 2014.
- A. Ellis, D. Bhatnagar, R. Guttromson, J. Ellison, D. Robinson, J. Henry, "NJ TRANSITGRID Feasibility Study," Sandia National Laboratories Report SAND2014-1100 (OUO), February 2014.
- T. Ackerman, A. Ellis, et al., "Code Shift - Grid Specifications and Dynamic Wind Turbine Models," *IEEE Power and Energy Magazine*, November/December 2013.
- J. Johnson, S. Gonzalez, M. Ralph, A. Ellis, R. Broderick, "Test Protocols for Advanced Inverter Interoperability Functions – Main Document," Sandia National Laboratories Report SAND2013-9880, November 2013.
- J. Johnson, S. Gonzalez, M. Ralph, A. Ellis, R. Broderick, "Test Protocols for Advanced Inverter Interoperability Functions – Appendices," Sandia National Laboratories Report SAND2013-9875, November 2013.
- M. Lave, A. Ellis, J. Stein, "Simulating Solar Power Plant Variability: A Review of Current Methods," Sandia National Laboratories Report SAND2013-4757, November 2013.
- A. Mammoli, A, Menicucci, T. Caudell, A. Ellis, S. Willard, J. Simmins, "Low-Cost Solar Micro-Forecasts for PV Smoothing," IEEE-USA Annual Meeting & SusTech Conference, Portland, OR, August 2013.
- P. Pourbeik, A. Ellis, J. Sanchez-Gasca, Y. Kazachkov, E. Muljadi, J. Senthil, D. Davies, "Generic Stability Models for Type 3 & 4 Wind Turbine Generators for WECC," Proceedings of the 2013 IEEE Power and Energy Society General Meeting, British Columbia, Canada, July 2013.
- J. Schoene, V. Zheglov, D. Houseman, J. Smith, A. Ellis, "Photovoltaics in Distribution Systems - Integration Issues and Simulation Challenges," Proceedings of the 2013 IEEE Power and Energy Society General Meeting, British Columbia, Canada, July 2013.
- A. Ellis, S. Gonzalez, Y. Miyamoto, M. Ropp, D. Schutz, T. Sato, "Comparative Analysis of Anti-Island Requirements and Test Procedures in the United States and Japan," Proceedings of the 39th IEEE Photovoltaic Specialist Conference, Tampa, FL, June 2013.
- M. Behnke, A. Ellis, "Contribution of Photovoltaic Generation to AC Short

Circuits – A Survey of Current Modeling Practices and Challenges," Proceedings of the 39th IEEE Photovoltaics Specialists Conference, Tampa, FL, June 2013.

- T. Lindl, K. Fox, A. Ellis, R. Broderick, "Integrated Distribution Planning Concept Paper," published by Interstate Renewable Energy Council, Inc., May 2013.
- J. Johnson, A. Ellis, Denda, K. Morino, T. Shinji, T. Ogata, M. Tadokoro, "PV Output Smoothing Using a Battery and Natural Gas Engine-Generator," Sandia National Laboratories Report SAND2013-1603, February 2013.
- M. Lave, J. Kleissl, A. Ellis, F. Mejia, "Simulated PV Power Plant Variability: Impact of Utility-imposed Ramp Limitations in Puerto Rico," Sandia National Laboratories Report SAND2013-4926C, 2013.
- R. Broderick, J. Quiroz, M. Reno, A. Ellis, J. Smith, R. Dugan, "Time Series Power Flow Analysis for Distributed Connected PV Generation," Sandia National Laboratories Report SAND2013-0537, 2013.
- Y. Miyamoto, T. Sato, M. Ropp, S. Gonzalez, A. Ellis, "Anti-islanding Technology for High-Penetration Residential PV Systems," CIGRE – SC C6 Colloquium on Distribution Systems and Dispersed Generation, Yokohama, Japan, 2013.
- A. Ellis, P. Pourbeik, "WECC solar PV dynamic model specification," Western Electricity Coordinating Council Report, September 2012.
- W. Price, A. Ellis, "CMPLDWD: Composite Load Model with Photovoltaic Distributed Generation," WECC Renewable Energy Modeling Task Force, July 2012.
- A. Ellis, R. Nelson, E. Von Engeln, R. Walling, J. MacDowell, L. Casey, E. Seymour, W. Peter, C. Barker, B. Kirby, J. Williams, "Reactive Power Performance Requirements for Wind and Solar Plants," Proceedings of the 2012 IEEE Power and Energy Society General Meeting, San Diego, CA, July 2012.
- A. Ellis, R. Nelson, E. Von Engeln, R. Walling, J. MacDowell, L. Casey, E. Seymour, W. Peter, C. Barker, B. Kirby, J. Williams, "A Review of Existing Reactive Power Requirements for Variable Generation," Proceedings of the 2012 IEEE Power and Energy Society General Meeting, San Diego, CA, July 2012.
- M. Lave, J. Stein, A. Ellis, "Analyzing and Simulating the Reduction in PV Powerplant Variability Due to Geographic Smoothing in Ota City, Japan and Alamosa, CO," Proceedings of the 38th IEEE Photovoltaic Specialists Conference, Austin, TX, June 2012.
- A. P. Meliopoulos, A. Ellis, J. Kalejs, "Development of a Model for Integrated PV Power Plant Design, Impact Studies, Commissioning, and Operations," Proceedings of Intersolar Europe, June 2012.
- S. Gonzalez, F. Hoffmann, M. Mills-Price, M. Ralph, A. Ellis, "Implementation of Advanced Inverter Interoperability and Functionality," Proceedings of the 38th IEEE Photovoltaic Specialists Conference, Austin, TX, June 2012.
- M. Ropp, A. Ellis, "Guidelines Document for Helping Utility Protection Engineers Determine when Additional Anti-Islanding Studies Are Prudent," Proceedings of the 38th IEEE Photovoltaic Specialists Conference, Austin, TX, June 2012 (SAND2012-1365).
- A. Ellis, D. Schoenwald, J. Hawkins, S. Willard, B. Arellano, "PV Output Smoothing with Energy Storage," Proceedings of the 38th IEEE Photovoltaics Specialists Conference, Austin, TX, June 2012 (SAND2012-6745).
- M. Reno, A. Ellis, J. Quiroz, S. Grijalva, "Modeling Distribution System Impacts of Solar Variability and Interconnection Location," Sandia National Laboratories Report SAND2012-2390C,

presented at the 2012 ASES World Renewable Energy Conference, Denver, CO, May 2012.

- A. Ellis., B. Karlson, J. Williams, "Utility-Scale Photovoltaic Procedures and Interconnection Requirements," Sandia National Laboratories Report SAND2012-2090, February 2012, Proceedings of the PV America West Conference, San Jose, CA, March 2012.
- A. Ellis, Y. Kazachkov, J. Sanchez-Gasca, P. Pourbeik, E. Muljadi, M. Behnke, J. Fortmann, S. Seman, "Generic Wind Power Plant Models," Book Chapter in *Wind Power in Power Systems*, Ackerman, Editor, Wiley, 2012.
- V. Helmut, D. Cracium, A. Ellis, J. Granata, S. Tselepis, A. Kyritsis, N. Hatziargyriou, "Harmonized Procedures for Long Term Energy Yield Measurements and Performance Evaluation of PV Modules in Outdoor Conditions," *Photovoltaics International Journal*, Vol. 1, pp. 194-201, 2012.
- R. Broderick, A. Ellis, "Evaluation of Alternatives to the FERC SGIP Screens for PV Interconnection Studies," Proceedings of the 38th IEEE Photovoltaic Specialists Conference, Austin, TX, 2012.
- M. Coddington, A. Ellis, B. Mather, B. Kroposki, R. Hill, K. Lynn, A. Razon, T. Key, K. Nicole, J. Smith, "Updating Technical Screens for PV Interconnection," Proceedings of the 38th IEEE Photovoltaics Specialists Conference, Austin, TX, 2012. (NREL/TP-5500-54063)
- A. Mills, M. Ahlstrom, M. Brower, A. Ellis, R. George, T. Hoff, B. Kroposki, C. Lenox, N. Miller, J. Stein, "Dark Shadows - Understanding Variability and Uncertainty of Photovoltaics for Integration with the Electric Power System," *IEEE Power and Energy Magazine*, November/December 2011. (LBNL Report LBNL-2855E)
- A. Ellis, M. Behnke, J. Keller, "Model Makers," *IEEE Power and Energy Magazine*, November/December, 2011.
- R. Zavadil, N. Miller, A. Ellis, E. Muljadi, P. Pourbeik, S. Saylors, R. Nelson, G. Irwin, M. Sahni, D. Muthumuni, "Models for Change," *IEEE Power and Energy Magazine*, November/December 2011.
- R. Piwko, M. Bradt, E. Camm, A. Ellis, R. Walling, M. O'Malley, "A Blast of Activity," *IEEE Power and Energy Magazine*, November/December 2011.
- M. Lave, J. Stein, A. Ellis, C. Hansen, E. Nakashima, Y. Miyamoto, "Ota City: Characterizing Output Variability from 553 Homes with Residential PV Systems on a Distribution Feeder," Sandia National Laboratories Report SAND 2011-90111, November 2011.
- A. Ellis, E. Muljadi, J. Sanchez-Gasca, Y. Kazachkov, "Generic Models for Simulation of Wind Power Plants in Bulk System Planning Studies," Proceedings of the IEEE 2011 Power Engineering Society General Meeting, Detroit, MI, July 2011.
- S. Lu, A. Ellis, et al., "Large-scale PV Integration Study," Pacific Northwest National Laboratories Report PNNL-20677, July 2011.
- C. Hansen, J. Stein, A. Ellis, C. Lenox, "Assessment of a New Simulation Approach for Estimating PV Output Variability from Satellite Imagery," Proceedings from the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, June 2011.
- M. Ralph, A. Ellis, D. Borneo, G. Corey, S. Baldwin, "Transmission and Distribution Deferment Using PV and Energy Storage," Proceedings of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, June 2011.
- A. Ellis, M. Behnke, C. Barker, "PV System Modeling for Grid Planning Studies," Proceedings of the 37th IEEE Photovoltaic Specialists Conference, Seattle, WA, June 2011.
- A. Ellis, Y. Kazachkov, E. Muljadi, P. Pourbeik, J. Sanchez-Gasca, "Description and

Technical Specifications for Generic WTG Models – A Status Report," Proceedings of the 2011 IEEE Power and Energy Society Power Systems Conference and Exposition, Phoenix, AZ, March 2011.

- M. Lave, J. Stein, A. Ellis, E. Nakashima, Y. Miyamoto, "Ota City: Characterizing Output Variability from 553 Homes with Residential PV Systems on a Distribution Feeder," Sandia National Laboratories Report SAND2011-90111, 2011.
- J. Johnson, B. Schenkman, A. Ellis, J. Quiroz, C. Lenox, "Initial Operational Experience with the La Ola 1.2 MW Photovoltaic System," Sandia National Laboratories Report SAND 2011-8848, 2011.
- A. Ellis, M. Behnke, C. Barker, "PV System Modeling for Grid Planning Studies," Proceedings of the 37th IEEE Photovoltaics Specialist Conference, Seattle, WA, 2011.
- T. Mousseau, A. Ellis, "Kauai Island Utility Co-op (KIUC) PV Integration Study," Sandia National Laboratories Report SAND2011-7441, 2011.
- J. Stein, C. Hansen, A. Ellis, V. Chadliev, "Simulation of One-Minute Power Output from Utility-Scale Photovoltaic Generation," Proceedings of the 2011 American Solar Energy Society SOLAR Conference, Raleigh, NC, 2011.
- C. Hansen, J. Stein, A. Ellis, "Simulation of One-Minute Power Output from Utility-Scale Photovoltaic Generation, Systems," Sandia National Laboratories Report SAND2011-5529, 2011.
- A. Ellis, et al., "WECC Guide for Representation of Photovoltaic Systems In Large-scale Load Flow Simulations," prepared by WECC Renewable Energy Modeling Task Force, December 2010.
- C. Hansen, J. Stein, A. Ellis, "Statistical Criteria for Characterizing Irradiance Time Series," Sandia National Laboratories Report SAND2010-7314, October 2010.
- S. Kuszmaul, A. Ellis, J. Stein, L. Johnson, "Lanai High-Density Irradiance Sensor Network for Characterizing Solar Resource Variability of MW-Scale PV System," Proceedings of the 35th IEEE Photovoltaics Specialists, Honolulu, HI, June 2010.
- R. Piwko, E. Camm, A. Ellis, E. Muljadi, R. Zavadil, R. Walling, M. O'Malley, G. Irwin, S. Saylors, "A Whirl of Activity," *IEEE Power and Energy Magazine*, November/December 2009.
- S. Gonzalez, S. Kuszmaul, A. Ellis, "Long-term Inverter Operation Demonstration at Sandia National Laboratories," Proceedings of the 34th Photovoltaic Specialists Conference, Philadelphia, PA, 2009.
- S. Kuszmaul, S. Gonzalez, A. Ellis, E. Serban, "Commanding Inverters to Establish Coordinated μGrid Functionality at Sandia National Laboratories," Proceedings of the 34th Photovoltaic Specialists Conference, Philadelphia, PA, 2009.
- A. Ellis, E. Muljadi, "Wind Power Plant Representation in Large-Scale Power Flow Simulations in WECC," Proceedings of the 2008 IEEE Power and Energy Society General Meeting, Pittsburgh, PA, July 2008.
- E. Muljadi, A. Ellis, "Validation of Wind Power Plant Dynamic Models," Proceedings of the 2008 IEEE Power and Energy Society General Meeting, Pittsburgh, PA, July 2008.
- M. Behnke, A. Ellis, "Reactive Power Planning for Wind Power Plant Interconnections," Proceedings of the 2008 IEEE Power and Energy Society General Meeting, Philadelphia, PA, July 2008.
- E. Muljadi, S. Pasupulati, A. Ellis, D. Kosterev, "Method of Equivalencing for a Large Wind Power Plant with Multiple Turbine Representation," Proceedings of the 2008 IEEE Power and Energy Society General Meeting, Pittsburgh, PA, July 2008.

- K. Mattern, A. Ellis, E. Williams, C. Edwards, A. Nourai, D. Porter, "Application of Inverter-based Systems for Peak Shaving and Reactive Power Management," Proceedings of the IEEE Transmission and Distribution Conference and Exposition, Chicago, IL, April 2008.
- E. Muljadi, Z. Mills, R. Foster, J. Conto, A. Ellis, "Fault Analysis at a Wind Power Plant for One Year of Observation," Proceedings of the 2008 IEEE Power and Energy Society General Meeting, Philadelphia, PA, 2008.
- R. Zavadil, A. Ellis, "PNM Wind Resource Integration Study," Public Service Company of New Mexico, 2008.
- N. Miller, A. Ellis, E. Muljadi, E. Camm, B. Kirby, "Queuing Up," *IEEE Power and Energy Magazine*, November/December 2007.
- A. Ellis, et al., "WECC Wind Power Plant Power Flow Modeling Guide," prepared by WECC Wind Generator Modeling Group, November 2007.
- IEEE Blackout Analysis Task Force (A. Ellis member), "Blackout Experiences and Lessons, Best Practices for System Dynamic Performance, and the Role of New Technologies," IEEE PES Special Publication 07TP190, July 2007.
- E. Muljadi, C. Butterfield, B. Parsons, A. Ellis, "Characteristics of Variable Speed Wind Turbines Under Normal and Fault Conditions," Proceedings of the 2007 IEEE Power Engineering Society General Meeting, Tampa, FL, June 2007.
- E. Muljadi, C. Butterfield, B. Parsons, A. Ellis, "Effect of Variable Speed Wind Turbine Generator on Stability of a Weak Grid," *IEEE Transactions on Energy Conversion*, Vol. 2, Issue 1, March 2007.
- E. Muljadi, C. Butterfield, A. Ellis, J. Mechenbier, J. Hocheimer, R. Young, N. Miller, R. Delmerico, R. Zavadil, J. Smith, "Equivalencing the Collector System of a Large Wind Power Plant," Proceedings of the 2006 IEEE Power and Energy Society General Meeting, Montreal, Canada, July 2006.
- S. Ranade, D. Sagi, A. Ellis, "Identifying Load Inventory from Measurements," Proceedings of the IEEE Transmission and Distribution Conference and Exhibition, Dallas, TX, May 2006.
- A. Ellis, D. Kosterev, A. Meklin, "Dynamic Load Models: Where Are We?," Proceedings of the IEEE Transmission and Distribution Conference and Exhibition, Dallas, TX, May 2006.
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Recommendation Letters

Sandia National Laboratories
Operated for the U.S. Department of Energy by
Sandia Corporation

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May 13, 2015

HENAAC Award Selection Committee
Great Minds in STEM™
602 Monterey Pass Road
Monterey Park, CA 91754

Dear HENAAC Award Selection Committee:

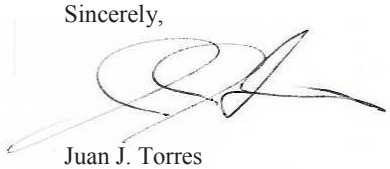
I would like to express my enthusiastic endorsement of Abraham (Abe) Ellis' nomination for the HENAAC Outstanding Technical Achievement Award. I first met Abe while he was a graduate student at New Mexico State University in 1997 when his advisor told me that he was assigning his "best student" to support our research project on the electric power grid. Even then his potential was clearly evident. I have since been able to engage with Abe on several levels over the years and observe the impact that he has made in industry, at Sandia, and for the nation.

Prior to Abe joining Sandia in 2008, he was already well known in the electric utility sector through his leadership in industry task forces and working groups, and through his publications. He has an outstanding list of impactful publications and his work is well recognized across the electric power, solar, and wind industry sectors. Upon joining Sandia he was immediately able to have an impact in our research, not just in the Solar Technologies Department where he was hired, but more broadly in our wind integration activities, microgrid research, and transmission analysis. Additionally, he has consistently been sought by Department of Energy (DOE) leadership to participate in leading edge activities such as the Hawaii Clean Energy Initiative's Technical Committee to review the design of an undersea electricity transmission cable between islands. He has worked with the infrastructure owners in the state of New Jersey to make their power grid more resilient in light of devastating storms like Hurricane Sandy. More recently, he was selected to serve on the DOE's Grid Modernization Laboratory Consortium to develop a multi-year program plan for the DOE's investment in modernizing our nation's power grid.

As strong as he is technically, Abe is equally impactful through his outstanding insight and interpersonal skills. He has always been willing to go out of his way to spend time with our young researchers. Because of my deep respect for Abe's technical and mentoring abilities, I have personally called upon Abe to mentor junior Hispanic staff needing guidance in their careers. Earlier this year, he took on the role of acting manager for our Photovoltaic and Distributed Systems Department. He has done a tremendous job in this role, both because of his leadership and communication skills as well as through his deep technical knowledge. As program manager for the renewables program, I engage with Abe regularly, as all the work in his department falls under my area of responsibility. Consequently, I have been able to see the direct impact that he has in leading his technical team while surpassing the expectations of his sponsors at DOE to meet the Nation's solar energy goals.

Over the years, Abe has demonstrated his technical excellence and leadership in many ways. This year he was promoted to the level of Distinguished Member of Technical Staff at Sandia, a title only bestowed on the top 10% of all our employees and based on a career of accomplishments. His impact is evident across numerous sectors of the energy industry, across Sandia, and in the nation. He is a role model, not just for Hispanic engineers, but for all engineers, researchers, and technical managers. It is truly an honor and a privilege to work with Abe and I wholeheartedly endorse his nomination for your prestigious award.

Sincerely,



Juan J. Torres
Senior Manager, Renewable Energy Technologies
Chair, Hispanic Leadership Outreach Committee

Public Service Company of New Mexico
Transmission/Distribution Planning & Contracts
2401 Aztec Road NE
MS Z220
Albuquerque, NM 87158
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Fax 505 241 4363

HENAAC Award Selection Committee
Great Minds in STEM
602 Monterey Pass Road
Monterey Park, CA 91754

May 11, 2015

Letter of Recommendation: Dr. Abraham Ellis

It is with pleasure to write this letter on behalf of Dr. Abraham Ellis. I have known Abraham since 2002 as he was an up and coming engineer directly reporting to me from 2002 until 2008. Abraham was the top performer within the Transmission Planning Department as the examples below will demonstrate. He was very active with PNM's Speaker's Bureau and the Albuquerque community in general. His dedication to the task at hand and his tireless effort to producing high quality work are traits that come only with special individuals.

Abraham was responsible for PNM's transmission system planning and technical studies as well as representing PNM on the Western Electricity Coordinating Council (WECC). Abraham played a key leadership role while at PNM in addressing highly technical issues in the area of renewable generation interconnections and the effects on the transmission system. His leadership was recognized as he was named chair of WECC's Modeling and Validation Group as well as the Wind Generator Modeling group where he challenged the wind industry for the development of wind turbine models for system studies. The result of his nationally recognized work resulted in development of software models that benefited utilities and the industry in general.

Abraham was also instrumental in analyzing power system electrical disturbances to determine their root cause based on the interaction of the transmission system and the behavior of the generation plant performance and other system grid components. This was accomplished through Abraham's leadership as project manager to install phasor measurement devices at critical stations on the PNM transmission system. This data was also used to improve system models for planning studies. His efforts were recognized by his peers as well as Senior Management.

Abraham was not only a very diligent engineer, but he also had a gift for communicating very technical and complicated issues to the lay person. This was demonstrated in his willingness to interact with customers while at PNM. It is not common for specialized engineers to volunteer to speak to the general public on complicated engineering topics (especially individuals who learned English as a sedond language), but Abraham was always the first to raise his hand. His interpersonal skills set him apart from the most technical minds in the industry whether he was addressing a group of prominent scientists at a national conference or a group of underserved elementary through high school children from Albuquerque's predominantly Hispanic neighborhoods. Abraham's interaction with the public at community outreach events ranging from Solar Fiestas to Speaker's Bureau presentations to Science Fairs demonstrated his commitment to sharing his knowledge and educating the public on matters that are important to him. His reputation extends well beyond PNM due to his excellent work as an engineer and his involvement to enlighten future Hispanic engineers and scientists by using his own achievements to inspire others to succeed.

I am proud to have continued to stay in touch with Abraham after his departure from PNM. We continue to discuss technical matters around renewable energy and the transmission issues that face utilities as well as workforce development issues facing us in order to keep our county technologically sound. Abraham's passion, enthusiasm and dedication to the discipline make him unique and eager to take on the challenges presented before him. I recommend Dr. Ellis without reservation and am more than willing to further discuss his attributes at your convenience. Please feel free to contact me if you so wish.

Sincerely,

Jeff Mechenbier

Director, Transmission/Distribution Planning & Contracts
Public Service Company of New Mexico
Jeff.Mechenbier@pnm.com
Phone number 505-241-4582

First Unitarian
A Unitarian Universalist Congregation
Albuquerque • Edgewood • Socorro • Carlsbad

The Rev. Christine Robinson, Senior Minister
The Rev. Angela Herrera, Associate Minister

May 12, 2015

To Whom It May Concern:

This letter is to express enthusiastic support for Abraham Ellis as a nominee for a Hispanic Engineers National Achievement Award. Abe has been a treasured lay leader First Unitarian since 2010.

A newcomer at that time, Abe discovered the church had an experimental contemporary service, designed with the interests of a young and racially/culturally diverse demographic in mind. He quickly revealed himself to be a leader of many talents and generous with his time. Abe joined the band as its regular drummer, and brought his son into the fold as well. He continues in that role, today.

Abe also joined the audio-visual team for the church, which consists entirely of volunteers and is responsible for videography and all sound components of all Sunday services. He has since become the volunteer leader of that team. Our sound system grew in complexity when we built a new sanctuary in 2013. To ensure a good experience for the four hundred or more people who attend worship each week, Abe has to have a good rapport with each team member and an ability to troubleshoot, set procedures, and communicate in a way that each will understand.

It takes special skill to manage a crew of "volunteer staff." The kinds of supervisory structures leaders work with in their professional lives don't translate into a congregational context. Instead, leadership agility is required—the ability to understand what makes each volunteer "tick" and what inspires them to serve, and provide guidance and appreciation accordingly.

Abe is a respected leader among leaders at First Unitarian. He is a blessing to the community. He is known to be patient and warm, fun-loving and professional. He lives his values, and is a good role-model to his son and other young men. I am glad to hear he is being considered for this award, and heartily endorse him.

Sincerely,

Angelica Herrera

The Rev. Angela Herrera

A Member Congregation of the Unitarian Universalist Association
3701 Carlisle NE Albuquerque, NM 87110-1642
505.884.1801 • *FirstUnitarianChurch@uuabq.org*
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Lori Stuit
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May 13, 2015

HENAAC Award Selection Committee

Great Minds in STEM™
602 Monterey Pass Road
Monterey Park, CA 91754

Re: Abraham Ellis

I would like to add my support to the nomination of Abraham Ellis for the HENAAC award. While it has been some time since I have seen him, my experience of working with him as a parent when I was a teacher and instructional coach at Longfellow Elementary remains a vivid memory.

While I realize that he is an engineer, I knew Mr. Ellis primarily as a father, one who was very involved in education. He enrolled his two children in the dual language program at Longfellow, and was an avid supporter of all students acquiring not only a second language, but also an appreciation for the culture, traditions and contributions of people from different countries. His presence was always welcome, since he served as positive Hispanic male role model. He supported our school as a volunteer in many ways, but I will list a few:

- As a judge at science fair (also recruiting others from PNM)
- Building sets and props for theatrical performances
- Translation of school letters and information
- Junior Achievement Program presenter, teaching economics to 5th grade classes
- Albuquerque Chihuahua student exchange program: fundraising, hosting a family, and participating in the Exchange personally by going to Chihuahua

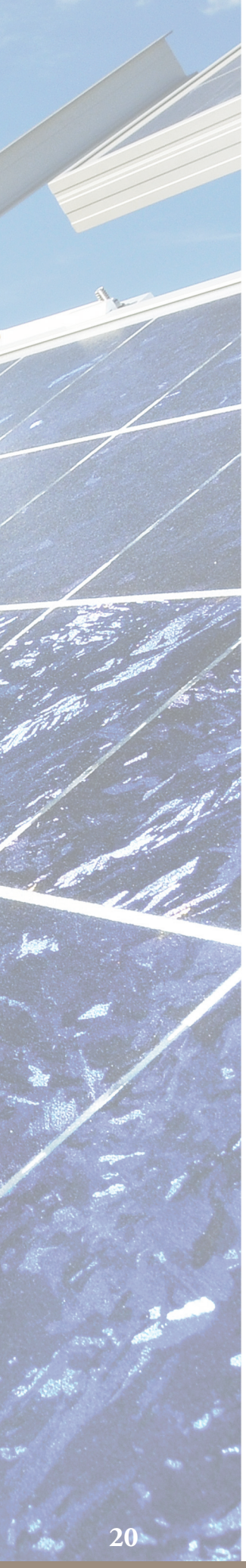
Again, I wholeheartedly support your nomination of Mr. Ellis. He is someone who is proud of his culture, an active participant in the life and education of his children, and supportive of the community at large.

Respectfully,

Lori Stuit, principal
Dolores Gonzales Elementary

An Equal Opportunity Employer

Organizational Chart



ENERGY TECHNOLOGIES AND SYSTEM SOLUTIONS

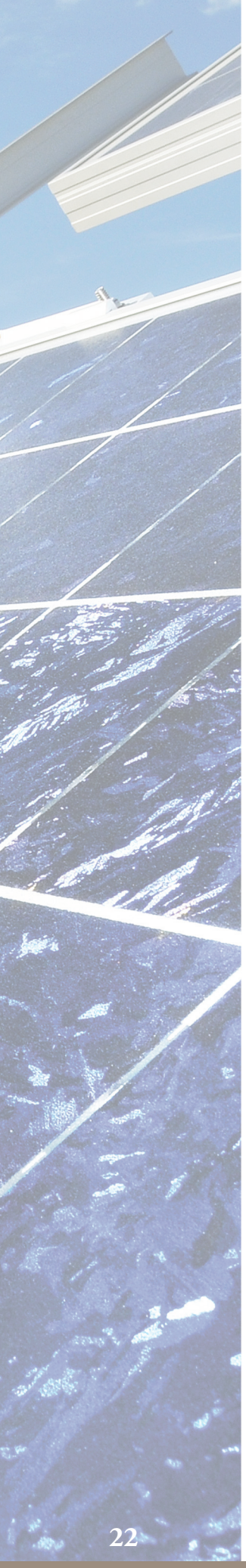
- **6110** GRID MODERNIZATION AND MILITARY ENERGY SYSTEMS
- **6111** ENERGY STORAGE TECHNOLOGY AND SYSTEMS
- **6112** PHOTOVOLTAIC AND DISTRIBUTED SYSTEMS INTEGRATION (ACTG) **Abe Ellis**
- **6113** ELECTRIC POWER SYSTEMS RESEARCH
- **6114** MILITARY AND ENERGY SYSTEMS ANALYSIS

Job Description

As acting manager of Sandia's Photovoltaic and Distributed Systems Department, Abraham Ellis provides strategic and tactical direction to Sandia's applied research to improve the performance and reliability of photovoltaic systems while removing barriers to greater penetration of renewable energy into the electric grid. As a Distinguished Member of the Technical Staff in this department, Dr. Ellis plays a technical leadership role and serves as a focal point for programmatic activities and partnerships that advance the state of the art in this research area.

The department supports Sandia's goal of making solar energy mainstream through research and development of system reliability, model development and validation, advanced technologies and analyses for high penetration on the electric grid, and assistance to partner organizations and governments installing products or developing new strategies for long-term sustainability. Department members collaborate extensively with manufacturers, utilities, governments, universities, and national laboratories.

Dr. Ellis leads multi-disciplinary research and development, including efforts in power electronics, controls and optimization, advanced mathematical models representing system performance and the electric grid, materials and physics-based reliability, performance characterization and metrology, removal of market-based barriers to greater adoption, and use of large data sets and associated data management and analytics. His duties include program development as Sandia works to strengthen core technical capabilities and diversify the department's customer base. He guides and oversees operations at the Distributed Energy Technology Laboratory and Photovoltaic Systems Evaluation Laboratory, both at Sandia, as well as the Department of Energy's (DOE's) Photovoltaic Regional Test Centers in New Mexico, Vermont, Florida, and Nevada.



Synopsis of Key Research

Development of industry-standard simulation models for grid-connected photovoltaic and wind power plants

Goal: This work is critical to facilitate the studies required to interconnect large photovoltaic (PV) and wind generators on the grid, and to allow solar and wind plants to comply with established power systems reliability standards.

Results: Over the last ten years, Dr. Ellis and the Western Electric Coordinating Council (WECC) Renewable Energy Modeling Task Force, which he founded and leads, have authored technical specifications, application guidelines, and model validation guidelines for a family of dynamic models for wind and solar power plants—models that are widely used in the industry today. He also helped develop and validate new methodologies for PV and wind power plant circuit equivalencing, and he authored power flow modeling guidelines that have become the industry standard. These dynamic models cover four types of wind turbine generators and three types of PV power plants interconnected at transmission and distribution systems. His latest contribution was the incorporation of distributed generation to the WECC composite load model, considered to be the world's gold standard for simulation of load response and distributed resources in large-scale power systems simulations.

Dr. Ellis also chairs the U.S. delegation to the International Electrotechnical Commission (IEC) Technical Committee 88 (TC88) Work Group 27 (WG27), which is pursuing international standards based on the work that he and the WECC task force have produced. Until recently, Dr. Ellis chaired the IEEE Dynamic Performance of Wind Power Generation Working Group, which has become the focal point for technical coordination and information dissemination on wind power plant models. These efforts have received substantial support from the U.S. Department of Energy and other entities in recognition of their high importance to enable PV and wind plants to comply with reliability standards and facilitate interconnection studies.

His work on generic and nonproprietary models for PV and wind have made a major impact in the industry, as those models—needed for compliance with North American Electric Reliability Corporation (NERC) reliability standards and for inclusion of wind and solar generation in collaborative regional planning studies that drive investment decisions—have been adopted industry-wide.

Improving electric infrastructure resilience via advanced microgrid applications

Goal: Enhancing the resilience of critical energy infrastructures against major natural disasters and terrorist attacks is a grand challenge on a national scale.

Results: Dr. Ellis's leadership has played a crucial role in refining Sandia's Energy Surety Design Methodology (ESDM) and Safe, Secure Energy Futures Mission. He has applied this research to impactful real-world projects, including a large, complex, and highly visible transportation energy resilience project in New Jersey. One impact of the damage caused by Superstorm Sandy on the

U.S. East Coast was that public transportation systems lost power and were unable to effectively evacuate people from the hardest-hit areas. Dr. Ellis serves as principal investigator and project manager of the Sandia team that applied the ESDM to a critical rail transportation system in New Jersey. The conceptual design he produced, known as NJ TRANSITGRID, uses a combination of centralized and distributed generation resources, energy storage, and power electronics components that perform frequency conversion and power quality enhancements. This technical solution was adopted by rail operators and was used by the New Jersey Transit Authority to secure nearly $600 million in funding to construct the recommended microgrid. The Transit Authority has requested that Dr. Ellis continue playing a leading role in the project implementation phase.

In another application, Dr. Ellis led a full-scale field demonstration of advanced distributed controls to optimize the integration of PV, battery storage, and a gas generator across a distribution feeder. This innovative project was selected as a finalist among 40+ entries worldwide for the 2014 International Smart Grid Action Network (ISGAN) Award of Excellence for its innovation and overall impact to the advancement of smart grid technologies. Recognizing the strategic importance of this work, Dr. Ellis recently organized and chaired the first International Workshop on Microgrid Applications for Critical Infrastructure Resilience in Kyoto, Japan, which had participation of more than 50 people representing 10 countries.

New methodologies for renewable energy grid integration studies

Goal: This research advances the state-of-the-art in renewable energy integration study methodologies.

Results: Dr. Ellis collaborated with several Sandia researchers to apply new methodologies to photovoltaic and wind integration analysis. The transmission grid integration project that he leads performs leading-edge research to model and characterize the spatial and temporal factors that affect PV plant output variability. These models allow for accurate prediction of PV variability based on measurements of irradiance at one location, a very important technical advance required to more accurately quantify the impact of large-scale deployment of PV on power system operations and estimate electricity cost. In 2009, he organized and co-chaired the first major workshop on PV variability in the U.S. in Cedar Rapids, Iowa. This workshop gathered, for the first time, the key stakeholders from leading utilities, system operators, PV system integrators, national laboratories, and consultants. He co-authored a seminal paper summarizing the material of the workshop, which is widely regarded as the milestone that launched substantial PV variability modeling and validation against measured data from large PV plants. With this in hand, Dr. Ellis collaborated with Sandia researchers in the development of new models to assess PV plant variability across ranges of sizes and timescales and initiated partnerships with industry to apply these methods on large-scale integration studies, some of which are currently underway. These efforts are widely referenced by other research organizations.

Dr. Ellis also led projects that made major contributions to the application of advanced stochastic optimization techniques to power system planning and operations, in partnership with NV Energy (the largest electric utility in Nevada), California Independent System Operator (CAISO), Arizona Public Service, WECC, and Lawrence Berkeley National Laboratories.

He is a recognized technical expert in the area of renewable energy grid integration and is often asked by a variety of research and policy organizations to provide technical advice. He has served as technical advisor to large-scale renewables integration studies, standards development activities under NERC and IEEE, and policy/regulatory processes led by state public utility commissions and the FERC (Federal Energy Regulatory Commission) on renewable energy integration topics. He has also played a leading role in the development of strategic program plans for DOE and NIST.

Development of advanced inverter testing protocols

Goal: Advanced inverter capabilities are required to enable future high penetration of PV generation on the grid.

Results: As principal investigator for the PV Grid Integration program, Dr. Ellis identified the need and obtained funding for the development of new performance assessment procedures for emerging advanced inverter functionality, which includes disturbance tolerance, voltage and frequency grid support, and other communication-enabled functions. He initiated an international collaboration around this subject involving European laboratories and the NREL and organized the inaugural workshop in Berlin in 2012. Resulting advanced inverter testing protocols were launched as the first major effort under the Smart Grid International Research Facility Network (SIRFN). This effort has been adopted by the International Smart Grid Action Network (ISGAN) and involves more than 10 laboratories around the world, with Sandia playing a leading role. This project entails the application of innovative methodologies to assess the performance and interoperability of power electronics equipment and allows manufacturers to introduce their products to a global market. It is affecting smart grid distributed generation technology standardization in the U.S. and abroad.

Leadership in standards development and policy/regulatory implementation

Goal: The establishment of national standards for renewable energy integration requires technical direction and expertise.

Dr. Ellis holds or has recently held leadership positions in stakeholder working groups under the NERC, IEEE, WECC, IEC, and the Utility Variable-generation Integration Group (UVIG). He was instrumental in the development and adoption of the first low voltage ride-through (fault tolerance) standard for wind power generation in North America. Through these endeavors, he has coordinated stakeholder efforts related to interconnection standards and model development for transmission and distribution applications, spanning renewable generation and smart grid technologies.

He has also provided direct input on standards to the Hawaii Public Utility Commission (PUC) and is currently providing technical leadership on establishing voltage and frequency tolerance standards for distributed PV systems within the IEEE 1547 Working Group, a cause he has been championing for the last several years as a measure to mitigate the risk of system instability due to distributed generation suddenly disconnecting from the grid. This is recognized as a key requirement to allow for future high penetration of wind and solar generation on the grid. He initiated Sandia's work on testing protocols that are now contributing to standardization at the national and international level. For example, his testing procedures are being used by Underwriters Laboratories to develop certification procedures for emerging California Rule 21 and IEEE 1547 interconnection standards.

Dr. Ellis has also had an impact in distributed generation from a policy and regulatory standpoint. His analysis of PV integration in distribution systems underpinned a decision by FERC to change procedures for interconnection of distributed generation nationwide, as part of its latest revision of the Small Generator Interconnection Procedures (SGIP). He collaborated with the Interstate Renewable Energy Council to write a paper describing a new proactive planning approach for deployment of PV systems.

Advanced photovoltaic plant performance monitoring

Goal: Successful integration of PV and wind energy systems on the electric grid requires a rich understanding of wind and solar plant performance.

Results: Dr. Ellis has made a significant impact on PV system monitoring and prognostics. Phasor measurement units (PMUs) are often used by utilities to detect or investigate disturbances on the transmission system. In

2010, he initiated a research effort that utilized PMUs for dynamic model validation. In addition to accomplishing model validation, this research demonstrated application of PMUs as an effective tool to assess online PV plant control performance. For example, analysis of the data obtained from a 20 MW PV plant in Colorado characterized the magnitude of voltage fluctuations caused by daily transformer switching. As a result of collaboration with Sandia on this topic, several leading PV integrators in the U.S., have adopted the use of PMUs in their standard plant designs. In partnership with the Georgia Institute of Technology, Dr. Ellis installed an advanced PMU at a PV system in Northern New Mexico. Under his direction, Sandia designed and deployed the world's first irradiance sensor network, co-located with a commercial PV power plant in Hawaii. He designed and had deployed irradiance sensor networks at a large PV plant in Colorado. He also directed the deployment of a state-of-the-art data acquisition system that allows data from PMUs and irradiance sensor networks located in Hawaii, Nevada, Colorado, and several locations in New Mexico to be received at Sandia in real time.

Leading creation of the first large wind power plant connected to the ultra-high voltage transmission system

While at the Public Service Company of New Mexico (PNM), Dr Ellis conducted the interconnection studies for a 204 MW wind power plant installed in New Mexico in 2003, at that time the largest wind power plant in the U.S. and the only one directly connected to the ultra-high voltage transmission system (345 kV). Those studies were technically groundbreaking in several respects. Analysis techniques, performance standards, and grid integration technologies for this application were incipient. As part of the studies, Dr. Ellis demonstrated the need for active voltage regulation and identified the reliability risk caused by possible disconnection from the grid as a result of a voltage disturbance. Standards covering disturbance tolerance for wind power plants did not exist in North America; he worked with stakeholders in WECC to develop the first technical requirement addressing low voltage tolerance in the U.S. in early 2005, and this requirement is still in effect today as a regional reliability criterion. This effort affected change at the national level. A petition to FERC filed by the American Wind Energy Association resulted in the establishment of the first national standard on disturbance, FERC Order 661A, which was largely based on the WECC regional criterion. This development had ramifications in the wind industry, as it allowed wind deployment to take place without the risk of causing disruption to power systems.

Deployment and practical application of phasor measurement units

Dr. Ellis pioneered the deployment and practical application of PMUs, making PNM one of the earliest adopters of the technology in the U.S. He championed the application of PMUs for power systems applications; he used the data to demonstrate that the Blackwater High Voltage DC converters were the source of power quality problems that had been affecting sensitive loads in the Albuquerque area for years. He also used PMU data to characterize control problems on a power system stabilizer, which was causing unnecessary wear and tear on a large 400 MW generator. His efforts resulted in adjustments to the generator's automatic voltage regulator and power system stabilizer. He is considered one of the pioneers among U.S. utility engineers in documenting technical challenges related to modeling and operational impacts of large-scale wind power generation on the grid, including variability, forecasting, disturbance tolerance, control interactions, and steady-state voltage control. He initiated work on generic models for wind power generators, which were unavailable at the time. A significant technical contribution was the collaborative development of a collector system equivalencing methodology. This standard was subsequently adopted by WECC and has become a de-facto modeling standard for all wind power plants as well as large-scale PV plants installed in the U.S. While at PNM, Dr. Ellis became chair of the WECC Modeling and Validation Working Group. In that capacity, he founded the Wind Generation Modeling Group as well as the High Voltage Direct Circuit Modeling/Source Voltage Converters (HVDC/SVC) Modeling Task Force.

Color Photograph

Biography

Abraham Ellis remembers the moment Mr. Pitano broadened his horizons. It was 1987, and Abe was a high school senior weighing his options. The best students in Panama usually aimed for medical school, but Abe's physics teacher had noticed his knack for math and science, and how Abe liked to think of practical solutions to technical challenges. "Abraham, you are an engineer," Mr. Pitano had said.

"If I was to see him again, I would tell him he read me right," says Abe, now a Distinguished Member of the Technical Staff and acting manager of the Photovoltaic and Distributed Systems Department at Sandia National Laboratories in Albuquerque, New Mexico. As manager, he leads a $15 million-a-year program to develop and advance solar energy technologies and their integration into the electric grid. Over the last six years, he has helped define new and critical research program directions for Sandia while continuing to build a national reputation as a key expert in renewable energy.

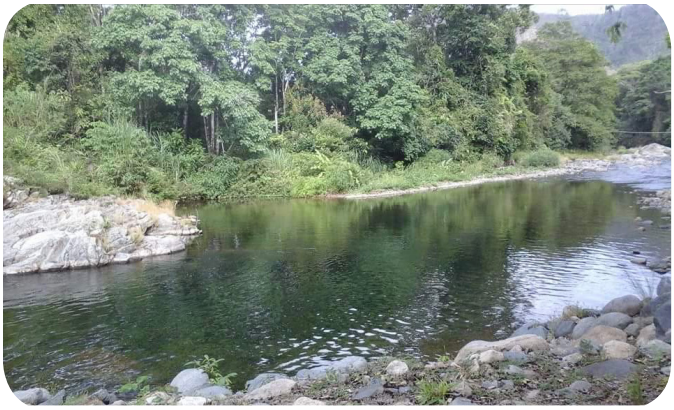
Born in 1969, Abe grew up in Chitra, a collection of villages dotting a valley 100 miles west of, and a few thousand feet above, Panama City. Chitra is, to this day, a picturesque farming community flanked by an impenetrable forest of dripping wet foliage—a vast green photosynthetic array perpetually capturing and transforming enough of the sun's energy to maintain a rich, diverse ecosystem. Under the forest's muggy canopy roam jaguars, monkeys, tapirs, snakes, and a staggering collection of colorful birds. Until 2012, when the road to Chitra was paved, only a four-wheel drive could climb the rough mountain trails and traverse multiple river crossings on the journey. But few people in Chitra had four-wheel drives, and no one had electricity. Abe remembers the valley as a happy place to grow up, precisely because it was remote and disconnected from city life.

Chitra, Panama

In those days, most of the men of Chitra spent their days farming beans, coffee, or vegetables on small plots, or hunting. Women typically kept the home and raised children. Some families had small stores, raised farm animals, or made and sold cinder blocks—"anything they could do to earn a living," says Abe. Children went to school in the mornings and explored the valley or helped the adults in the afternoons. His parents were both teachers. Yunito—that's what his family calls Abe to this day—attended the first few years of elementary school at a local two-room schoolhouse. In those days, his mother organized the village's women to grow their own food in communal gardens. She recently passed away, having worked as a school teacher and administrator and "standing out as a person working for social justice and as a community leader," Abe says. His father, who also bears the name Abraham, became Chitra's representative to the Panamanian National Assembly in 1972 and enjoyed a successful career in politics. He is also an accomplished poet.

Abe standing by the window of his 2nd grade classroom in Chitra.

Although the schoolhouse was within walking distance from home, the Ellis children sometimes traveled to and from school on horseback. A river ran between Abe's house and the school. In the afternoons after it rained, crossing the swollen river on horseback was safer than crossing on foot.



A photo of the river Abe used to cross on the way to school.

After school, "the shirt came off and the brown polyester shorts went on," recalls Abe. He typically ran off with friends, swam in the river, played fútbol, or flew kites. The group often took to building things from materials they could find or make. A favorite pastime was crafting go-carts out of nothing but wood. Slices of the trunk of a local tree called the Guarumo, round on the outside and hollow on the inside, made pretty good wheels. "We'd take our car to the top of the hill, hold on tight, and let it rip," says Abe. "I was no stranger to bruises or sprained joints."

In the 1970s, most of Chitra's children ended their educations after 6th grade "when school ran out," Abe says. But his educator parents expected more. In the middle of Abe's 4th grade year, he and his sisters, Jannette and Janny, moved to Santiago, a town 25 miles south of Chitra, with a population, at that time, of 10,000 people. (His two younger brothers, Jorge and Ascanio, were born years later.) Abe's parents had a small house in Santiago but had to be away for work during the week. The three siblings lived with just a maid and often had help from aunts, uncles, and cousins. That was the formula until all the siblings graduated high school. "I didn't feel unsafe, but I remember it being a tough time," he says of living without his parents. Perhaps in response, Abe made school a refuge, staying after classes were done for the day or helping his friends with schoolwork or special projects. He and his friends organized a newspaper, *The Urraquito*, a reference to the school's name, Instituto Urracá. "It was very honest about the things going on at the school, and maybe a little bit provocative," Abe says, acknowledging that he followed his mother's example of organizing to challenge the status quo.

He also led a group of students in establishing a self-sustaining cooperative by selling school supplies to students. "We made the case that kids can learn life lessons by working together on something like this," he says. The project attracted interest and funding from a government agency and an international organization promoting the idea of youth cooperatives, and their effort became one of the first co-ops in the world run by kids. "I remember typing these letters that I would send to the kids' parents explaining why the cooperative was important, how it was good for their educations," he says. "I think back and I am amazed that it worked."

Abe was an eager learner and adept at math, always near the top of his class. During the first half of his senior year, a teacher encouraged him to enter a national chemistry contest. He did, and took second place in Panama. That same year, 1987, Panama's government decided to participate for the first time in the 28th World Math Olympics, a prestigious annual event for high school students. Abe entered the national competition…and won, earning him and his math teacher, César García, the honor of leading the six-student Panamanian delegation to the world competition in Havana, Cuba. "It was a very high level competition, and we were ill-prepared," he says. "We did poorly, rather typical for delegations competing for the first time." Abe was the only Panamanian to score points during the competition, managing to solve just one out of the six math problems they were given. Soon after his return home, Abe found that his well-publicized appearance in Havana had gotten him caught in a political whirlwind. Right at that time, teachers in

Panama were demanding better pay and benefits from the government, and the dialogue between the teachers' union and the Ministry of Education was tense. There were newspaper articles about what the results meant about the state of education in Panama. "I started getting calls from a parade of reporters wanting to know more of the story," he says. "I was even invited to speak at a Ministry of Education meeting in Panama City."

It was around this time, leading up to graduation, that Mr. Pitano had said: "Abraham, you are an engineer." Abe graduated second in his class. Perhaps emboldened by his recent successes, or perhaps yearning for additional worldly experiences, he took the road less traveled, accepting a scholarship to attend a U.S. university to study engineering. He started the program, but the trip was suddenly put on hold due to political turmoil in Panama. Abe started medical school the next year in Panama City and successfully completed two semesters. "Then they called me up and said the trip was back on," he says. He was accepted by three U.S. universities with good electrical engineering programs, and he chose New Mexico State University (NMSU) in southern New Mexico.

Abe earned his B.S. in electrical engineering, specializing in power systems, in 1993, and his M.S. in 1995, also in electrical engineering and power systems. He fondly remembers Dr. Satish Ranade, who was his M.S. and Ph.D. advisor. "I feel extremely lucky have run into Satish," Abe says. "He is a friend and a mentor, someone who has had a hugely positive influence in my life." After earning his M.S degree, Abe accepted a job at NMSU, where he worked on a program to bring renewable energy systems to rural areas of Mexico and Central America. "This is when I started to get a taste for renewable energy as a way to solve problems of development," he says. He made many dozens of extended trips to rural communities to install photovoltaic systems and teach people to use and maintain them.

Abe earned his Ph.D. in 2000, doing his dissertation on how electrical demand from homes and businesses reacts to power disturbances. He soon accepted an offer from the Public Service Company of New Mexico (PNM), where he took on complex projects in transmission planning and engineering, including creation of the largest (at the time) wind energy farm in the U.S. and the first to connect to the high voltage power grid. Abe joined Sandia's technical staff in 2008 and began building a new program in grid modernization and grid integration of renewable energy technologies. While at PNM and continuing at Sandia, Abe led some of the first studies of how to handle the power variability introduced by wind and solar generation, and he has become a leading figure in the United State in the grid integration of renewable energy technologies.

Abe on top of a 1.5 MW wind turbine generator in New Mexico.

Abe is also a leader in his community. While at PNM, he volunteered to serve on the Speakers' Bureau, bringing low-income families information about home ownership, working with utilities, and saving on energy cost by weatherizing homes and other means. He often gave his presentations in Spanish. He volunteered for Albuquerque's Junior Achievement Program, reaching out to schools serving Spanish-speaking youth. He coached a soccer team and led a Cub Scout troop—working with under-represented minorities. He was a member of the accreditation advisory board of the Northern New Mexico Community College's School of Engineering, a Hispanic-serving institution. At PNM, he was a member of the organizing committee for the 2007 International Science and Engineering Fair in Albuquerque.

He met his wife, Bernadette, while they were both undergraduates at NMSU. Though their backgrounds were worlds apart, geographically speaking, the two are "culturally, linguistically, and spiritually very much a match," he says. Bernadette grew up in the small northern New Mexico town of Espanola. Her hard-working parents were teachers. Abe and Bernadette, now married 21 years, have two children: their son, Abraham Antonio, 21, and daughter, Analiese, 19.

Today, Abe is thinking about the future of renewable energy. The biggest challenges for utility-scale wind and solar power, he says, are scaling up their energy contributions by an order of magnitude without negatively affecting how the grid performs. This will eventually require massive energy storage systems, and operating the grid in smarter ways.

If Abe had to summarize his life's ambition, he says it would be "making wind and solar power sustainable, reliable, and affordable." While most of what he does feeds into grid modernization initiatives, Abe says that the most rewarding thing he's done is "to see how big a difference renewable energy can make in development, realizing that one can help, not by being a savior, but by working within a community to make it sustainable."

There is still much work to do in energy for development. "One-third of the world's population is struggling just to have reliable electricity," he says—electricity to pump and purify water, to irrigate fields, to light classrooms, and to build communities. In the past, renewable energy was prohibitively expensive, so rural development energy projects were often viable only with government assistance. "Now things have changed dramatically," he says. "Renewable energy systems are cheaper and more reliable. And that means that many of the world's energy challenges can be addressed in a sustainable manner with renewables."

Last summer, Abe and Bernadette visited Abe's family in Panama, making the trip to Chitra in a rental car over the newly paved road. On the river Abe once crossed on horseback is a small hydroelectric plant. It powers the homes of about 500 people nearest the plant. Abraham and Bernadette saw solar panels on many of the homes that are not connected to the small grid—the families of Chitra addressing their energy needs sustainably.

The house with the blue roof was built by the Ellis siblings on the hill where they used to fly kites. The road was paved three years ago.

The background image shows a mountain called "Cerro San Antonio" near Chitra, beyond which lays a tropical jungle that goes all the way to the Atlantic Ocean.

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