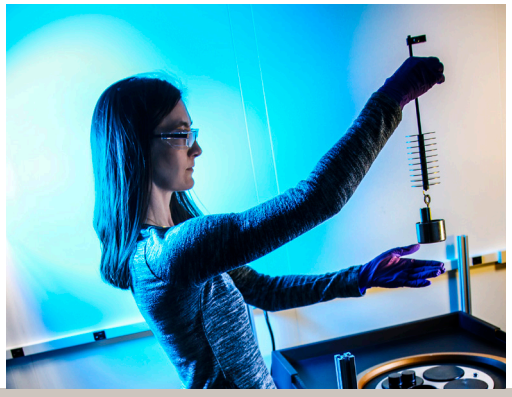
Exceptional service in the national interest

Sandia National Laboratories



U.S. DOE Office of Electricity and Energy Reliability Energy Storage Program

at Sandia National Laboratories

Summary of Accomplishments and Impacts for FY17

U.S. DEPARTMENT OF ENERGY

Table of Contents

Introduction

Energy storage can play a key role in creating a resilient, reliable, and secure U.S. electric grid. Currently, grid energy storage technology is being deployed for selected applications, and further cost reductions and performance improvements are needed to make energy storage cost effective across all applications in the electricity infrastructure. Sandia National Laboratories' Energy Storage Program is focused on making energy storage cost effective through research and development (R&D) in new battery technology development and advancements in power electronics and power conversion systems, improving the safety and reliability of energy storage systems, and enabling the deployment of new energy storage technologies in the electric grid. During FY17, Sandia executed R&D work supported by U.S. Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability – Energy Storage Program under the leadership of Dr. Imre Gyuk. This document summarizes the impact of Sandia's contributions through notable accomplishments, journal publications, patents, and technical conferences and presentations.

Notable Accomplishments

13

During this period, Sandia contributed to multiple energy storage system installations, received prestigious professional and technical recognition, including an R&D100 Green Tech Special Recognition Award, and organized the 2017 ESS Safety Forum and other technical symposium. Brief descriptions of these and other selected accomplishments are provided on pages 5 through 8.

Publications

28

Sandia researchers produced a large number of energy storage-related publications, including 20 published peer-reviewed journal papers and 8 Sandia technical reports. A list of publications is provided on pages 10 through 12.

Patents

13

Sandia's efforts have produced a number of patents and applications on topics that include redox flow batteries, sodium ion batteries, lithium primary batteries, and control systems. Two granted patents and 12 patent applications have been filed and are listed on page 14.

Technical Conferences and Presentations

92

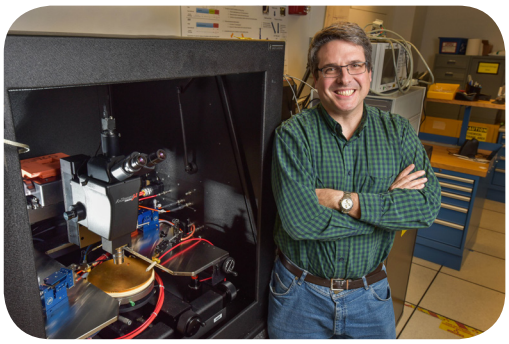
Sandia researchers were invited to talk at multiple conferences, contributed to 51 conference papers, participated in webinars and on conference panels, and organized symposiums. These technical conference contributions and additional presentations are listed on pages 16 through 22.

Notable Accomplishments

Research Updates & Accomplishments

Sandia's Research in Ultrawide Bandgap Technology Could Help Improve the Grid

January 2017 - Sandia researchers are currently studying how ultrawide bandgap semiconductor materials could be used to create more compact and efficient power electronics, leading to higher absolute voltages for distributing power grid energy. These materials, such as AlGaN, allow devices to operate at higher voltages, frequencies, and temperatures than wide bandgap materials, such as silicon carbide (SiC) and GaN. When made into transistors, the materials have the potential to vastly improve the performance and efficiency of not only electrical power grids, but also electric vehicles, computer power supplies, and motors for such things as heating, ventilation, and air conditioning (HVAC) systems.



Sandia Joins Forces with Singapore Energy Market Authority to Develop Energy Storage System

January 2017 - Sandia's Energy Storage Projects team within the Stationary Energy Storage Program is working with the government of Singapore's Energy Market Authority (EMA) to help set up Singapore's first grid energy storage test-bed. This will lead to the selection and development of three energy storage test-beds at existing electrical substations. Sandia will help develop standards and guidelines for grid integration and fire safety, assess the economic case for energy storage systems, offer guidance on the policy and regulatory frameworks, and provide periodic reports to EMA on the performance of the test systems. Sandia is working with EMA under a four-year Cooperative Research and Development Agreement sponsored by the U.S. Department of Energy's (DOE) Office of Electricity's Stationary Energy Storage Program managed by Dr. Imre Gyuk.

Installation of New England's Largest Battery Energy Storage System is Underway

January 2017 - With support from Sandia, NEC Energy Solutions has begun the installation and commissioning of a 2-MW, 3.9-MWh GSS® grid energy storage solution for the Sterling Municipal Light Department in Sterling, Massachusetts. Once complete, it will be the largest system of its kind installed in New England and the first utility scale project in the state. In the event of an extended grid outage due to a natural disaster, this utility scale Battery Energy Storage System can be used to power local emergency response facilities using power generated from two nearby solar plants. The system will also provide enhanced clean energy usage and cost savings to the town.

Grid-Scale Vanadium Flow Energy Storage System to be Installed in Hawaii

July 2017 - A 100kW/500kWh advanced vanadium energy storage system will be installed later this year at the Hawaii Ocean Science and Technology Park (HOST Park) administered by Natural Energy Laboratory of Hawaii Authority. Sandia will develop a test plan for the system, evaluate test results, and analyze how a flow battery performs in an island climate and on an island grid.

National Labs Partner with EPB to Energize Flow Battery in Support of Grid Modernization Efforts

On September 22, the Electric Power Board of Chattanooga, TN (EPB) energized a 100kw/400kWh Vanadium Redox Flow Battery as part of a GMLC project led by Sandia in partnership with Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and UniEnergy Technologies. The battery system will be used for a wide variety of applications including solar integration, voltage regulation, back-up power, advanced microgrid operations, and energy management. EPB will work with the national labs to hone the control strategies, maximize the value proposition, and analyze the different benefits from the project. Learn more.

Awards

Sandia Receives R&D 100 Award for Precision High-Power Battery Tester

January 2017 - Sandia's Precision High-Power Battery Tester, co-developed with Arbin Instruments, Ford Motor Co., and Montana Tech, received the 2016 Green Tech Special Recognition Award presented by R&D Magazine. The tester significantly improves battery life predictions, helping meet the growing demand for better, longer-life electrified vehicle and grid storage batteries.

Ray Byrne Named 2017 IEEE Fellow

January 2017 - Ray Byrne, Distinguished Member of the Technical Staff, has been named an IEEE Fellow for his contributions to miniature robotics and grid integration of energy storage. The IEEE Grade of Fellow is conferred by the IEEE Board of Directors upon a person with an outstanding record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year cannot exceed one-tenth of one-percent of the total voting membership. IEEE Fellow is the highest grade of membership and is recognized by the technical community as a prestigious honor and an important career achievement.

Sterling Municipal Light Department Energy Storage Project wins Grid Edge Award

May 2017 - Sandia contributed to the analysis, request for proposal, and deployment of a grid energy storage system for the Sterling Municipal Light Department project that has been named as a 2017 Grid Edge Award winner by Greentech Media. This 2 MW, 3.9MWh GSS® grid energy storage system is the largest system of its kind installed in New England and the first utility scale project in the State. Using solar energy, the system can provide up to 12 days of clean backup power to critical facilities during an outage. The team will receive the award at the Grid Edge World Forum in June.

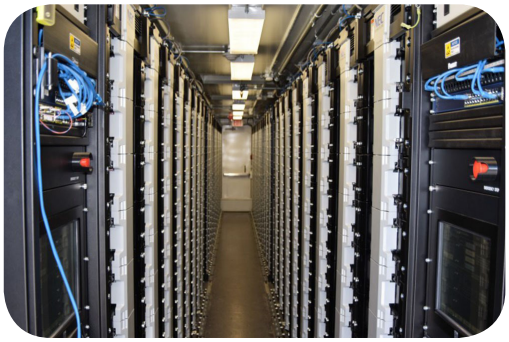
Julian Vigil receives National Science Foundation Graduate Research Fellowship

May 2017 - Julian Vigil, a student intern in Sandia's Materials, Devices, and Energy Technologies Department, was awarded a 2017 National Science Foundation (NSF) Graduate Research Fellowship. The award was based on Vigil's demonstrated potential to contribute to strengthening the vitality of the U.S. science and engineering enterprise. Vigil, who has worked with Sandia since his junior year of high school, researches electrochemical catalysis related to energy conversion and storage. The work is done under the supervision of Sandia researcher Timothy Lambert, with whom Vigil has co-authored seven peer-reviewed publications, including three as first author. Prior acknowledgments include the Barry Goldwater Scholarship Award, The Churchill Scholarship, and a 2016 ACS Division of Inorganic Chemistry Award for Undergraduate Research.

Jon Ihlefeld receives American Ceramics Society's Richard M. Fulrath Award

May 2017 - Jon Ihlefeld, a Distinguished Member of the Technical Staff at Sandia, has been selected to receive the 2017 Richard M. Fulrath Award from The American Ceramics Society. Jon was selected by unanimous decision for his contributions to electronic ceramics research and development. This award recognizes individuals under the age of 45 that have demonstrated excellence in research and development in the ceramics sciences. Presented to 2 American researchers and 3 Japanese researchers annually since 1978, this award promotes technical collaboration among the diverse cultures surrounding the Pacific Rim. Dr. Ihlefeld is internationally recognized for his work on dielectric integration, funded, in-part, by the DOE Office of Electricity's Energy Storage Program managed by Dr. Imre Gyuk; ferroelectrics, funded, in-part, by the Laboratory Directed Research Development Office at Sandia; and fast ion conductors, funded, in-part, by the Office of Nuclear Energy. The award will be presented at the 119th annual meeting of The American Ceramics Society, in Pittsburg PA, October 9th, 2017.

Sterling Energy Storage Project Selected as a Finalist for 2017 Energy Storage North America Awards



July 2017 - The Sterling Municipal Light Department (SMLD) Energy Storage Project has been selected as one of eight finalists for the 5th Annual Energy Storage North America (ESNA) Innovation Awards. The projects were selected based on their outstanding achievements in either centralized or distributed storage and their impact on the energy storage ecosystem, services supplied to customers and the grid, and unique technology application. Sandia contributed to the analysis, request for proposal, and deployment of this 2 MW, 3.9MWh GSS® grid energy storage system.

Sandia Researchers Present Best Papers at IEEE Power & Energy Society General Meeting

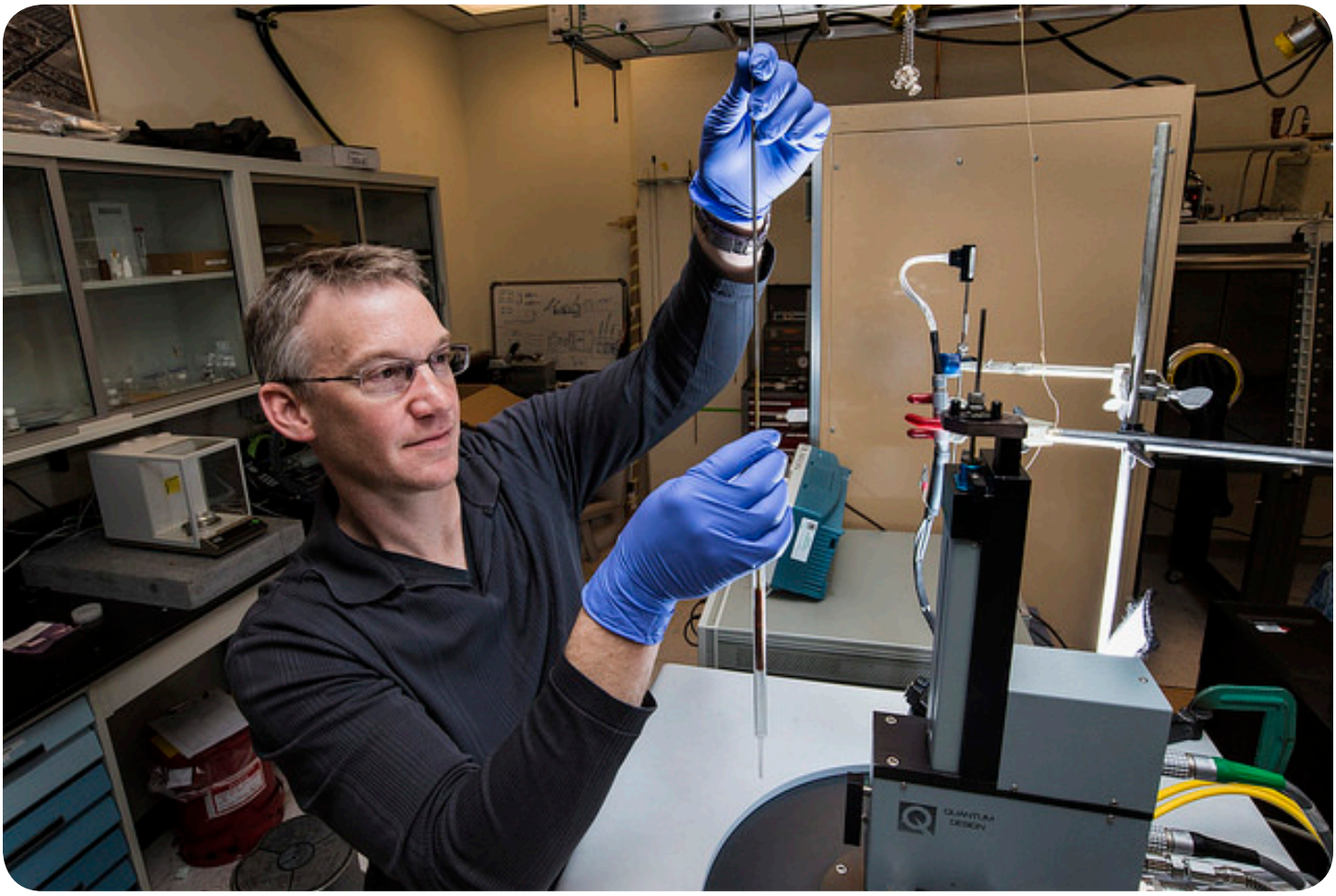
July 2017 - Two Sandia papers were selected to be presented as Best Conference Papers submitted to the 2017 IEEE Power & Energy Society General Meeting July 16-20 in Chicago, IL. The first was authored by Mohamed Elkhatib and Abraham Ellis, titled "Communication-assisted Impedance-based Microgrid Protection Scheme," and presented during the session on Microgrids, Renewables, and Distributed Energy Resources. The second was authored by Felipe Wilches-Bernal, Brian Pierre, Ryan Elliott, David Schoenwald, Raymond Byrne, Jason Neely, and Daniel Trudnowski, titled "Time Delay Definitions and Characterization in the Pacific DC Intertie Wide Area Damping Controller," and presented during the session on Power System Stability, Control, and Protection. Sandia provided a total of 16 technical presentations.

Events

Energy Storage Systems Safety Forum

May 2017 - Over 130 participants from industry, academia, national labs, the Department of Energy, Singapore, South Korea, and Canada, came together February 22-24 in Santa Fe, NM for Meeting the Challenge: 2017 ESS Safety Forum. Participants discussed the current state of energy storage system safety and mitigation strategies for improving cell to system level safety and reliability. A summary report will be generated with these findings.

Publications



Journal Publications

1. A.M. Pezeshki, Z.J. Tang, C. Fujimoto, C.N. Sun, M.M. Mench, T.A. Zawodzinski, "Full Cell Study of Diels Alder Poly(phenylene) Anion and Cation Exchange Membranes in Vanadium Redox Flow Batteries," Journal of the Electrochemical Society, Volume: 163, Issue: 1, Pages: A5154-A5162.
2. D.F. Sava Gallis, H.D. Pratt III, T.M. Anderson, K.W. Chapman, "Electrochemical Activity of Fe-MIL-100 as a Positive Electrode for Na-ion Batteries," Journal of Material Chemistry A 2016, 4, 13764-13770.
3. E. Allcorn, G. Nagasubramanian, E. Spoerke, D. Ingersoll, "Elimination of Active Species Crossover in a Room Temperature, Neutral pH, Aqueous Flow Battery Using a Ceramic NaSICON Membrane," Journal of Power Sources, publication under revision.
4. H.M. Barkholtz, A. Fresquez, B.R. Chalamala, S.R. Ferreira, "A Database for Comparative Electrochemical Performance of Commercial 18650-Format Lithium-Ion Cells" Journal of Electrochemical Society 2017 volume 164, issue 12, A2697-A2706 doi: 10.1149/2.1701712jes.
5. J. Duay, T.N. Lambert, R. Aidun, "Stripping Voltammetry for the Real Time Determination of Zinc Membrane Diffusion Coefficients in High pH: Towards Rapid Screening of Alkaline Battery Separators," Electroanalysis 2017, http://dx.doi.org/10.1002/elan.201700337.
6. J.S. Lawton, A.M. Jones, Z.I. Tang, M. Lindsey, C. Fujimoto, T.A. Zawodzinski, "Characterization of Vanadium Ion Uptake in Sulfonated Diels Alder Poly(phenylene) Membranes." Journal of the Electrochemical Society, Volume: 163, Issue: 1, Pages: A5229-A5235.
7. J.E. Martin, L.E.S. Rohwer, J. Stupak, "Elastic Magnetic Composites for Energy Storage Flywheels," Composites Part B: Engineering, vol. 97, pp. 141-149, 2016. https://doi.org/10.1016/j.compositesb.2016.03.096
8. K.S. Lee, J.S. Spendelow, Y.K. Choe, C. Fujimoto, Y.S. Kim, "An Operationally Flexible Fuel Cell Based on Quaternary Ammonium-biphosphate Ion Pairs," Nature Energy, Volume: 1.
9. L.J. Small, A. Eccleston, J. Lamb, A.C. Read, M. Robins, T. Meaders, D. Ingersoll, P.G. Clem, S. Bhavaraju, and E.D. Spoerke. "Next Generation Molten NaI Batteries for Grid Scale Energy Storage," Journal of Power Sources. 360, 569-574, 2017.
10. L.J. Small, E.D. Spoerke, et al. "Deposition of Tungsten Metal by an Immersion Process," Journal of the Electrochemical Society, 164 (6) D269-D274, 2017.
11. L.J. Small, H.D. Pratt, C.H. Fujimoto, T.M. Anderson, "Diels Alder Polyphenylene Anion Exchange Membrane for Nonaqueous Redox Flow Batteries," Journal of the Electrochemical Society, Volume: 163, Issue: 1, Pages: A5106-A5111.
12. L. J. Small, H.D. Pratt III, C.L. Staiger, T.M. Anderson, "MetILs3: A Strategy for High Density Energy Storage Using Redox-Active Ionic Liquids," Advanced Sustainable Systems 2017, 1700066.

13. M.A. Beuerlein, N. Kumar, T.M. Usher, H.J. Brown-Shaklee, N. Raengthon, I.M. Reaney, D.P. Cann, J.L. Jones, G.L. Brennecka, "Current Understanding of Structure–Processing–Property Relationships in BaTiO3–Bi(M)O3 Dielectrics," Journal of the American Ceramic Society, 99 [9] 2849–2870 (2016) DOI: 10.1111/jace.14472.

14. P. Sarobol, A. Vackel, J. Adamczyk, T. Holmes, M. Rodriguez, J. Griego, M. Blea, and H. Brown-Shaklee, "Aerosol Method for Room Temperature Thick-Film Deposition: Aerosol Deposition Offers an Alternative to Conventional Thin Film Processes when Mesoscale Coatings are Needed," Advanced Materials and Processes, Feature Article Nov/Dec 2016.

15. R.H. Byrne, T.A. Nugyen, D.A. Copp, B.R. Chalamala, I. Gyuk. "Energy Management and Optimization Methods for Grid Energy Storage Systems," IEEE Access, 2017. vol. PP, no. 99, pp. 1-30.

16. S. Martin, H.D. Pratt III, T.M. Anderson, "Screening for High Conductivity/Low Viscosity Ionic Liquids Using Product Descriptors," Molecular Informatics 2017, 36, 1600125.

17. T.G. Tucker, S.K. Davidowski, C.A. Angell, "Inorganic vs Organic Cation Ionic Liquids and Their Solutions with Alkali Metal Containing Ionic Liquids," Journal of the Electrochemical Society, 164 (4) H153-H158 (2017).

18. T. Monson, (Guest Editor) "Soft Magnetic Materials: Synthesis, Characterization, and Applications," Journal of Materials Research, Focus Issue, August 2016.

19. X. Leigang, X. Sen, J.B. Goodenough, C.A. Angell, "An Inverse Aluminum Battery: Putting the Aluminum as the Cathode," ACS Energy Lett., 2017, 2 (7), pp 1534–1538, April 25, 2017. DOI: 10.1021/acsenergylett.7b00234.

20. Y. Dvorkin, R. Fernandez-Blanco, D.S. Kirschen, H. Pandzic, JP Watson, C.A. Silva-Monroy, "Ensuring Profitability of Energy Storage," IEEE Transactions On Power Systems, Volume 32, Issue 1, Pages 611-623, Jan 2017.

Sandia National Laboratories Technical Publications

1. D. Borneo, et al, "Green Mountain Power (GMP): Significant Revenues from Energy Storage" SAND2017-6164.

2. D. Borneo, et al, "Energy Storage Procurement - Guidance Documents for Municipalities," SAND2016-8544O.

3. L.J. Small, H.D. Pratt, C. Staiger, R.I. Martin, T.M. Anderson, B.R. Chalamala, "Vanadium Flow Battery Electrolyte Synthesis via Chemical Reduction of V2O5 in Aqueous HCl and H2SO4," SAND2017-0875.

4. S.R. Ferreira, P. Cole, D. Conover, A.B. Muna, C.B. LaFleur, D.M. Rosewater, "A Roadmap to ESS Safety and Reliability," SAND2017-5024 PE.

5. S. Ferreira, D. Conover, P. Cole, “DOE OE Energy Storage Systems Safety Roadmap Focus on Codes and Standards—May 2017,” SAND2017-5685R.
6. S. Ferreira, D. Conover, P. Cole, “DOE OE Energy Storage Systems Safety Roadmap Focus on Codes and Standards—June 2017,” SAND2017-9147R.
7. S. Ferreira, D. Conover, P. Cole, “DOE OE Energy Storage Systems Safety Roadmap Focus on Codes and Standards—July 2017,” SAND2017-8018R.
8. S. Ferreira, D. Conover, P. Cole, “DOE OE Energy Storage Systems Safety Roadmap Focus on Codes and Standards—August 2017” SAND2017-6682R.

Patents

Patents

Issued

1. C. Fujimoto, H. Pratt, T.M. Anderson, "High Performance, Durable Polymers including Poly(phenylene)," Appl. No.:14/933,981, U. S. Patent 9,580,541, Issued February 28, 2017.
2. T.M. Anderson, N.S. Hudak, C.L. Staiger, H.D. Pratt III, "Polyoxometalate Active Charge-Transfer Material for Mediated Redox Flow Battery," U.S. Patent 9,548,509, Issued January 17, 2017.

Applications

1. C. Fujimoto, "Functionalization of Diels-Alder Polyphenylene Polymers," Appl. No.:15/398,545, filed January 4, 2017.
2. D. Ingersoll, E. Allcorn, G. Nagasubramanian, "Aqueous Na-ion Redox Flow Battery with Ceramic NaSICON Membrane," Non-provisional patent: filed on SD-14061.
3. D.A Schoenwald, J. Johnson, M.A. Smith, M. El Khatib, "Systems, Methods and Computer Program Products for Electric Grid Control," Appl. filed February 6, 2017.
4. D.A. Schoenwald, B.J. Pierre, R.H. Byrne, R.T. Elliott, J.C. Neely, F. Wilches-Bernal, "Systems and Methods for Active Damping Control of Inter-Area Oscillations in Large-Scale Interconnected Power Systems," Appl. filed March 30, 2017.
5. E.D. Spoerke, P.G. Clem, J.S. Wheeler, L.J. Small, J. Ihlefeld "Cation-Enhanced Chemical Stability of Ion-Conducting Zirconium-Based Ceramics." Appl. 15/460,570, filed March 16, 2017.
6. K.R. Fenton, G. Nagasubramanian, C. Staiger, H. Pratt, K. Leung, S. Rempe, M. Chaudhari, T.M. Anderson, "Organosilicon-Based Electrolytes for Long-Life Lithium Primary Batteries," Appl. No. US20170207485 A1, filed January 19, 2017.
7. L.J. Small, E.D. Spoerke, et al. "Electroless Process for Depositing Refractory Metals." Appl. 15/374,775, filed December 9, 2016.
8. L.J. Small, T.M. Anderson, H.D. Pratt III, "Method for Maximizing Energy Density in Redox Flow Battery Electrolytes," Appl. filed May 17, 2017.
9. M. Moonem, S. Atcitty, "Cell-level Micro-dual-active-bridge Controller for Precise Energy Storage Management," SD-1437, submitted May 17, 2017.
10. T. M. Anderson, H.D. Pratt, D.F. Sava Gallis, "Electrodes for Sodium Ion Batteries," Appl. filed July 31, 2017.
11. Y.S. Kim, K.S. Lee, C. Fujimoto, "Poly(phenylene) Based Anion Exchange Polymers and Methods Thereof," Appl. No.:15/398,547, filed January 4, 2017.

Technical Conferences and Presentations

Technical Conferences

Invited Talks

1. B. Chalamala, S. Atcitty, and A. Morgan, "The Role of Power Electronics and Power Conversion Systems in Grid Energy Storage," Materials Research Society 2016 Fall Meeting, Symposium ES1: Materials Science and Chemistry for Grid-Scale Energy Storage, Boston, MA, Nov 2016.
2. B. Chalamala, "Energy Storage Technologies and Long-Term Environmental Considerations," IEEE Power and Energy Society 2017 General Meeting, Chicago, IL, July 2017.
3. B. Chalamala, "Energy Storage Technology and Electric Propulsion," AIAA Propulsion and Energy Forum, Atlanta, GA, July 2017.
4. B. Schenkman, presented and chaired the "Long Duration Energy Storage" session, presentation title "Cordova Energy Storage".
5. C. Fujimoto, "Ion conducting membranes for electrochemical systems," TechConnect World 2017 Session: Advanced Materials for Fuel Cells Presentation, May 2017.
6. D. Borneo, "Sandia's Energy Storage Research and Development," BATTCON, Orlando, FL, May 2017.
7. D. Borneo, "SMLD Financial," Energy Storage North America (ESNA), San Diego, CA, August 2017.
8. D. Borneo, "Sandia's Energy Storage Projects," JCESR at UCSD, San Diego, CA, April 2017.
9. D. Borneo, "Sandia's Energy Storage Research and Development," NAATBATT, Phoenix, AZ, March 2017.
10. D. Borneo, "Sandia's Hawaiian Initiative," NELHA Conference, Kona, Hi, September 2016.
11. D. Borneo, "Developing an Energy Storage Project – Technical Perspective," NEXTGEN, San Francisco, CA, February 2017.
12. E.D. Spoerke, L.J. Small, et al. "Emerging Stationary Battery Technologies," 2017 DLA Worldwide Energy Conference, April 2017.
13. H. Barkholtz, "Addressing Lithium-ion Battery Resilience," Albuquerque IEEE Section Science and Society Distinguished Public Talk, Albuquerque, NM, September 7, 2017.
14. J. Lamb, Invited participant at the Battery Safety Council, Washington, DC, December 2016 and June 2017.
15. L.J. Small, H.D. Pratt III, C. Fujimoto, T.M. Anderson, "MetILs3: A Strategy for Maximizing Energy Density in Flow Battery Electrolytes," Spring 2017 MRS Meeting.
16. R. H Byrne, "Grid Stability with High Renewable Penetration", South Dakota State University Fall Banquet, Brookings, SD, October 2016.

17. R. H. Byrne, "Estimating Potential Revenue from Electricity Energy Storage in PJM," Electric Market Authority (EMA) of Singapore, Singapore, November 2016.

18. S. Atcitty, Keynote address signifying success as an American Indian professional at a National Laboratory and student mentorship, Shiprock High School Graduation Commencement, May 2017.

19. S. Atcitty, Keynote address, "Role of Wide Bandgap Power Electronics and Power Conversion Systems in Grid-tied Energy Storage," 2016 4th Annual IEEE Workshop on Wide Band Gap Power Devices and Applications Conference, November 2016.

Conference Papers

1. B. A. Magar, I. Vasiliev, T. N. Lambert, J. Duay, B. Chalamala, "First-Principles Study of Hydrogen Trapping in Electrolytic Manganese Dioxide" Annual Meeting of the APS Four Corners Section, Fort Collins, CO, October 2017.

2. B. J. Pierre et al., "Open-Loop Testing Results for the Pacific DC Intertie Wide Area Damping Controller," 2017 IEEE Manchester PowerTech, Manchester, June 2017.

3. B. J. Pierre, F. Wilches-Bernal, R. T. Elliott, D. A. Schoenwald, J. C. Neely, R. H. Byrne, and D. J. Trudnowski, "Simulation Results for the Pacific DC Intertie Wide Area Damping Controller," 2017 IEEE Power and Energy Society General Meeting, Chicago, IL, July 2017.

4. B. Schenkman, presented poster "Energy Storage Demonstrations - Validation and Operational Optimization," Grid Modernization Initiative Peer Review, April 2017.

5. C. Lackner, T.A. Nguyen, R.H. Byrne, and F. Wiegandt, "Energy Storage Participation in the German Secondary Regulation Market," accepted to 2018 IEEE Transmission and Distribution Conference and Exposition, Denver, CO, April 2018.

6. C. Matthews, J. Flicker, R. Kaplar, M. van Heukelom, S. Atcitty, I. Kizilyalli, and O. Aktas, "Switching Characterization of Vertical GaN PiN Diodes," Workshop on Wide-bandgap Power Devices and Applications, Fayetteville, AR, November 2016.

7. D. A. Schoenwald, B. J. Pierre, F. Wilches-Bernal, and D. J. Trudnowski, "Design and Implementation of a Wide-Area Damping Controller Using High Voltage DC Modulation and Synchrophasor Feedback," IFAC World Congress, Toulouse, France, July 2017.

8. D. Borneo, "Sandia's Energy Storage Project Overview," DOE Energy Storage Peer Review, Washington, DC, October 2016.

9. D. Borneo, et. al, "The Value Proposition for Energy Storage at the Sterling Municipal Light Department," 2017 IEEE Power Energy Society General Meeting, Chicago, IL, July 2017.

10. D. Copp, "Control of Distributed Energy Storage Devices for Power Grid Resiliency," Los Alamos National Laboratory 2017 Research Symposium, August 2017.

11. D. Copp, F. Wilches-Bernal, I. Gravagne, D.A. Schoenwald, "Time-Domain Analysis of Power System Stability with Damping Control and Asymmetric Feedback Delays," 49th North American Power Symposium, September 2017.

12. D. J. Trudnowski, B. J. Pierre, F. Wilches-Bernal, D. A. Schoenwald, R. T. Elliott, J. C. Neely, R. H. Byrne, and D. N. Kosterev, "Initial Closed-Loop Testing Results for the Pacific DC Intertie Wide Area Damping Controller," IEEE Power and Energy Society General Meeting, Chicago, IL, July 2017.

13. E. Allcorn, G. Nagasubramanian, D. Ingersoll. "Aqueous Na-ion Redox Flow Battery with Ceramic NaSICON Membrane," DOE OE Energy Storage Peer Review, Washington, DC, October 2016.

14. E. D. Spoerke, L.J. Small, et al. "Enabling Next Generation Sodium-Based Batteries with Engineered NaSICON Ion Conductors," Electronic Materials and Applications 2017, January 2017.

15. E.D. Spoerke, L. J. Small, et al. "Sodium-Based Battery Development," DOE OE Energy Storage Peer Review, Washington, DC, October 2016.

16. E.D. Spoerke, L.J. Small, et al. "Safety-by-Design in All-Inorganic Sodium Batteries." 2017 ESS Safety Forum, February 2017.

17. E.D. Spoerke, L.J. Small, et al. "Sodium-Based Batteries: Engineering Interfaces for Optimized Performance," 2017 Spring Materials Research Society Meeting, April 2017.

18. F. Wilches-Bernal, R. Concepcion, J. C. Neely, D. A. Schoenwald, R. H. Byrne, B. J. Pierre, and R. T. Elliott, "Effect of Time Delay Asymmetries in Power System Damping Control," IEEE Power and Energy Society General Meeting, Chicago, IL, July 2017.

19. H. Barkholtz, A. Fresquez, B. Chalamala, S. Ferreira, "Addressing Lithium-ion Battery Reliability: A Survey of Electrochemical Behavior," Spring 2017 ECS.

20. H. Barkholtz, A. Fresquez, B. Chalamala, S. Ferreira, "Baseline Electrochemical Performance of Commercial Lithium-Ion Cells," 2017 ESS Safety Forum, Santa Fe, NM, February 2017.

21. H. Barkholtz, A. Fresquez, S. Ivanov, J. Lamb, B. Chalamala, S. Ferreira, "Quantifying Lithium-ion Battery Safety and Failure for Modern Stationary Energy Storage," Spring 2017 MRS.

22. H. Brown-Shaklee, M. Blea-Kirby, J. Griego, M. Rodriguez, J. Ihlefeld, and E. Spoerke, "High-Density Li5La3Ta2O12 (LLTO) Ceramics for Ion-selective Fission Waste Processing," 12th Pacific Rim Conference on Ceramic and Glass Technology, May 2017.

23. J. Duay, T. N. Lambert, R. Aidun "Screening of Alkaline Zinc Battery Separators using Anodic Stripping Voltammetry," accepted to Electrical Energy Storage Applications and Technologies, San Diego, CA, October 2017.

24. J. Hewson, R. Shurtz, "Modeling for Understanding and Preventing Cascading Thermal Runaway in Battery Packs," presented at the 2017 Energy Storage Systems Safety & Reliability Workshop, Santa Fe, NM, February 2017.

25. J. Hewson, R. Shurtz, "Modeling Thermal Runaway in Lithium-ion Packs as a Function of Scale and Heat Source," 10th U. S. National Combustion Meeting, College Park, MD, April 2017.

26. J. Hewson, R. Shurtz, S. Ferreira, J. Lamb, C. Orendorff, B. Chalamala, "Fundamental Aspects of Large-Scale Energy Storage System Safety," presented at the Electrochemical Society PRiME 2016 Meeting, Honolulu, HI, October 2016.

27. J. Hewson, R. Shurtz, S. Ferreira, J. Lamb, C. Orendorff, B. Chalamala, "Modeling for Understanding and Preventing Cascading Thermal Runaway in Battery Packs" FAA Triennial Fire and Cabins Safety Research Conference 2016, Atlantic City, NJ, October 2016.

28. J. Lamb, "Alternative Battery Failure Initiation Methods," Spring ECS Meeting, New Orleans, LA, June 2017.

29. J. Lamb, "Battery Safety Testing," Energy Storage Safety Workshop, Santa Fe, NM, February 2017.

30. J. Lamb, "Development of a Propagating Battery Failure Test" The Battery Show, Novi, MI, September 2017.

31. J. Lamb, "Understanding and Detecting Catastrophic Battery Failure," 2nd International Battery Safety Workshop, Albuquerque, NM, May 2017.

32. L.J. Small, E.D. Spoerke, et al. "Electroless Process for Depositing Tungsten Metal for Sodium Battery Electrodes," DOE OE Energy Storage Peer Review, Washington, DC, October 2016.

33. M. A. Moonem, "Capacitor Voltage Balancing In A Neutral-Point Clamped Multilevel Dc-Dc Dual Active Bridge Converter," IEEE Power Electronics for Distributed Generation Systems, Brazil, April 2017.

34. M. Kelly, T. N. Lambert, J. Duay, E. Allcorn, G. Nagasubramanian, J. A. Vigil, "Alkaline Zinc-Manganese Oxide Batteries for Grid-level Storage," 28th Annual Rio Grande Symposium on Advanced Materials, Albuquerque, NM, October 2016.

35. P. Sarobol; A. Vackel; J. Adamczyk; T. D. Holmes; M. Rodriguez; J. Griego; H. Brown-Shaklee "Microstructure and Properties of Room Temperature Deposited, Thick BaTiO3 Dielectric Films," 41st International Conference and Exposition on Advanced Ceramics and Composites, January 2017.

36. R. H. Byrne, "Estimating Revenue from Energy Storage in Market Areas," Stationary Energy Storage Conference, San Francisco, CA, February 2017.

37. R. H. Byrne, S. Hamilton, D. R. Borneo, T. Olinsky-Paul, and I. Gyuk, "The Value Proposition for Energy Storage at the Sterling Municipal Light Department," 2017 IEEE Power and Energy Society General Meeting, Chicago, IL, July 2017.

38. R. Kaplar, "Charge Trapping in GaN Power Devices," International Reliability Physics Symposium Workshop on GaN Power Device Reliability, Monterey, CA, April 2017.

39. R. Kaplar, J. Flicker, C. Matthews, S. Sandoval, O. Slobodyan, M. van Heukelom, S. Atcitty, I. Kizilyalli, and O. Aktas, "Reliability Characterization of Vertical GaN PiN Diodes," accepted to Electrical Energy Storage Applications and Technologies, San Diego, CA, October 2017.

40. R. Shurtz, J. Hewson, "Modeling Thermal Runaway in Li-ion Packs as a Function of Scale and Heat Source," presented at the 231st Electrochemical Society Meeting, New Orleans, LA June 2017.

41. R. Shurtz, J. Hewson, "Modeling Thermochemical Sources for a Broader Range of Materials and Conditions," presented at the 231st Electrochemical Society Meeting, New Orleans, LA, June 2017.

42. R.H. Byrne, T.A. Nguyen, "Opportunities for Energy Storage in California," accepted to the 2017 EESAT Conference, San Diego, CA, October 2017.

43. T. N. Lambert, J. A. Vigil, J. Duay and M. Kelly "Manganese Oxide Nanomaterials for Electrocatalysis and Energy Storage" 253rd ACS National Meeting, San Francisco, CA, April 2017.

44. T. N. Lambert, J. Duay, M. Kelly, "Advanced Zinc-Manganese Oxide Batteries," DOE OE Energy Storage Peer Review, Washington DC, October 2017.

45. T. Nguyen, "Maximizing Benefit of Electrical Energy Storage for Behind-the-meter Applications," 2017 EES North America Conference, San Francisco, CA, April 2017.

46. T. Nguyen, "Maximizing Revenue from Electrical Energy Storage in MISO Energy & Frequency Regulation Markets," 2017 IEEE PES General Meeting, Chicago, IL, July 2017.

47. T. Stevens, "Synthesis of Fe4N" poster, ACS Meeting, Washington DC, August 2017.

48. T.A. Nguyen, R.H. Byrne, "Maximizing the Cost-savings for Time-of-use and Net-metering Customers Using Behind-the-meter Energy Storage Systems," in the proceedings of the 2017 IEEE North American Power Symposium (NAPS), Morgan Town, WV, September 2017.

49. T.A. Nguyen, R.H. Byrne, R.J. Concepcion, and I. Gyuk, "Maximizing Revenue from Electrical Energy Storage in MISO Energy & Frequency Regulation Markets," in the proceedings of the 2017 IEEE Power Energy Society General Meeting, Chicago, IL, July 2017.

Award Winning Conference Papers

1. F. Wilches-Bernal, B. J. Pierre, R. T. Elliott, D. A. Schoenwald, R. H. Byrne, J. C. Neely, and D. J. Trudnowski, "Time delay definitions and characterization in the Pacific DC Intertie wide area damping controller," proceedings of the 2017 IEEE Power and Energy Society General Meeting, Chicago, IL, July 16-20, 2017, pp. 1-5 (best paper session).

2. M. Kelly, T. N. Lambert, J. Duay, E. Allcorn, G. Nagasubramanian, J.A. Vigil, "Alkaline Zinc-Manganese Oxide Batteries," 2016 AIChE Annual Meeting, San Francisco, CA, November 2016. Student (M. Kelly) Awarded 2nd place, Materials Engineering and Sciences Division, Section 11.

Invited Conference Panels

1. B. Chalamala, panel member, DOE BES Basic Research Needs for Next-Generation Electrical Energy Storage Workshop, Gaithersburg, MD, March 2017.
2. R. H. Byrne, panel member on "Impacts of Rate Structure on Storage Margins and ROI", 2017 Storage Week, Oakland, CA, February 2017.
3. S. Ferreira, panel member on "Grid Safety and Energy Storage," Energy Storage Association, April 2017.

Organization of Symposia

1. E.D. Spoerke: Ion Conducting Ceramics symposium at Electronic Materials and Applications 2017 (an American Ceramics Society meeting), Orlando, FL, January, 2017.
2. H. Brown-Shaklee: PACRIM 12 Symposium Organization - Materials for Next Generation Nuclear Energy, Pacific Rim Conference on Ceramic and Glass Technology, Hawaii, May 2017.
3. S. Ferreira: Symposium ES5: Materials and Design for Resilient Energy Storage, Fall 2017 MRS, Boston, MA, December 2017.
4. S. Ferreira: Chair and organizer of ESS Safety Forum: Meeting the Challenge two-day workshop and half-day ESS Safety Working group meeting, Santa Fe NM, MRS Endorsed event, February 2017.
5. T. Anderson: Materials and Systems for Grid Energy Storage: Redox Flow Batteries, Spring 2018 MRS, Phoenix, AZ, April 2017.
6. T. Monson: Symposium ES12: Soft Magnetic Materials for Next-Generation Power Electronics, Spring 2017 MRS, Phoenix, AZ, April 2017.
7. T. Nguyen: Session Chair for "Forecasting, Operations, and Planning in Power System" at the 2017 IEEE North American Power Symposium (NAPS), Morgan Town, WV, September 2017.
8. T. Nguyen: Session Chair for "Power System Reliability" at the 2017 IEEE North American Power Symposium (NAPS), Morgan Town, WV, September 2017.

Additional Presentations

Tutorials/Webinars

1. B. Chalamala, R. Byrne, D. Borneo, "The IEEE Power and Energy Society/Energy Storage and Stationary Battery Committee, Tutorial on Energy Storage," Chattanooga, TN, June 2017.
2. B. Chalamala, "Tutorial ES1: Grid-Scale Energy Storage-Materials, Manufacturing, and Systems Aspects," MRS Fall Meeting, November 2016.
3. D. A. Schoenwald, Webinar, "Energy Storage Webinar: Presentation to BPA," July 2017.

4. D. Borneo, CESA Webinar, "Developing an Energy Storage Project – Technical Perspective," March 2017.
5. D. Borneo, SMLD Webinar, "Sandia's Energy Storage Projects," October 2016.
6. D. Rosewater, CESA Webinar, "Comparing the Abilities of Energy Storage, PV, and Other Distributed Energy Resources to Provide Grid Services," March 13, 2017.
7. R. Byrne, CESA Webinar, "The Value Proposition for Energy Storage at the Sterling Municipal Light Department," April 27, 2017.

Seminar Presentations

1. S. Ferreira, "Grid Energy Storage Safety R&D," Sandia National Laboratories Energy Speaker Series
2. T. N. Lambert, E. Allcorn, M. Kelly, J. Duay, L. Leung, G. Nagasubramanian, J. A. Vigil, "Alkaline Zinc-Manganese Oxide Batteries for Grid Storage," 2016 Energy Storage Seminars, Sandia National Laboratories, September 2016.

Technical Briefing to Industry

1. B. Schenkman, presented "Energy Storage and Energy Security" to the following:

a) Gil's River Indian Community Utility Authority

b) Eastern Band Cherokee Indian Council

c) Taos Water Treatment Plant

2. S. Ferreira, provided RFP review of safety aspects for Massachusetts CEC proposals; developed checklist for evaluating safety of proposals and grading criteria.

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