

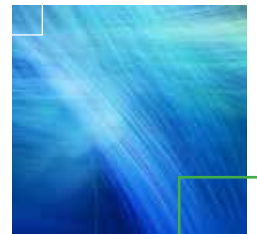
SAND REPORT  
SAND2018-10471M  
Unlimited Release  
September 2018



# PEER REVIEW 2018

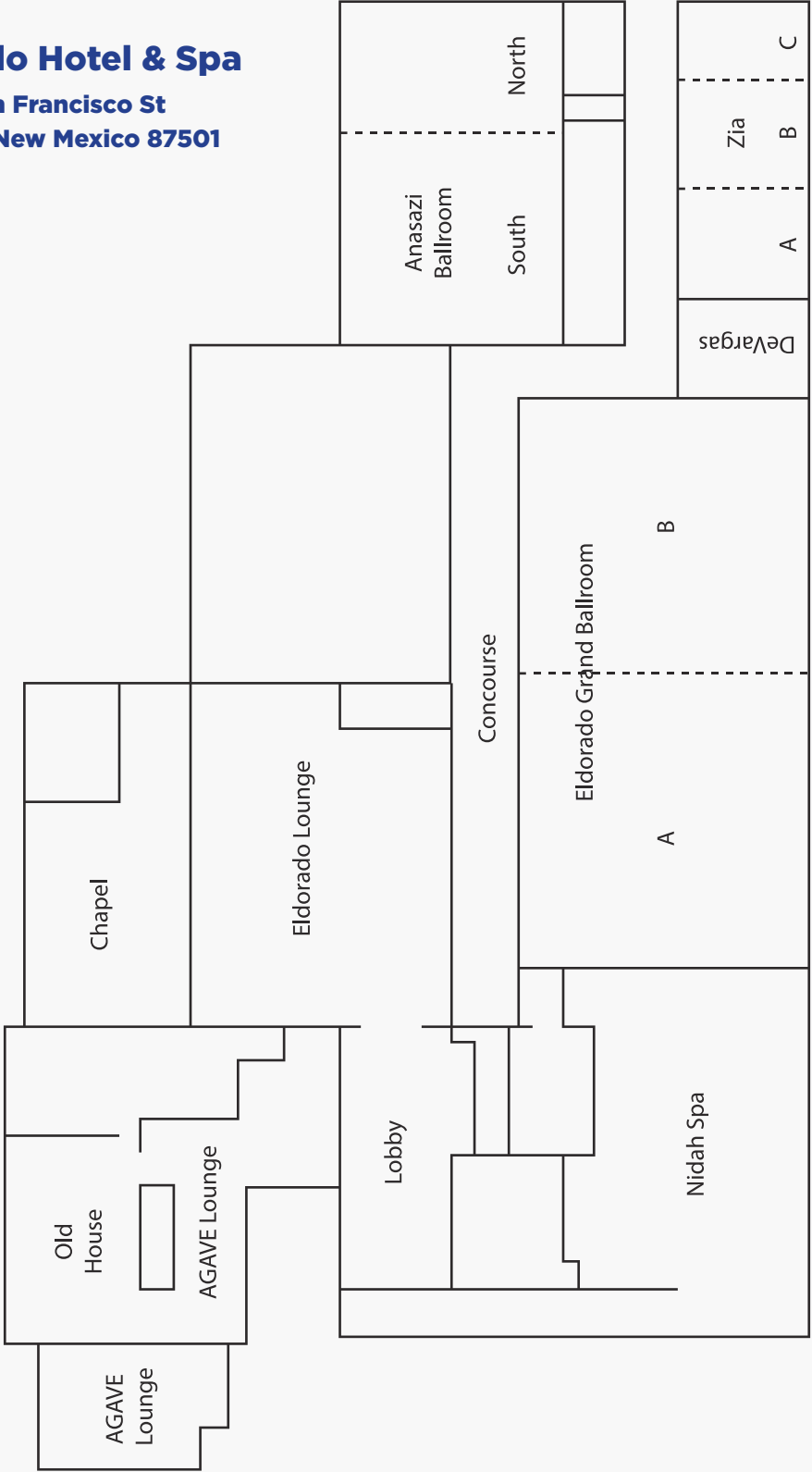
Santa Fe, New Mexico | September 25-27, 2018

## ENERGY STORAGE AND THE MODERN GRID: *Methods, Materials, and Metrics*



# Eldorado Hotel & Spa

309 W San Francisco St  
Santa Fe, New Mexico 87501





## PEER REVIEW 2018

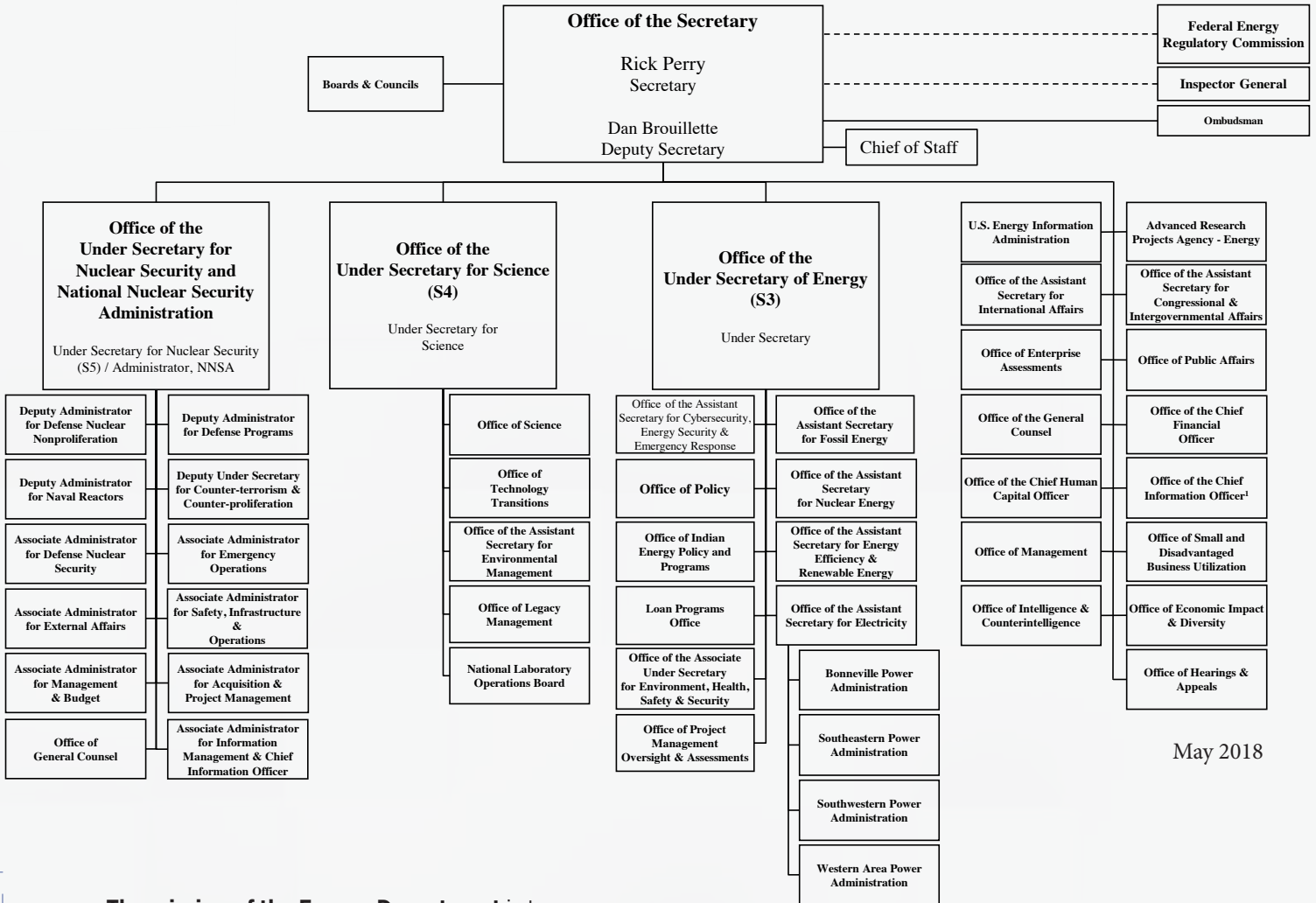
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# U.S. DEPARTMENT OF ENERGY



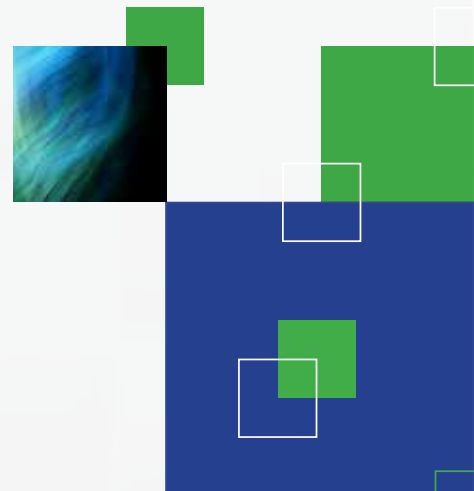
May 2018

**The mission of the Energy Department** is to ensure America’s security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.

The Office of Electricity (OE) provides national leadership to ensure that the Nation’s energy delivery system is secure, resilient and reliable. OE works to develop new technologies to improve the infrastructure that brings electricity into our homes, offices, and factories, and the federal and state electricity policies and programs that shape electricity system planning and market operations.

MISSION: OE drives electric grid modernization and resiliency in the energy infrastructure.

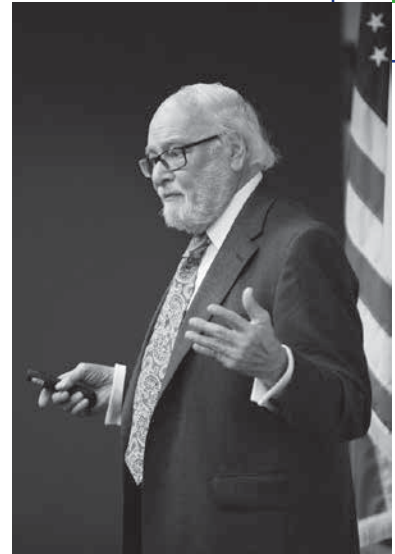
OE leads the Department of Energy’s efforts to ensure a resilient, reliable, and flexible electricity system. OE accomplishes this mission through research, partnerships, facilitation, and modeling and analytics.



# Dr. Gyuk Welcome

**SEPTEMBER 25, 2018**

## **The United States Department of Energy (US DOE) welcomes you to the annual Office of Electricity Delivery and Reliability (OE) Energy Storage Program Peer Review.**



The paper and poster presentations represent a comprehensive picture of the outstanding research, development, and deployment work done over the last year under the Energy Storage Program. The project leaders, their team members, and affiliates will share in detail the depth and breadth of their scientific tasks – their methods, materials, and metrics.

This body of work was achieved through the collaborative efforts of three outstanding labs: Sandia National Laboratories, Pacific Northwest National Laboratory, and Oak Ridge National Laboratory. Over the last year, this team has managed to gain an eighth R&D 100 Award, be issued two new patents with six new patent applications filed, and have twenty technical journals articles published (by mid-July).

Among the greatest achievements over time are the extensive partnerships with academia, industry, utilities, standards organizations,

clearly demonstrating competency in:

- Completion of basic and applied research
- Application of intelligent methods and approaches to research and deployments
- The quality of the research teams and support staff
- Laboratory and facilities use, standards, and best practices

The two-and-a-half-day event features 11 sessions with full papers, a poster session, and a round table to advance energy storage research and deploy up to grid-scale energy storage systems. Conference materials for the Peer Review will be available online after the conclusion of the Peer Review at: <https://www.sandia.gov/ess-ssl/publication/conference-archives/>.

We encourage you to continue engaging with others at this event with our mission in mind.

*Dr. Imre Gyuk, Manager  
Energy Storage Program  
U.S. Department of Energy*



For more than 60 years, Sandia has delivered essential science and technology to resolve the nation's most challenging security issues. Sandia National Laboratories is a multi-mission laboratory managed and operated by the National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Agency. Sandia Corporation operates Sandia National Laboratories as a contractor for the U.S. Department of Energy's National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations. As a Federally Funded Research and Development Center (FFRDC), Sandia may perform work for industry responding to certain types of federal government solicitations.

A strong science, technology, and engineering foundation enables Sandia's mission of national security through a capable research staff working at the forefront of innovation, collaborative research with universities and companies, and discretionary research projects with significant potential impact. Sandia's employees are recognized by their professional peers for their outstanding contributions.

Although most of Sandia's approximately 10,000 employees work at Sandia's headquarters in Albuquerque, New Mexico, or at its second principal laboratory in Livermore, California, others are working at various sites in the U.S. and abroad to deliver innovative and reliable solutions in a changing world.



Discovery in action. These words describe what we do at PNNL, which has been operated by Battelle and its predecessors since our inception in 1965. For more than 50 years, we've advanced the frontiers of science and engineering in the service of our nation and the world. We make fundamental scientific discoveries that illuminate the mysteries of our planet and the universe. We apply our scientific expertise to tackle some of the most challenging problems in energy, the environment, and national security.

Research is our business. With an unwavering focus on our missions, scientists, and engineers at PNNL deliver science and technology. We conduct basic research that advances the frontiers of science. We translate discoveries into tools and technologies in science, energy, the environment and national security.

For more than four decades, our experts have teamed with government, industry, and academia to tackle some of the toughest problems facing our nation. The result: We're delivering the science, technology, and leadership our customers need to succeed.



The Oak Ridge National Laboratory (ORNL) is the nation's largest multi-program science and technology laboratory. ORNL's mission is to deliver scientific discoveries and technical breakthroughs that will accelerate the development and deployment of solutions in clean energy and global security. Today, ORNL pioneers the development of new energy sources, technologies, and materials and the advancement of knowledge in the biological, chemical, computational, engineering, environmental, physical, and social sciences.

Originally known as Clinton Laboratories, ORNL was established in 1943 to carry out a single, well-defined mission: the pilot-scale production and separation of plutonium for the World War II Manhattan Project. The laboratory was also highly involved in isotope research and production. From this foundation, ORNL has evolved into a unique resource for addressing important national and global energy and environmental issues.

The EM program has numerous missions and responsibilities at the ORNL campus, and our employees are focused on removing past legacies and improving environmental health and employee safety—allowing modernization of one of DOE's greatest assets. The main ORNL site occupies approximately 4,470 acres and includes facilities in two valleys: Bethel Valley and Melton Valley.



PEER REVIEW 2018

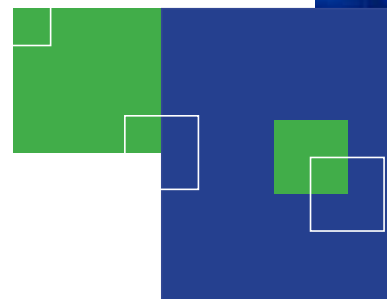
# AGENDA AT A GLANCE

| TUESDAY, SEPTEMBER 25TH |  |
|-------------------------|--|
| ALL DAY                 | REGISTRATION                                     |
| 7:00-8:40am             | Breakfast  |
| 8:45-8:55am             | Facilitator Opening & Introduction               |
| 9:00-9:30am             | DOE Welcome                                      |
| 9:30-9:45am             | Energy Advisory Committee                        |
| 9:50-10:20am            | Laboratories' Summary Overview                   |
| 10:45-11:50am           | Meet the 2018 Peer Reviewers                     |
| 12:00-1:00pm            | <b>Lunch (Provided Onsite)</b>                   |
| 1:00-1:55pm             | Energy Storage R&D and Academic Partners         |
| 2:00-2:40pm             | Energy Storage: Industrial Acceptance            |
| 2:45-3:50pm             | Equitable Regulatory Environment & Status Report |
| 4:00-5:15pm             | Applied Materials I                              |
| 5:30-6:30pm             | <b>Meet &amp; Greet Reception</b>                |

| WEDNESDAY, SEPTEMBER 26TH |  |
|---------------------------|--|
| ALL DAY                   | REGISTRATION   |
| 7:00-8:30am               | Breakfast  |
| 8:30-9:00am               | Energy Storage / Industry Acceptance: Demonstrations and Deployment  |
| 9:00-9:45am               | Energy Storage for Grid Resilience                                   |
| 10:00-10:50am             | Power Electronics  |
| 11:00-11:55am             | New Energy Storage Technologies                                      |
| 12:00pm                   | <b>Lunch (Provided Onsite)</b>                                       |
| 1:05-2:00pm               | Energy Storage Safety & Reliability                                  |
| 2:00-3:00pm               | ES - Applied Materials II  |
| 3:15-4:15pm               | Focus on ES Partnerships and Collaborations With Industry & Academia |
| 4:20-4:50pm               | 2018 ES Poster Session Introductions                                 |
| 5:00-6:30pm               | Poster Session & Interviews  |

| THURSDAY, SEPTEMBER 27TH |  |
|--------------------------|--|
| 7:30-9:00am              | Breakfast  |
| 9:00-10:00am             | Innovative Next Steps & Funding Opportunities Round Table Discussion |
| 10:00-10:30am            | DOE OE Closeout Remarks  |

# PARTICIPATING INSTITUTIONS\*



## ACADEMIA

Case Western Reserve University (PNNL)  
CCNY City University of New York (SNL)  
Clemson University (SNL)  
Davidson College (SNL)  
Harvard University (PNNL)  
Michigan State University (SNL)  
New Mexico State University (SNL)  
New Mexico Tech (SNL)  
Northeastern University (SNL)  
Ohio State University (SNL)  
Pennsylvania State University (PNNL)  
Santa Fe Community College (SNL)  
South Dakota State University (SNL)

Southern Methodist University (SNL)  
Stony Brook University (SNL)  
University of Alaska (SNL, PNNL)  
University of Arkansas (SNL)  
University of California Irvine (SNL)  
University of Kentucky (SNL)  
University of Tennessee (ORNL, PNNL, SNL)  
University of Texas Arlington (SNL)  
University of Texas Austin (SNL)  
University of Utah (SNL)  
University of Washington (PNNL, SNL)  
Washington University in St Louis (SNL)  
West Virginia University (PNNL)

## INDUSTRY

ANZA Electric (SNL)  
AVISTA (PNNL)  
Blue Sigma (PNNL)  
Burlington Electric Department (SNL)  
Cordova Electric Cooperative (SNL)  
Creare (SNL)  
CSA Group (PNNL)  
Demand Energy (PNNL, SNL)  
Ecoult Battery (SNL)  
Electric Power Research Institute (PNNL, SNL, ORNL)  
EnerG2 (PNNL)  
Eugene Water & Electric Board (EWEB)  
Electric Power Board of Tennessee (SNL, ORNL)  
Energy Northwest (PNNL)  
GoldenShare Mining (PNNL)  
GeneSiC Semiconductor (SNL)  
General Motors (ORNL)  
Green Mountain Power (SNL)  
Habitat for Humanity (ORNL)  
Hawaii Electric Light (PNNL, SNL)  
Helix Power (SNL)  
Integrated Energy Storage (PNNL)

ITN Energy Systems (PNNL)  
Los Alamos County (LAC)  
Mustang Prairie Energy (SNL)  
Navajo Tribal Utility Association (NTUA)  
National Grid (PNNL)  
National Rural Electric Cooperative Association (NRECA)  
Orcas Power and Light (PNNL)  
Pohang Oil and Steel (POSCO)  
Public Service of New Mexico (PNM)  
Puget Sound Energy (PNNL)  
Pure Vanadium (PNNL)  
Riverside Specialty Chemicals (PNNL)  
Shell North America (PNNL)  
Snohomish Public Utility District (PNNL)  
Spiers New Technologies (ORNL)  
Sterling Municipal Light Department (SNL)  
Strategen Consulting (SNL)  
Ultra Power (PNNL)  
UniEnergy Technologies (PNNL, SNL)  
Urban Electric Power (SNL)  
WattJoule (ORNL, PNNL, SNL)





## STATE PARTNERS

California Energy Commission (CEC)  
Connecticut Dept of Energy (SNL) (CT Deep)  
Massachusetts Department of Energy Resources (Mass CEC)  
New Mexico Energy, Minerals and Natural Resources Department (EMD)  
Natural Energy Lab of Hawaiian Authority (NELHA)

## FEDERAL PARTNERS

Bonneville Power Administration (SNL, PNNL)  
DOE Energy Efficiency and Renewable Energy  
Fuel Cell Technology Office (PNNL, SNL)  
Hydropower (PNNL)  
Buildings Technologies Office (PNNL)  
National Highway Transportation and Safety Administration (PNNL)

## STANDARDS BODIES

CSA Group (PNNL)  
IEEE Energy Storage & Stationary Battery Committee (SNL, PNNL, ORNL)  
IEC (PNNL, SNL)  
Underwriters Laboratories (PNNL)  
NFPA (SNL)



\*subject to change due to mission, nature of project(s)

The mission of the Electricity Advisory Committee is to provide advice to the U.S. Department of Energy in implementing the Energy Policy Act of 2005, executing the Energy Independence and Security Act of 2007, and modernizing the nation's electricity delivery infrastructure.

**John Adams**

Electric Reliability Council of Texas

**Christopher Ayers**

NC Utilities Commission Public Staff

**Tom Bialek**

San Diego Gas & Electric Company

**Laney Brown**

AVANGRID

**Paul Cicio**

Industrial Energy Consumers of America

**Armond Cohen**

Clean Air Task Force

**Robert Cummings**

North American Electric Reliability Corporation

**Ann Delenela**

Ameren

**Kimberly Denbow**

American Gas Association

**Andrew (Drew) Fellon**

Trane Energy Supply Services

**Flora Flygt**

American Transmission Company (Ret.)

**Sheri Givens**

Givens Consulting

**Lisa Grow**

Idaho Power

**Michael Heyeck**

The Grid Group LLC  
*Committee Chair*

**Paul Hudson**

General Infrastructure, LLC

**Lola Infante**

Edison Electric Institute

**Mladen Kezunovic**

Texas A&M University

**Clay Koplín**

Cordova Electric Cooperative

**Arthur Kressner**

Grid Connections, LLC

**Charlotte Lane**

West Virginia House of Delegates

**Shaun Mann**

Tri-State Generation and Transmission

**Jeff Morris**

WA State House of Representatives

**Richard S. Mroz**

Resolute Strategies

**Bryan Olnick**

Florida Power and Light

**Delia Patterson**

American Public Power Association

**Darlene Phillips**

PJM Interconnection

**Anda Ray**

Electric Power Research Institute

**Wanda Reder**

Grid-X Partners, LLC  
*Committee Vice Chair*

**Pam Silberstein**

National Rural Electric Cooperative  
Association

**Ramteen Sioshansi**

The Ohio State University

**Marcos Valenzuela Ortíz**

National Control Center for Energy in Mexico (CENACE)

**David Wade**

Electric Power Board of Chattanooga

**Tom Weaver**

American Electric Power

**\*membership as of July 2018**



# TUESDAY | SEPTEMBER 25, 2018

## 7:00am EVENT REGISTRATION

|                     |   |  |  |
|---------------------|---|--|--|
| <b>7:00-8:40am</b>  | Breakfast                                       |  |  |
| <b>7:30-8:40am</b>  | Peer Reviewer's Breakfast & Information Meeting | Gina Fresquez<br>J. Hernandez                        | Sandia National Laboratories   |
| <b>8:45-8:55am</b>  | Facilitator Opening & Introductions             | James Greenberger                                    | NAATBatt International   |
| <b>9:00-9:30am</b>  | DOE Welcome                                     | Dr. Imre Gyuk  | US Department of Energy<br>Office of Electricity Delivery and Energy Reliability                       |
| <b>9:35-9:45am</b>  | Electricity Advisory Council                    | Ramteen Sioshansi                                    | The Ohio State University  |
| <b>9:50-10:20am</b> | Laboratories' Summary Overview                  | Michael Starke<br>Vincent Sprenkle<br>Babu Chalamala | Oak Ridge National Laboratory<br>Pacific Northwest National Laboratory<br>Sandia National Laboratories |

## MORNING BREAK

|                      |                              |                                   |  |
|----------------------|------------------------------|-----------------------------------|--|
| <b>10:45-11:50am</b> | Meet the 2018 Peer Reviewers | James Greenberger,<br>Facilitator |  |
|----------------------|------------------------------|-----------------------------------|--|

## 12:00pm LUNCH (PROVIDED ONSITE)

### 1:00-1:55pm ENERGY STORAGE R&D AND ACADEMIC PARTNERS

|   |                 |                               |
|---|-----------------|-------------------------------|
| Session Chair   | Erik Spoerke    | Sandia National Laboratories  |
| Alkaline Zn-MnO <sub>2</sub> Batteries                  | Sanjoy Banerjee | City University of New York   |
| Advanced Capacitors for Future Power Conversion Systems | Bruce Gnade     | Southern Methodist University |

### 2:00-2:40pm ENERGY STORAGE: INDUSTRIAL ACCEPTANCE

|   |                  |                                       |
|---|------------------|---------------------------------------|
| Session Chair   | Patrick Balducci | Pacific Northwest National Laboratory |
| Battery Storage State of Health Model   | Vish Viswanthan  | Pacific Northwest National Laboratory |
| Control System Enhancement Using the Optimization Performance Evaluation Tool | Jan Alam         | Pacific Northwest National Laboratory |
| HECO Demand Response Program  | Di Wu            | Pacific Northwest National Laboratory |

### 2:45-3:50pm EQUITABLE REGULATORY ENVIRONMENT & STATUS REPORT

|   |                             |   |
|---|-----------------------------|---|
| Session Chairs                              | Ray Byrne<br>Rebecca O'Neil | Sandia National Laboratories<br>Pacific Northwest National Laboratory |
| Energy Storage: State Regulatory Engagement | Jeremy Twitchell            | Pacific Northwest National Laboratory                                 |
| ES Valuation Optimization Tool              | Ricky Concepcion            | Sandia National Laboratories  |

|   |                |                              |
|---|----------------|------------------------------|
| Optimal Sizing of Behind-the-Meter Energy Storage with Stochastic Load and PV Generation for Islanded Operation | David Copp     | Sandia National Laboratories |
| Optimal Time-of-Use Management with Power Factor Correction Using Behind-the-Meter Energy Storage Systems       | Tu Nguyen      | Sandia National Laboratories |
| Energy Storage & Financing  | Richard Baxter | Mustang Prairie              |

## AFTERNOON BREAK

### 4:00-5:15pm APPLIED MATERIALS I

|  |                 |                                       |
|--|-----------------|---------------------------------------|
| Session Chair  | Wei Wang        | Pacific Northwest National Laboratory |
| Flow Battery Electrolyte Chemistry Development         | Vijay Murugesan | Pacific Northwest National Laboratory |
| Aqueous Soluble Organic (ASO) Flow Battery Development | Aaron Hollas    | Pacific Northwest National Laboratory |
| Intermediate Temperature Na-Metal Halide Development   | Guosheng Li     | Pacific Northwest National Laboratory |
| Na-ion Battery Development                             | Xiaolin Li      | Pacific Northwest National Laboratory |
| Li-ion Reliability                                     | Daiwon Choi     | Pacific Northwest National Laboratory |

### 5:30-6:30pm MEET & GREET RECEPTION

## WEDNESDAY | SEPTEMBER 26, 2018

### 7:00am EVENT REGISTRATION

7:00-8:30am Breakfast

### 8:30-9:00am ENERGY STORAGE / INDUSTRY ACCEPTANCE: DEMONSTRATIONS AND DEPLOYMENT

|   |              |                               |
|---|--------------|-------------------------------|
| Session Chair   | Dan Borneo   | Sandia National Laboratories  |
| Applications that Reduce the Use of Gensets   | Craig Kuntz  | Cordova Electric Cooperative  |
| NEC Lithium-Ion ESS located at Howard Elementary: Resiliency and Utility Support (EWEB) | Matt Ibaraki | Eugene Water & Electric Board |

### 9:00-9:45am ENERGY STORAGE FOR GRID RESILIENCE

|  |                    |                              |
|--|--------------------|------------------------------|
| Session Chair                                      | Frank Currie       | Sandia National Laboratories |
| ESS on ANZA Grid for T&D and Resiliency Support    | Frank Currie       | Sandia National Laboratories |
| Multi-objective Labs for Energy Storage Resiliency | Benjamin Schenkman | Sandia National Laboratories |
| Grid Stability Using Distributed Energy Storage    | David Schoenwald   | Sandia National Laboratories |

# WEDNESDAY | SEPTEMBER 26, 2018 *(continued)*

## MORNING BREAK

### 10:00-10:50am POWER ELECTRONICS

|  |                   |                              |
|--|-------------------|------------------------------|
| Session Chair  | Stan Atcitty      | Sandia National Laboratories |
| Power Dense Converter Electronics for Grid-tied ESS                  | Bruce Pilvelait   | Creare                       |
| All-SiC Power Module for Grid-tied Energy Storage                    | Ranbir Singh      | GeneSic                      |
| Smart GaN-based Inverters for Grid-tied ESS                          | Medhi Ferdowsi    | InnoCit                      |
| Reliability Characterization of Wide-Band Gap Semiconductor Switches | Slobodyan Oleksiy | Sandia National Laboratories |

## MORNING BREAK

### 11:00-11:55am NEW ENERGY STORAGE TECHNOLOGIES

|  |                   |                                    |
|--|-------------------|------------------------------------|
| Session Chair  | Michael Starke    | Oak Ridge National Laboratory      |
| Low Cost Membrane Separators for High Energy Density Organic Radical Mediated Flow Batteries | Ethan Self        | Oak Ridge National Laboratory      |
| Processes in Components for the Redox Flow Battery   | Tom Zawodzinski   | University of Tennessee, Knoxville |
| Novel Ground Level Integrated Diverse Energy Storage (GLIDES)                                | Ayyoub Momen      | InnoCit                            |
| Power Electronics Based Grid Integration Technology for Energy Storage Applications          | Madhu Chinthlavai | Oak Ridge National Laboratory      |

### 12:00pm LUNCH (PROVIDED ONSITE)

### 1:05-2:00pm ENERGY STORAGE SAFETY & RELIABILITY

|  |                   |                                       |
|--|-------------------|---------------------------------------|
| Session Chair  | Summer Ferreira   | Sandia National Laboratories          |
| Aging and Abuse of Commercial Li-ion Cells   | Summer Ferreira   | Sandia National Laboratories          |
| Battery Abuse Test Development   | Josh Lamb         | Sandia National Laboratories          |
| Using Modeling to Predict & Mitigate Thermal Runaway   | John Hewson       | Sandia National Laboratories          |
| Codes and Standards Development Activities in the US – What's Happening & Why it's Important to Energy Storage | Charlie Vartanian | Pacific Northwest National Laboratory |

**2:00-3:00pm ES - APPLIED MATERIALS II**

|  |                              |                              |
|--|------------------------------|------------------------------|
| Session Chair  | Travis Anderson              | Sandia National Laboratories |
| Alkaline Batteries for Grid Storage Applications   | Tim Lambert                  | Sandia National Laboratories |
| Membranes for Flow Battery Applications  | Cy Fujimoto                  | Sandia National Laboratories |
| Aqueous-Soluble Organic Flow Battery Chemistry with Long Lifetime in Weak Alkaline Electrolyte | Michael Aziz                 | Harvard University           |
| Relating Membrane Materials Properties to Crossover Mechanisms in Flow Batteries               | Travis Anderson<br>Leo Small | Sandia National Laboratories |
| Materials Advances for Molten Sodium Batteries   | Erik Spoerke                 | Sandia National Laboratories |

**AFTERNOON BREAK****3:15-4:15pm FOCUS ON ES PARTNERSHIPS AND COLLABORATIONS WITH INDUSTRY & ACADEMIA**

|  |                   |  |
|--|-------------------|--|
| Session Chair  | David Rosewater   | Sandia National Laboratories                   |
| Update on Energy Storage System Safety Roadmap Codes and Standards Activities                        | Charlie Vartanian | Pacific Northwest National Laboratory          |
| On the Role of Energy Storage in the Operation of Future Fossil Free Utilities                       | Robb Thomson      | National Institute of Standards and Technology |
| Demonstration of a kW Class Redox Battery Using an Advanced Bi-additive Vanadium Sulfate Electrolyte | Brian Berland     | ITN Energy Systems                             |
| Improving Stability of Battery Additives and Electrolytes Using Redox Non-Innocent Ligand Complexes  | Mitch Anstey      | Davidson College (North Carolina)              |

**4:20-4:50pm** 2018 ES Poster Session Introductions James Greenberger NAATBatt International

**5:00-6:30pm** Poster Session & Interviews

**Dinner - On your own**

**THURSDAY | SEPTEMBER 27, 2018**

**7:30-9:00am** Breakfast

|                      |  |               |                              |
|----------------------|--|---------------|------------------------------|
| <b>9:00-10:00am</b>  | Innovative Next Steps & Funding Opportunities Round Table Discussion | Abbas Akhil   | Revtx                        |
| <b>10:00-10:30am</b> | DOE OE Closeout Remarks  | Dr. Imre Gyuk | US Department of Energy      |
| <b>8:00-11:00am</b>  | Completed Peer Review Evaluations Accepted Onsite                    | J. Hernandez  | Sandia National Laboratories |

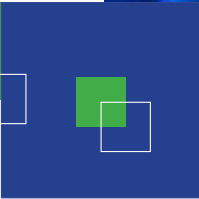
**THANK YOU AND TRAVEL WELL!**

# DOE OE ENERGY STORAGE PEER REVIEW POSTER SESSION

WEDNESDAY | SEPTEMBER 26, 2018

| POSTER TITLE   | PRESENTER                   | ORGANIZATION                          |
|--|-----------------------------|---------------------------------------|
| <b>NEW ENERGY STORAGE TECHNOLOGIES</b>   |                             |                                       |
| <b>Oak Ridge National Laboratory</b>   |                             |                                       |
| Development of a Large Secondary Use System with Multi-Chemistry Aspects   | Michael Starke              | Oak Ridge National Laboratory         |
| Determination of Thermal Runaway Risks of Li-ion Batteries Used in Energy Storage  | Hsin Wang                   | Oak Ridge National Laboratory         |
| <b>MATERIALS I</b>   |                             |                                       |
| <b>Pacific Northwest National Laboratory</b>   |                             |                                       |
| Flexible Na-metal Halide Electrolyte Development   | Xiaochun Lu                 | Pacific Northwest National Laboratory |
| Neutral pH, Reversible Zn-MnO <sub>2</sub> Battery Development   | Huilin Pan                  | Pacific Northwest National Laboratory |
| Zn-MnO <sub>2</sub> Battery Characterization   | Hee Jung Chang              | Pacific Northwest National Laboratory |
| Advances in Na-ion Battery Electrodes  | Biwei Xiaa                  | Pacific Northwest National Laboratory |
| Mechanistic Understanding of Vanadium Electrolyte Additives  | Zimin Nie                   | Pacific Northwest National Laboratory |
| <b>SAFETY AND RELIABILITY</b>  |                             |                                       |
| <b>Pacific Northwest National Laboratory</b>   |                             |                                       |
| Redox Flow Reliability Testing with NRC  | Bin Li                      | Pacific Northwest National Laboratory |
| <b>REGULATORY</b>  |                             |                                       |
| <b>Pacific Northwest National Laboratory</b>   |                             |                                       |
| Integrated Resource Planning (IRP) Analysis  | Jeremy Twitchell            | Pacific Northwest National Laboratory |
| <b>INDUSTRIAL ACCEPTANCE</b>   |                             |                                       |
| <b>Pacific Northwest National Laboratory</b>   |                             |                                       |
| Market Analysis Results for Shell North America's Small Modular Pumped Storage Hydro Unit  | Kendall Mongird             | Pacific Northwest National Laboratory |
| Washington Clean Energy Fund Energy Storage Demonstration Projects: GridScale Battery Operation Performance Test Results, Modeling & Reliability | Alastair Crawford           | Pacific Northwest National Laboratory |
| <b>SAFETY AND RELIABILITY</b>  |                             |                                       |
| <b>Sandia National Laboratories</b>  |                             |                                       |
| Physics-based Models for Thermal Runaway Heating Rates: Advanced Anode Models  | Randy Shurtz<br>John Hewson | Sandia National Laboratories          |





| POSTER TITLE  | PRESENTER   | ORGANIZATION                 |
|---|---|------------------------------|
| Predicting and Preventing Cascading Thermal Runaway   | Andrew Kurzawski<br>Randy Shurtz<br>John Hewson     | Sandia National Laboratories |
| Degradation Mechanisms of Overcharged Li-ion Batteries  | Loraine Torres-Castro<br>Josh Lamb                  | Sandia National Laboratories |
| Aging Behavior and Abuse Response of Commercial Lithium-ion Cells as a Function of Chemistry and Cycling Conditions | Yuliya Preger<br>Summer Ferreira                    | Sandia National Laboratories |
| Modeling Lithium-ion Battery Internal Temperature Under Load with Convective Cooling                                | Austin Mier<br>David Rosewater                      | Sandia National Laboratories |
| Simulated Venting Flow from 18650 Format Lithium-ion Batteries Incorporating Optical Diagnostics                    | Austin Mier<br>Michael Hargather<br>Summer Ferreira | Sandia National Laboratories |
| Modeling Uncertainty in Grid-Connected Electrochemical Energy Storage Systems                                       | David Rosewater                                     | Sandia National Laboratories |

## DEMONSTRATIONS AND DEPLOYMENT

### Sandia National Laboratories

|   |                     |  |
|---|---------------------|--|
| Update on the Natural Energy Laboratory of Hawai'i Authority (NELHA)<br>Energy Storage Systems Projects | Laurence Sombardier | NELHA                                  |
| Helix Power Flywheel: Motor Back Iron Test – Eddy Current Heating                                       | Matthew Lazarewicz  | Helix Power Corporation                |
| Cordova Electric Cooperative (CEC) – Applications that Reduce the Use of Diesel Gensets                 | Craig Kuntz         | Cordova Electric Cooperative (CEC)     |
| NEC Lithium-ion ESS Located at Howard Elementary: Resiliency and Utility Support (EWEB)                 | Matt Ibaraki        | Eugene Water and Electric Board (EWEB) |
| Energy Storage Technology Advancement Partnerships (ESTAP) Program; Engaging the States                 | Todd Olinsky-Paul   | Clean Energy States Alliance (CESA)    |
| Energy Storage Demonstrations – Validation and Operational Optimization                                 | Todd Olinsky-Paul   | Clean Energy States Alliance (CESA)    |
| An Overview of the Microgrid at Santa Fe Community College (SFCC)                                       | Stephen Gomez       | Santa Fe Community College (SFCC)      |
| DOE/SNL Webinars: Expanding an Energy Storage Knowledge Hub   | Mark Higgins        | Strategen                              |

## ENERGY STORAGE FOR GRID RESILIENCE

### Sandia National Laboratories

|   |                  |                              |
|---|------------------|------------------------------|
| Energy Storage Lab – Test Controls for Energy Storage Systems                 | Ben Schenkman    | Sandia National Laboratories |
| Navajo Tribal Utility Authority (NTUA): ESS Installations in Remote Locations | Frank Currie     | Sandia National Laboratories |
| ESS Data Acquisition Project Update   | Frank Currie     | Sandia National Laboratories |
| Grid Stability Using Distributed Energy Storage                               | David Schoenwald | Sandia National Laboratories |

| POSTER TITLE  | PRESENTER                                | ORGANIZATION  |
|---|--|---|
| <b>ES PARTNERSHIPS &amp; COLLABORATIONS</b>   |  |   |
| <b>Pacific Northwest National Laboratory</b>  |  |   |
| The IEEE Energy Storage Task Force – A New Team to Address Energy Storage Challenges                            | Charlie Vartanian                        | Pacific Northwest National Laboratory               |
| Battery Reliability Laboratory at PNNL  | David Reed                               | Pacific Northwest National Laboratory               |
| Comprehensive Cell Design and Testing for Low Cost Na-metal Halide Batteries                                    | Guosheng Li                              | Pacific Northwest National Laboratory               |
| <b>EQUITABLE REGULATORY ENVIRONMENT</b>   |  |   |
| <b>Sandia National Laboratories</b>   |  |   |
| Optimal Time -of- Use Management with Power Factor Correction Using Behind-the-Meter Energy Storage Systems     | Tu Nguyen                                | Sandia National Laboratories                        |
| Evaluation of Grid-Scale Energy Storage for T&D Deferral and Resiliency   | Tu Nguyen                                | Sandia National Laboratories                        |
| Optimal Sizing of Behind-the-Meter Energy Storage with Stochastic Load and PV Generation for Islanded Operation | David Copp                               | Sandia National Laboratories                        |
| QuEST: an Energy Storage Evaluation Application Suite   | Ricky Concepcion                         | Sandia National Laboratories                        |
| Electrical Energy Storage Participation in the NYISO Electricity and Frequency Regulation Markets               | Felipe Wilches-Bernal                    | Sandia National Laboratories                        |
| Models for Evaluation and Optimization of Grid-Scale Energy Storage   | Atri Bera<br>Joydeep Mitra               | Michigan State University                           |
| <b>POWER ELECTRONICS</b>  |  |   |
| <b>Sandia National Laboratories</b>   |  |   |
| Power Dense Converter Electronics for Grid-tied Energy Storage Systems  | Bruce Pilvelait                          | Creare  |
| All SiC Power Module for Grid-Tied Energy Storage   | Ranbir Singh                             | GeneSic Semiconductor                               |
| Smart Ga N-Based Inverters for Grid-Tied Energy Storage Systems   | Medhi Ferdowsi                           | Innocit   |
| Reliability Characterization of Wide-Band Gap Semiconductor Switches  | Robert (Bob) Kaplar<br>Slobodyan Oleksiy | Sandia National Laboratories                        |
| Power Electronics Laboratory for Energy Storage Optimization (PELESO)   | Jacob Mueller<br>M A Moonem              | Sandia National Laboratories                        |
| Advanced Magnetics for Next Generation Power Converters used in Grid-tied Energy Storage Systems                | Ryan Reeves                              | Mainstream Engineering Corp                         |
| Nanoengineered Soft Magnetics Materials   | Haixiong Tang                            | Powdermet, Inc.                                     |
| Extreme Distributed Storage for Photovoltaic Systems  | Valerio De Angelis<br>Satish Ranade      | Urban Electric Power<br>New Mexico State University |
| Medium-voltage Power Electronics for Grid-tied Energy Storage   | Anant Argawal                            | The Ohio State University                           |
| Low Voltage and High Current Bidirectional Converter for Grid-tied Flow Battery Energy Storage System           | Alex Huang                               | University of Texas at Austin                       |



| POSTER TITLE  | PRESENTER            | ORGANIZATION                         |
|---|----------------------|--------------------------------------|
| Connecting Alaska Remote Villages using Medium Voltage Intertie System                              | Mariko Shirazi       | University of Alaska Fairbanks       |
| Micro Dual Active Bridge for Grid Storage   | Satish Ranade        | New Mexico State University          |
| Monolithic SiC Semiconductor Switch Development   | Ranbir Singh         | GeneSiC Semiconductor                |
| Advanced Capacitors for Future Power Conversion System  | Bruce Gnade          | Southern Methodist University        |
| High Frequency Link Converters using Advanced Magnetics<br>Todd Monson Sandia National Laboratories | Todd Monson          | Sandia National Laboratories         |
| High Temperature Reliable Dielectrics for DC-link Capacitors  | Harlan Brown-Shaklee | Sandia National Laboratories         |
| Reliable High-performance Gate Oxides for WBG Devices   | Peter Dickens        | Sandia National Laboratories         |
| Designing High Temperature Optocoupler for Future High Density Power Module                         | Syam Madhusoodhanan  | University of Arkansas, Fayetteville |

## MATERIALS II

### Sandia National Laboratories

|   |                                       |   |
|---|---------------------------------------|---|
| Flow Battery Prototyping and Testing Facility   | Harry Pratt, III                      | Sandia National Laboratories                        |
| Ions on the Loose: Quantifying Crossover in Aqueous-Organic Redox Flow Batteries                                | Travis Anderson<br>Leo Small          | Sandia National Laboratories                        |
| Membrane Development for Flow Batteries   | Cy Fujimoto                           | Sandia National Laboratories                        |
| Rechargeable Alkaline Zinc-Manganese Oxide Batteries for Grid Storage   | Matthew Lim<br>Tim Lambert            | Sandia National Laboratories                        |
| Evaluation of a Ceramic Separator for use in Rechargeable Alkaline Zn/MnO <sub>2</sub> Batteries                | Jonathon Duay<br>Tim Lambert          | Sandia National Laboratories                        |
| Soluble Metal Sulfide Superatoms for Aqueous Flow Batteries   | Christopher Bejger                    | University of North Carolina (Charlotte)            |
| Molten Salt Catholyte Development for Low Temperature Na-Halide Batteries                                       | Erik Spoerke                          | Sandia National Laboratories                        |
| Sodium Ion-Conducting Separator Development   | Erik Spoerke                          | Sandia National Laboratories                        |
| Open Data, Models, and Codes for Static Redox Flow Batteries  | Seongbeom Lee<br>Venkat Subramanian   | University of Washington                            |
| Advanced Battery Manufacturing Initiative   | Sanjoy Banerjee<br>Valerio De Angelis | City University of New York<br>Urban Electric Power |
| Stable Zinc Anodes for High-Energy-Density Rechargeable Aqueous Batteries                                       | Damon Turney                          | City College of New York                            |
| Ab Initio Studies of Electrolytic MnO <sub>2</sub> in Shallow-Cycled Rechargeable Zn/MnO <sub>2</sub> Batteries | Igor Vasiliev<br>Birendra Ale Magar   | University of Arkansas, Fayetteville                |

# BIOGRAPHICAL NOTES

## **JAMES GREENBERGER**

*Event Facilitator*

*Executive Director, National Alliance for Advanced Technology Batteries*

Jim Greenberger is the Executive Director of the National Alliance for Advanced Technology Batteries (NAATBatt), a not-for-profit trade association of companies involved in the manufacture of large format advanced batteries for automotive and grid-connected energy storage applications. Mr. Greenberger co-founded the predecessor of NAATBatt in 2008.

Prior to leading NAATBatt, Mr. Greenberger practiced law for more than 25 years, most recently as a partner at Reed Smith LLP in Chicago, where he led its cleantech practice group. Mr. Greenberger's law practice focused on mergers and acquisitions, private equity and venture capital transactions. He has represented some of the leading private equity and venture capital firms in the country and published several articles on private equity transactions and structures. He also writes a weekly column entitled "Executive Director's Notes" in the NAATBatt Advanced Battery Weekly.

In addition to his duties at NAATBatt, Mr. Greenberger serves on the Board of Directors of the Association for Corporate Growth-Chicago, on the governing board of the Kentucky-Argonne Battery Manufacturing Center, and is the principal of Private Equity Law Advisors, a private law practice in Chicago. He is a past chair of the Commercial Finance & Transactions Committee of the Chicago Bar Association and a member of the American Bar Association. He is a graduate of Haverford College and the University of Michigan Law School.

## **CURTIS ASHTON**

*Century Link*

Curtis has 26 years of experience in telecommunications backup power and grounding, following 4 years working at an electric utility generation station. He has been published and has presented numerous times around the world. He is the vice-chair of IEEE PES ESSB (Energy Storage & Stationary Battery) technical committee, and the vice-president of IEEE PELS TC7 (annual intelec conference). He served a term on IEEE RevCom (standards Review Committee). And, he is also the chair of the technical committee for the annual Battcon conference.

## **ERIK BRANDON**

*Jet Propulsion Laboratory*

Dr. Erik Brandon received the Ph.D. degree in Inorganic Chemistry from the University of Utah in 1997, followed by a post-doctoral fellowship at the California Institute of Technology. Dr. Brandon joined the staff of the Jet Propulsion Laboratory (JPL) in 1999, and is a Research Technologist focused on a wide range of development efforts in the areas of materials and devices for power generation, energy storage and sensors for space exploration. He is currently the Technical Group Supervisor for the Electrochemical Technologies Group at JPL, which is comprised of 20 staff members including 10 Ph.D. level researchers. Dr. Brandon initiated a new research thrust at JPL in the area of supercapacitor technologies in 2005, to support wide temperature and high power applications. Specific efforts

he has led as principal investigator include the development of integrated passive components and micro-batteries for miniaturized small spacecraft power sources, flexible electronics and multi-functional materials for deployable space structures, advanced thermoelectric couples for power generation, primary batteries for deep space missions and supercapacitors and supercapacitor/hybrid battery technologies for extreme environment applications. He is currently the battery lead for the Europa Lander pre-project.

### **STEPHEN BUKOWSKI**

*Director of New Technology Integration, El Paso Electric Company*

Steve Bukowski, El Paso Electric Co.

As an electrical engineer of 26 years, Steve has worked with a diverse background of various companies in several different fields of electrical engineering, including Power and Energy systems, telecommunication, data networking, and the communication industry as director of research, chief architect, senior managing engineer, lead engineer, systems engineer, senior consultant, technical sales, and integration and test engineer. His current focus at EPE is developing a technology vision and roadmap in support of EPE corporate goals and implementing the road map with strategic objectives. Steve's goals at EPE include shifting EPE to a technology position preparing it for external and internal pressures from rapid advances of technology, increased regulation, changing legislation, changing workforce, and climate change.

### **GARTH COREY**

*Retired, Sandia National Laboratories*

After more than 15 years at Sandia, Garth P. Corey, recently retired as a Principal Member of the Technical Staff. He had project management responsibilities with the Energy Infrastructure and Distributed Energy Resources Department. Most of his Sandia career was dedicated to communicating his system engineering and battery system management expertise to engineers involved in the integration of various energy storage technologies.

He has managed projects spanning the utility scale energy storage arena, including flywheels and ultra capacitor systems, sodium sulfur, nickel cadmium, lead acid, (including advanced lead-acid technologies), and lithium ion batteries, and several flow battery technologies. Much of his time was dedicated to assisting Sandia Renewable Power engineers in the proper integration of batteries in off-grid and grid-tied Photovoltaic systems.

He is a member of the IEEE Power and Energy Society and is active with the PES Stationary Battery Committee. In addition to continuing his association with Sandia as a consultant, with responsibilities related to electric energy storage system development, he is also very active in a consulting role to industry in the evaluation of emerging energy storage technologies for distributed energy and storage applications on the national grid.

# BIOGRAPHICAL NOTES

## **JOE ETO**

*Lawrence Berkeley National Laboratory*

Joe Eto is a staff scientist at the Lawrence Berkeley National Laboratory where he serves as the strategic advisor for the Electricity Markets and Policy Group and for the Energy Storage and Demand Resources Division. He supports the U.S. Department of Energy's Office of Electricity by coordinating and conducting grid research supported by the Advanced Grid R&D program, notably in the area of synchrophasors and microgrids. He also supports OE's Transmission Permitting and Technical Assistance program by conducting research and analysis on electricity reliability and resilience topics and on transmission planning and policies. He has authored over 250 publications on frequency response, transmission planning, electricity reliability metrics, trends and reliability value based planning, power quality, distributed generation, energy efficiency, and demand response.

## **FLORA FLYGT**

*DOE Electricity Advisory Committee*

Flora Flygt was in the electric utility industry for approximately 35 years in a variety of planning and leadership positions. She has worked for Madison Gas & Electric Company, Alliant Energy, and American Transmission Company LLC (ATC). She was involved in many innovative electric planning approaches including leading the development of integrated resource planning and participating in demand-side planning at Madison Gas & Electric Company. She implemented a leading-edge strategic flexibility approach to investment decisions at Alliant Energy, where she was Director of Corporate Research and Market Planning. As Director of Transmission Planning at ATC, Flora led the development of the first economically justified transmission project in MISO and of ATC's first Multi-Value Projects approved by MISO in 2011. She has been an expert witness on transmission planning, long-term electric forecasting, demand-side planning, and integrated resource planning. She has presented at and chaired many industry conferences and was very actively involved in the Eastern Interconnection Planning Collaborative. Flora holds an M.S. degree in Land Resources with a Master's certificate in Energy Analysis & Policy from the University of Wisconsin-Madison and a B.A. degree in Economics from the University of Michigan-Ann Arbor. Currently, Flora is an industry representative on the U.S. Department of Energy's Electricity Advisory Committee.

## **JONATHAN HAWKINS**

*Manager of Advanced Technology and Strategy, PNM Resources*

Jonathan Hawkins is the Manager of Advanced Technology and Strategy at PNM Resources, an energy holding company based in Albuquerque New Mexico. Jonathan's team is responsible providing research and development of new technologies and the proposal of possible business applications of emerging technologies in support of PNM Resources strategic objectives. Areas of responsibility include "smart grid" technologies and strategy, integration of distributed energy resources; plug in hybrid electric vehicles, and storage technologies. Jonathan Hawkins received his Bachelor of Science degree in Electrical Engineering from the University of New Mexico in 1994. After graduation, he went to work for Sumitomo Sitix Silicon, Inc. as an engineer responsible for semiconductor pre and post production material characterization. Jonathan joined PNM Resources in 2002 where he managed PNM's Distribution

Standards organization, which provides material specifications and model standards for design and construction of utility infrastructure. In 2010 he became the Manager of the Advanced Technology group. Jonathan is a member of the Institute of Electrical and Electronics Engineers (IEEE), a member of the Research Advisory Committee to EPRI as well as an advisor to multiple individual research programs, and an invited reviewer for proposals to the Department of Energy.

### **MICHAEL HOFF**

*CTO and VP of Research and Technology, NEC Energy Solutions, Inc.*

Michael Hoff has over 30 years of experience in electric utilities, uninterruptible power supplies, advanced energy storage, battery systems, communications, manufacturing and construction. He is currently CTO and VP of Research and Technology and directs the research and modeling of advanced energy storage technologies at NEC.

Mr. Hoff was the first member of A123's Energy Solutions Group, where he helped build the core systems engineering capability for the company before it was acquired by NEC. Before that, Mr. Hoff served 18 years in various roles developing UPS products for American Power Conversion. This experience gave him broad exposure in energy storage technologies, power control, electronic controls and communications, manufacturing processes and the power market. Michael holds a BS in Electrical Engineering and Power from Drexel University, and a MS in Electrical Engineering and Power from Northeastern University.

### **JEREMY LEWIS**

*State of New Mexico, EM&NR Department*


Jeremy Lewis has a B.S. degree in Natural Resource Studies from the University of Massachusetts and a Masters of Community and Regional Planning degree from the University of New Mexico. His current role with the New Mexico Energy Office includes developing and managing programs in renewable energy, energy efficiency and alternative transportation. He currently serves as a board member for the Clean Energy States Alliance, chairs the New Mexico Renewable Energy Storage Working Group and is former chair of Albuquerque Public Schools' Water & Energy Conservation Committee. Jeremy has served as a Transmission Policy Analyst with Western Resource Advocates, as a Peace Corps Volunteer expanding sustainable agriculture in Central Africa, and as an AmeriCorps Volunteer for literacy and conservation programs in Northern New Mexico.

### **MADHAV MANJREKAR**

*University of North Carolina, Charlotte*

Dr. Madhav Manjrekar, Senior Member of IEEE, is an Associate Professor at the University of North Carolina in Charlotte and also serves as an Assistant Director of the Energy Production & Infrastructure Center (EPIC). Named as an e4 Carolinas Emerging Leader in Energy in 2015, Dr. Manjrekar has led technology and innovation teams in the areas of energy and power systems for more than 15 years. Prior to joining academia in 2012, he worked as the Vice President of Global Research and Innovation at Vestas (the wind turbine company), and previously has held various leadership

# BIOGRAPHICAL NOTES



and management positions at Siemens, Eaton and ABB. Dr. Manjrekar holds 10 US and international patents, has published over 55 journal and conference papers and has received multiple IEEE prize paper awards. He has also served on various task forces, including High Mega-Watt Leadership Team of National Institute of Standards and Technology, the Smart Grid Task Force of North American Electric Reliability Corporation, IEEE Standard P2030, and on review panels for ARPA-E, and the National Science Foundation. Dr. Manjrekar's research interests are in applications of power electronics in utility power systems and variable speed motor drives, interfaces for renewable power generation and energy storage, smart grids, and cyber vulnerability of electric infrastructure. Dr. Madhav Manjrekar received his B.E. degree from Government College of Engineering, Pune, India, his M.Tech. from Indian Institute of Science, Bangalore, India, M.S. from Montana State University, Bozeman, Montana, and Ph.D. from University of Wisconsin, Madison, Wisconsin, in 1993, 1995, 1997, and 1999 respectively.

## **NEVILLE MOODY**

*Retired, Sandia National Laboratories*

Neville Moody obtained his PhD degree in Materials Science from the University of Minnesota in 1981. After joining Sandia National Laboratories, his research focused on the determination of hydrogen effects on deformation and fracture in titanium, stainless steels, and superalloys, employing experimental testing, modeling, and simulation techniques. For the past 20 years his research has included the study of deformation and fracture on the submicron scale in thin films and small volumes. He has given more than 100 invited presentations and authored or co-authored more than 170 publications, including invited reviews and chapters in the encyclopedia on Comprehensive Structural Integrity and the encyclopedia of Gaseous Hydrogen Embrittlement of High Performance Metals in Energy Systems. Dr. Moody has co-organized three International Conferences on Hydrogen Effects in Materials, three International Conferences on Environmental Damage in Structural Materials, three regional materials and welding technology conferences, and 23 symposia for materials societies and topical conferences. He co-chaired the 2005 MRS Spring Meeting in San Francisco and was vice chair 2012 and chair 2014 of the Gordon Conferences on Thin Film and Small Volume Mechanical Behavior. He served as the Director of Programming on the TMS Board of Directors from 2012 until 2015. He also managed the Sandia National Laboratories Energy Nanomechanics Department from 2011 until 2015. Dr. Moody is an active member of several TMS and MRS committees and is a Fellow of ASM International and MRS.

## **MUKUND MUKUNDAN**

*Los Alamos National Laboratory*

Mukundan's research focuses on fuel cells, electrochemical gas sensors and energy storage devices. He is a steering committee member for the Department of Energy's Fuel Cell Consortium for Performance and Durability (FC-PAD), where he coordinates the thrust area Operando Evaluation (i.e. evaluation of working fuel cells to determine how to improve the performance and durability). The thrust area includes benchmarking, accelerated stress testing, and contaminants. He is the co-inventor of six U.S. patents, has authored more than 125 papers, and is the principal investigator of a 2017 Los Alamos Laboratory Directed Research and Development (LDRD) project titled "Flow Cells for Scalable Energy Conversion and Storage."



Mukundan has received the Electrochemical Society's J.B Wagner Award of the High Temperature Materials Division and the Sensor Division Outstanding Achievement Award, the highest recognition the division can bestow on an ECS member. He is also the technical editor for ECS journals in the area of sensors and measurement sciences, and previously served on the Board of Directors and as chair of the Sensor Division.

He earned a Ph.D. in materials science and engineering from the University of Pennsylvania, and joined Los Alamos in 1997 as a postdoctoral fellow. He became a staff scientist in 1999.

### **VITTAL S. RAO**

*Texas Tech University*

Dr. Vittal S. Rao is a professor of Electrical & Computer Engineering and Director at the Smart Grid Energy Center (SGEC) at Texas Tech University. His research interests include Cyber Security of SCADA Control Systems, Smart Grid and Microgrid Systems, Smart Structural Systems, Control of Wind Turbines; Cyber Security of Smart Grid Systems; Robust Control Systems. He has supervised 198 publications, developed three courses in smart structures and structural health monitoring and a state-of-the-art research laboratory in Smart Grid using the Major Research grant of NSF. Dr. Rao received his Ph.D at the Indian Institute of Technology in New Delhi.

### **ROBERT REUSS**

Dr. Robert Reuss has consulted to government organizations since 2006. He was a DARPA Program Manager in the Microsystems Technology Office from 2001 to 2006. He was responsible for several research thrusts into fabrication of flexible, large area electronics including high mobility TFTs for digital and RF applications and organic photovoltaics, as well as conventional microelectronics efforts that included exploiting mainstream semiconductor processes for high performance analog, mixed signal RF and MMW applications, reconfigurable, multi-core processor design, asynchronous logic design methodology, and sub-threshold, ultra-low power operation. Since September 2006, he has been an independent consultant. Prior to joining DARPA, Dr. Reuss spent twenty years in various technology and research management positions with Motorola. Earlier, he worked for the U.S. government as a research and development manager for seven years and was a Research Faculty member at the University of Colorado for three years. Dr. Reuss received a Ph.D. in Chemistry from Drexel University in 1971. He has published over 50 papers and has been awarded 13 U.S. patents. His technology interests lie in the area of application of materials and electrochemistry technologies for advanced microelectronic applications and microsystems integration as well as large area electronics.

Recently he was the recipient of the 2018 FLEXI Awards Innovation and Leadership in Flexible Hybrid Electronics Technology Champion.

### **RAMTEEN SIOSHANSI**

*The Ohio State University*

Ramteen Sioshansi is a professor in and the associate chair of the Department of Integrated Systems Engineering and an associate fellow in the Center for Automotive Research at The Ohio State University. He holds a B.A. in economics and applied mathematics and an M.S. and Ph.D. in industrial engineering and operations research



# BIOGRAPHICAL NOTES

from the University of California, Berkeley and an M.Sc. in econometrics and mathematical economics from the London School of Economics and Political Science. Prior to joining OSU, he was a postdoctoral research fellow at the National Renewable Energy Laboratory.

His research focuses on the integration of advanced energy technologies, including renewables, energy storage, and electric transportation, into energy systems. He also works in energy policy and electricity market design, especially as they pertain to advanced energy technologies.

He has published numerous academic journal articles and serves on the editorial boards of the Foundations and Trends in Energy Markets and Policy, IEEE Transactions on Power Systems, Journal of Energy Engineering, IET Renewable Power Generation, and Journal of Modern Power Systems and Clean Energy. He received the 2010 Campbell Watkins Energy Journal Best Paper Award from the International Association for Energy Economics. He is currently serving a third term on the Electricity Advisory Committee of the U.S. Department of Energy and is chair of its Energy Storage Subcommittee.

## **REINALDO TONKOSKI**

Reinaldo Tonkoski (S'04, M'11) received his B.A.Sc. degree in Control and Automation Engineering, in 2004, his M.Sc. in Electrical Engineering in 2006 from PUC-RS (Pontifícia Universidade Católica do RS), Brazil, and his Ph.D. in 2011 from Concordia University, Canada. He was with CanmetENERGY, Natural Resources Canada, from January 2009 to January 2010 where he worked on projects related to the grid integration of renewable energy sources. Presently, Reinaldo is an Assistant Professor in the Electrical Engineering and Computer Science Department, South Dakota State University, Brookings, US. He has authored over 60 technical publications and is a Member of the IEEE. Reinaldo's research interests include grid integration of renewable energy systems, distributed generation, power quality, and power electronics.

## **ANTHONY VAN BUUREN**

*Deputy Division Director for Materials Science, Lawrence Livermore National Laboratory*

Dr. Tony Van Buuren is currently working as a Professor in the Department of Materials Science Division, Lawrence Livermore National Laboratory, United States. His research interests includes Materials Science . He is serving as an editorial member and reviewer of several international reputed journals. Dr. Tony Van Buuren is the member of many international affiliations, and has authored many research articles and books related to Materials Science.

## **S. CAT WONG**

*Entergy Services, Inc.*

Cat Wong, Ph.D., P.E., PMP is leading the planning, design, and implementation activities of Distributed Energy Resources (utility and retail scale) at Entergy, including PV, battery storage, micro-grids, etc. She is a registered Professional Engineer in the State of Louisiana. She was the lead of the Real Time Simulation Lab and performed hardware-in-the-loop simulation. She supported PMU deployment, transmission and distribution standard development, protection studies, and planning analysis. Prior to joining Entergy, Cat was invited to work with the real time simulation development team at the Hydro Quebec Research Institute in Montreal, Canada.

### **ALEXANDER HEADLEY** (Observer)

Alexander Headley recently joined the Energy Storage Technology & Systems department at Sandia National Laboratories. Here, his research will center around evaluating the potential of hydrogen storage for grid support, integrated system design, and the development of demonstration facilities for grid-connected energy storage. His previous work at Sandia focused on experimental and modeling support for thermal battery design efforts. Before joining Sandia, Alex earned his master's and doctorate in mechanical engineering from The University of Texas at Austin where he developed new methods of modeling and assessing the state-of-health of Proton Exchange Membrane (PEM) fuel cell systems.

### **HOWARD PASSELL** (Observer)

Howard Passell works in the Strategic Futures Group at Sandia National Laboratories in Albuquerque, New Mexico. His work focuses on emerging national security issues associated with water, energy, food, ecosystems (including climate), and population, with an emphasis on the relationships between resource scarcity and human security. Over the years his work has included resource monitoring, modeling, management, capacity building, and policy-related projects at various scales in the US, Central Asia, the Middle East, and North Africa. He teaches as an adjunct professor in the Water Resources Program at the University of New Mexico. His undergraduate studies were in classical literature and the liberal arts at St. John's College in Santa Fe, NM, and the Ohio State University in Columbus, Ohio. He earned his master's and doctorate degrees in conservation biology and hydrogeocology at the University of New Mexico.

### **SUSAN SCHOENUNG** (Observer)

Dr. Susan Schoenung, a registered Professional Engineer in California, holds a Bachelor of Science Degree in Physics from Iowa State University and a Masters and Doctorate in Mechanical Engineering from Stanford University.

She is President of Longitude 122 West, Inc., an energy consulting firm in Menlo Park, California, specializing in design and analysis of renewable energy systems, energy storage and alternative fuel infrastructure. Longitude 122 West is a member of the Energy Storage Association, EPRI Energy Storage Integration council, California Energy Storage Association and California Hydrogen Business Council. Dr. Schoenung has performed energy systems analysis for the US Department of Energy, Clean Energy States Alliance, Electric Power Research Institute and numerous industry clients. Previously, she worked for Chevron Research Laboratories, Bechtel Engineering and Schafer Associates.



**UPCOMING EVENTS:**

**Zinc Battery Workshop  
November 2018**

**Energy Storage Safety &  
Reliability Workshop  
March 2019**



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