



Summary of 2018 Conference

In this inaugural conference, the organizers planned technical discussions inclusive of faculty, researchers, regulators, technology developers, community leaders, and utility/ISO experts on the newest of technologies and applications of energy storage. The conference included invited and contributed presentations, panel discussions, industry exhibition, poster contest, and networking reception. The theme of the conference focused on two pillars of energy storage technologies as well as system integration, operation, and business models for energy storage across a variety of applications.

The highlights of discussions in this year included but not limited to:

- Impact of California Energy Storage Policies and Activities on Recent Growth in the Energy Storage Market
- Current and Future Horizon for Energy Storage Industry
- Grid Integration and Applications of Battery Energy Storage
- Alternative and Innovative Energy Storage Technologies
- Latest Advances and Next Generation of Battery Energy Storage
- California Rule 21 and IEEE1547-2018 standard for Energy Storage Integration



The conference was structured around technical program, poster session, and industry exhibition during which regional experts presented their works.

The technical program was varied with a keynote speaker as well as 18 invited speakers, panelists and moderators from industry sectors, universities, national laboratories, and regulatory agencies. The technical program was a combination of presentation sessions and discussion panels. In each presentation session, the invited speakers talked about the best practices, lessons learned, and future opportunities in the field. During each discussion panel a knowledgeable moderator and expert panelists discussed on a timely topic and shared their perspectives.

In the poster session, students presented posters from past and ongoing projects relevant to the topics areas of the conference. The poster presentations were evaluated based on technical and presentation criteria by judging committee, and three awards were granted to the contest winners during the closing remark.

This year we were also pleased to provide technical demonstrations through industry exhibitors. During the industry exhibition, the latest advancement in related technologies and also ongoing and active projects in the field were presented by industry participants. Finally, the conference provided numerous opportunities for informal networking and discussion.

Keynote Presentation

The conference's keynote speaker, Mr. Mike Gravely, who is the team leader for energy technology systems integration of the energy research and development division at California Energy Commission (CEC), talked about "How California energy storage policies and activities are impacting the recent growth in the energy storage market". He started with statistics regarding the energy storage market growth in recent years as well as the market growth projection up to 2022. He continued with current status of the nationwide energy storage procurements and CPUC targets for deployment of energy storage in California. Then he summarized the role and plan of state to drive innovations and to meet targets. Finally, he concluded with some examples of successful projects funded by CEC in energy storage area including three compressed air energy storage projects, six flow batteries projects, two zinc-air batteries projects, eight projects on lithium-Ion batteries, four on electric vehicle solutions, two sodium sulfur batteries, and two flywheels related projects.



Presentation Session 1: Current and Future Horizon for Energy Storage Industry



In this panel the speakers discussed the current state and the roadmap for adoption of energy storage technologies. The discussions included the current challenges facing this industry and the path to effectively overcome the barriers, as well as the opportunities for energy storage. In addition, it described the role of policy, technology, and business advancements for accelerating the energy storage market, and growing its benefits. The session started by Mr. Rahul Chopra's talk on "Energy Storage – Disrupter of energy sector". Rahul, the Leader of Grid Integration Group at the Energy Storage & Distributed Resources Division of Lawrence Berkeley National Laboratory, discussed about the barriers and roadmap for grid integration of energy storage addressing some of the existing challenges of power grid. He listed the grid market necessities and technical requirements for energy storage. Based on these requirements, he emphasized the need for further research and development on next generation of battery energy storage, packing and integration as well as characterization, modeling and operation. The session continued by presentation of Mr. Ed Cortez, the principal electrical engineer at Riverside Public Utility (RPU), on "Energy Storage at Riverside Public Utilities". Ed talked to us about benefits and applications of energy storage at distribution system. He explained the benefits of energy storage to RPU through four categories including 1) Power Distribution System Support such as voltage regulation, 2) Distribution Upgrade Deferral 3) Distribution Equipment Life Extension, and 4) Substation On-site Power.

Panel 1: Grid Integration and Applications of Battery Energy Storage



During the first panel, moderated by Mr. Erik Bakke, Senior Account Executive at EnerNOC- an Enel Group Company, the speakers discussed their experiences and viewpoints on successful implementations, the promising applications, emerging markets, significant values, and innovative advancements in integration of energy storage technologies. The discussions also included the breakthroughs that enhance the performance, lower the costs, and improve the economics of energy storage. In specific, Mr. Kent Redwine talked about a vision for new energy by leveraging technology and building vertical integrated manufacturing facility to achieve significant cost savings solution. Dr. Seyed Madaeni focused on integration of distributed energy resources in competitive electricity markets. He started with explaining the existing challenges with today's grid. Then he introduced energy storage as an effective solution to benefit both utilities and host clients. He continued with describing how economically optimize the operation of energy storage systems across multiple revenue streams to harness maximum value. Dr. Antonio Tong talked about integration, testing and valuation of energy storage systems within a microgrid. He demonstrated economic valuation of energy storage system in stack applications by presenting a case study. Finally, Mr. Michael Lee presented a case study of control systems that enable value-stacking with multiple stakeholders including ISO, Utility, and end-use customers. He also shared some lessons learned and execution considerations for energy storage integration in front of the meter.

Presentation Session 2: Efforts in Enhanced Energy Storage Operation & Safety

In this session, the speaker, Mr. Richard J. Bravo, presented various innovative monitoring, controls, and operation management methods as well as technologies and standards to improve the capabilities of energy storage systems, and enhance safety. To this end, under the topic of "Storage Smart Functions", he explained the advanced features of smart inverters, compatible with CA Rule 21 and IEEE1547 standards. He described how these features may be used for grid integration of inverter-interfaced energy storage systems. He demonstrated the test results and



potential benefits for the features including voltage ride-through, frequency ride-through, dynamic Volt/Var control, Volt-Watt control, Ramp Rates, reconnect by soft start, and frequency-watt control.

Panel 2: Alternative and Innovative Energy Storage Technologies

The focus of panel 2 was on developing, demonstrating, and commercializing novel technologies of alternative energy storage, including fuel cells, thermal storage, compressed air energy storage, supercapacitors and other non-battery-based energy storage technologies. This panel was moderated by Mr. Jin Noh, Policy Manager at California Energy Storage Alliance (CESA). Mr. Matt Gregori started the panel by introducing Power-to-Gas technology as a way to store large amount of energy for long durations. He summarized some of the advantages of this type of energy storage, and concluded his talk by demonstrating highlights of a real-world project. Prof. Pirouz Kavehpour gave an overview on different energy storage technologies including a comparison based on energy and power capacity, performance, efficiency and cost. Then he focused on Compressed Air Energy Storage (CAES), challenges and promises. He presented a modified hybrid Thermal-CAES design and showed how it could maximize the efficiency and minimize the cost. The last but not least speaker in this panel, Mr. David Lentsch illustrated the practical use of supercapacitors in grid and microgrid for applications which require high power density, Fast response, and repetitive cycling. He also showed how hybrid energy storage systems including supercapacitor and battery can optimize and expand stacked grid services.



Panel 3: Latest Advances and Next Generation of Battery Energy Storage

The Speakers in panel 3 presented and discussed various innovative technologies, materials, and processes to improve the characteristics, performance, and costs of battery energy storage technologies based on their applications in different industry sectors. Dr. Juchen Guo, the panel moderator, started the discussion by introducing four panelists. Then, Dr. Will West gave a talk on energy storage and conversion technologies for space applications. He mentioned some of the consideration for deploying energy storage for space projects such as Europa Orbiter, Mars Helicopter, InSight, and Europa Lander. Then he discussed about research on disruptive new energy storage technologies for extreme environments with capability of operation at high/low temperature, robust recovery from boil/freeze events, and high radiation tolerant. The second panelist, Prof. Mihri Ozkan, explained the future outlook for electric vehicle batteries. She talked about battery technology including sulfur cathode, li-metal anode and solid electrolyte. Dr. GJ la O' presented an innovative Zinc Bromide Flow-Battery for grid scale energy storage. He presented several pilot projects in which flow battery is helping utility, commercial, industrial, microgrid and data center customers generate savings. Finally, Prof. Sarah Tolbert explained using nanoscale architectures to improve stability and power density in batteries and pseudocapacitors. She

outlined that the full cell pseudocapacitive systems- as an essential part of supercapacitors- with good rate capabilities will be on the market soon.



Poster Session

One of the highlights of the conference was the student poster presentation sessions. The committee accepted twenty two posters for presentation at the conference this year from both graduate and undergraduate student teams. The teams were from many universities including UC Riverside, California State University Northridge, University of Washington, University of Virginia, California Baptist University, and Instituto Tecnológico de Costa Rica. The student poster presentation sessions witnessed an enthusiastic participation from the conference attendees particularly from the industry professionals. The posters included a variety of innovative topics such as control approaches for battery storage operation, developing new applications and testbeds for energy storage integration, the coupling of energy storage and electric vehicle charging applications, design and analysis of advanced electrolytes for Li-ion batteries, developing new models for electrochemical behavior of batteries, and more.



There were active discussions going on during poster presentation sessions, which not only informed attendees on some of the frontier projects carried on across multiple participating academic institutions, but also provided a unique opportunity for students to expose their work to outside academia and receive feedback and comments from the attendees. The committee also received feedback and evaluations from the attendees to select the contest awards. Based on evaluations, the committee announced the contest awards. The first place poster award plus \$1000 cash prize went to the team from California State

University Northridge while the second and third place awards with \$ 400 and \$ 200 cash prizes went to two teams of graduate and undergraduate students from UCR. In addition, five student teams received a certificate of honorable mention for their work.



Industry Exhibition

The Industry exhibition section of the conference provided a great opportunity for networking and showcase of products, services, successful projects demonstrated in the area of energy storage and renewable generation. Several companies from California, and across US, including **OPAL-RT Technologies, Origis Energy, Sunrun, EnerBlu, SolarMax, EPCpower, and Biogass engineering** participated and hosted booths at the conference. The presented companies were all active in the area of renewable energy and energy storage systems, spanning product and system development, system integration and deployment, software and modeling tools, and consulting services.



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For more information about the conference please visit: <http://www.wcgec.ucr.edu/events.html>