# Day 1—September 21, 2022, 1:00 to 5:00 p.m. Mountain Time

## Welcome, Call to Order

Song Wang, Modeling and Validation Subcommittee (MVS) Chair, called the meeting to order at 1:06 p.m. MT on September 21, 2022. A quorum was present to conduct business. A list of attendees is attached as Exhibit A.

## Review WECC Antitrust Policy

Doug Tucker, System Stability Senior Engineer, read aloud the WECC Antitrust Policy statement. The meeting agenda included a link to the posted policy.

## Approve Agenda

Mr. Wang introduced the proposed meeting agenda.

**On a motion by Spencer Tacke, the MVS approved the agenda.**

## Review and Approve Previous Meeting Minutes

Maddy Eberhard, Administrative Coordinator, introduced the minutes from the meeting on May 16, 2022.

Mr. Tacke submitted edits to Ms. Eberhard and Mr. Tucker to update.

**By consensus, the MVS approved the minutes from May 16, 2022.**

## Review Previous Action Items

Ms. Eberhard reviewed action items carried over from the MVS meeting on May 16, 2022. Action items that are not closed and will be carried forward can be found [here](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/MVS%20Action%20Items.pdf&action=default&DefaultItemOpen=1).

## Review Approved Dynamic Modeling List

Mr. Tucker stated that entities should review the “Unapproved models – 23HS4a.xlsx” and suggest updates. Most of the entries on this list are either Phase 1 Wind Models or the REEC\_B Models, which are no longer approved.

## Power Plant Modeling

Quincy Wang, British Columbia Hydro and Power Authority, provided a brief update of the roadmap and proposed that the committee send out a status update inquiry for all software vendors for their excitation systems.

Philip Cui, British Columbia Hydro and Power Authority, presented an update for the GENTPJ model saturation function and its three versions. The committee discussed the parameters of the field current error comparison between versions that were compared, including the curve of calculated field current and test field current.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/WECC%20MVS_2022_09_21.pdf&action=default&DefaultItemOpen=1).

Eric See-Toh, Powertech Labs, went through an application example of one of the machines that was modeled using the GENQEC model and project parameters for open circuit testing. He continued to present the results of varied tests and concluded that it was a successful application to model validation using original data from the equipment manufacturer.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/GENQEC%20Model%20Workshop.pdf&action=default&DefaultItemOpen=1).

Lin Zhu, Electric Power Research Institute (EPRI), presented an overview of techniques for tuning power system stabilizers. The main issue that Mr. Zhu discussed was that natural oscillation events have occurred in continental Europe, and they occur frequently. Both the local stabilizers—Power System Stabilizer (PSS) and Wide-Area Damping Controller (WADC)—can support and improve the damping ratio of target oscillation mode. The committee discussed the ringdown measurements, Power Oscillation Damper (POD) on inverter-based resources (IBR), and actuators.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/PSS_Tuning_WECC_MVS_Sep2022_EPRI_Lin.pdf&action=default&DefaultItemOpen=1).

Mr. Wang presented the guideline and techniques for field tuning PSS with recordings taken from on-site tests The presented field tuning results cover PSS with both static and brushless excitation systems. Simulation results were also compared with the field recording to validate the PSS model.

Not included in his presentation, Mr. Wang suggested an update about the status of IEEE-421.5-2016 excitation system model implementation. PowerWorld had implemented all the new models last year, but some vendors had the plan to implement some models in 2022; but not all the vendors, and not all the models have implementation plans.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/PSS%20Gain%20Tuning.pdf&action=default&DefaultItemOpen=1).

Kwami Sedzro, National Renewable Energy Laboratory, presented on modeling turbine dynamics for the discussion of why it is important to reflect the availability in hydraulic turbine dynamic modeling. Ideally, there would be a switch to a hybrid tool at some point. The committee discussed the parameters of other models such as HDAM.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/KwamiSedzro_turbine_dynamic_modeling_gaps_and_recommendations.pdf&action=default&DefaultItemOpen=1).

John Undrill, an independent subject matter expert, gave an update on GENOPZ. Because there is a difficult sub-transient representation, but a good representation of magnetization saturation, Mr. Undrill suggests that the other GEN models—such as GENROU, GENTPJ, and GENTPF—be retired. The committee discussed the GENOPZ model performance Mr. Undrill presented. GENOPZ’s simplification in sub-transient feedback needs further discussion.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/JohnUndrillgenopzSep2022.pdf&action=default&DefaultItemOpen=1).

Gregory Brooks, U.S. Army Corp of Engineers, gave an update on the parameters for GENTPJ and GENTPZ and noted that they were identical.

# Day 2—September 22, 2022, 8:30 a.m. to 12:00 p.m. Mountain Time

## Load Modeling

Bo Gong, Salt River Project, presented a brief description of what the Load Model Work Group (LMWG) is working on and its plans. The committee discussed the online or short-term operations planning, using the composite load model in an energy management system (EMS).

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/LMWG_roadmap_BG%20-%20long-term%20plan.pdf&action=default&DefaultItemOpen=1).

Chris Gilden, Tri-State, presented information about a performance slowdown in the GE PSLF software v22.03 that was associated with the composite load model. Mr. Gilden detected this slowdown when he was testing a generator model.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/MVS%209_21_2022.pdf&action=default&DefaultItemOpen=1).

Shruti Dwarkanath Rao, GE Energy Consulting Group, added to the comments made by Mr. Gilden, stating that the 2204 model has had a parameter introduced called “adjcap\_delta.” This is a threshold at which, if the change in the fraction tripped in the composite mode model exceeds that threshold between consecutive time steps, then the network matrix is rebuilt with the default value of the threshold, which is 0.001. The parameter can be increased to 0.1 for simulations that see a significant slowdown. It is not an issue in PowerWorld or Power System Simulator for Engineering (PSS/E).

Katy Waechter, NREL, presented information about the behind-the-meter (BTM) solar development and how it affects residential, commercial, and industrial areas. The committee discussed BTM distributed photovoltaic (DPV) siting and capacity factor profiles, as well as aggregation and supply.

The presentation is posted to the [WECC website.](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/20220922_nrel_wecc_btmdpv_mvs.pdf&action=default&DefaultItemOpen=1)

Nick Hatton, System Stability Engineer, presented what WECC does with the composite load models and how they are generated. WECC goes through the data from the base cases and removes anything that is not a valid climate zone and feeder combination type. The committee discussed the presented oscillation charts that were observed with distributed generation (DG) and the parameters of the models. The MVS also discussed the recommendation for WECC planning cases that should be turning off the frequency response to the DER\_A model in the composite load model. This will be discussed in depth at the next meeting.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/WECC%20load%20modeling%20development%20for%20base%20cases%20-%20Hattonv2.pdf&action=default&DefaultItemOpen=1).

Jay Senthil, Siemens Energy, Inc., provided an update on the load modeling. Mr. Senthil and his company built all the necessary application programming interfaces before breaking into the composite load model. This allows the PSS/E to read the dynamics data file. The data file can also have a PSS/E library. The load component models are going to be different than the current load characteristic model. The committee discussed the components for the static model and load composite models.

Kannan Sreenivasachar, ISO-NE, presented the LMWG updates. The committee discussed the NERC modeling activity, including the single-face motor C model that needs to be approved and whether this model needs to be benchmarked.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/September_2022_MVS_Mtg_presentation.pdf&action=default&DefaultItemOpen=1).

Parag Mitra, EPRI, presented the data center modeling for transmission planning and how it is becoming more important. Mr. Mitra spoke about what data centers look like and how the U.S. is far ahead for how many data centers it houses. This is important because data centers can be more energy-intensive than normal commercial buildings. He presented the typical setup for a data center and what data needs to be collected. The committee discussed data center cooling systems depending on the data center’s geographic location and how it will use model systems.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/DataCenterModeling_MVS_PM.pdf&action=default&DefaultItemOpen=1).

# Day 2—September 22, 2022, 1:00 to 5:00 p.m. Mountain Time

## Renewable Energy Modeling

Songzhe Zhu, GridBright, presented an update for the roadmap of renewable energy modeling. The committee discussed electromagnetic modeling transient (EMT) models and that they are needed for detailed studies, e.g., subsynchronous resonance (SSR). The committee also discussed that generic models are not appropriate for project-specific studies related to high-frequency control and interactions and SSR.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/1-REMWG%20roadmap%2020220922.pdf&action=default&DefaultItemOpen=1).

Pouyan Pourbeik, PEACE, presented the memo for second-generation RES model updates. REGC\_C is the only thing that has not been approved. Mr. Pourbeik would like to add this as an approval item for the next MVS meeting.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Memo_RES_Modeling_Updates_091922_Rev22_Clean.pdf&action=default&DefaultItemOpen=1).

Deepak Ramasubramanian, EPRI, presented the benchmark results for REGC\_C tests from PowerWorld, PSS/E, and positive sequence load flow (PSLF). Mr. Pourbeik continued the discussion by summarizing the test results of REGC\_C and that this model has been used from 2019 and tested against real-life data as well. The committee discussed the control logic and parameters of the models as well as the approval process for the REGC\_C. The committee discussed the concerns that the REGC\_C model should not be used to completely replace all existing REGC\_A or REGC\_B models, but is an additional model to be used when necessary (e.g., in weak-grid scenarios), as well as seeking vendor input on REGC\_C model. The committee decided that the model updates memo would be revised to reflect the discussion above on the usage of REGC\_C, and at least one vendor at the meeting expressed their support, so such vendor support will be brought to the next meeting. The above model will be up for approval in the upcoming MVS meeting in January 2023.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/REGC_C%20Model%20Benchmarking.pdf&action=default&DefaultItemOpen=1).

Mr. Pourbeik presented the memo for new plant and electrical control modules for Version E with new features. The committee discussed how this model does not need to be based on a generator, or anything at all, but it can be connected to a bus if needed. They also discussed the parameters of the new model that the plant is on the megavolt-ampere base of all downstream units online.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Memo_RES_Modeling_Updates_For_New_Plant_and_Electrical_Controls_091922.pdf&action=default&DefaultItemOpen=1).

Dmitry Kosterev, Bonneville Power Administration, presented the frequency response in high IBR scenario information. The committee discussed the conclusions Mr. Kosterev provided, including fast frequency response.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/IBR%20Grid%20Forming%20vs%20Following%20Frequency%20Response.pdf&action=default&DefaultItemOpen=1).

Wei Du, PNNL, presented the updates for the comparison between hardware testing and simulation results for droop grid forming model (GFM). The committee discussed the difference between droop grid forming and virtual synchronous machine (VSM) grid forming using existing model structures.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Updates%20on%20Single-Loop%20Droop-Controlled%20GFM%20Model.pdf&action=default&DefaultItemOpen=1).

Mr. Ramasubramanian presented the generic vendor agnostic grid forming inverter models. The committee discussed single loop (wave model that is not part of the controller) versus multi-loop models (cascade voltage). The committee suggested having one model shared between two vendors instead of two separate models, that PNNL and EPRI work together on this, and that they should come back to the MVS with a single GFM model for each category, namely:

* One droop-based GFM model that both PNNL and EPRI agree on and support;
* One virtual-synchronous, machine-based GFM that both support;
* One virtual-oscillator-based GFM that both support.

The committee discussed GFM modeling and the conclusion that PNNL and EPRI should work together closely on a single GFM model in each category to present to the MVS to approve the three products listed above.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Generic%20grid%20forming%20inverter%20model_EPRI.pdf&action=default&DefaultItemOpen=1).

Jian Fu, U.S. Department of Energy (DOE), presented the DOE’s stance on wind models. Ms. Fu continued to discuss the importance of wind energy in the United States, and what needs to be done for wind models and wind validations.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/WECC_092222_JFu.pdf&action=default&DefaultItemOpen=1).

## Active Transmission System Modeling Update

Mr. Pourbeik presented a brief summary of the Active Transmission System Modeling Work Group (ATSMWG) tasks and updates. Mr. Pourbeik also presented information on SVSMO4, IPP DC line, and Transbay DC line.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/ATSMWG.pdf&action=default&DefaultItemOpen=1).

Rajat Majumder, Orsted, presented the offshore wind integration with VSC-HVDC information, including the concept, benefits, and modeling needs. Offshore winds use a type 4 wind turbine generator. Mr. Majumder went through the requirements to use this turbine and how to implement the integration.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Orsted_WECC_MVS_Sep2022.pdf&action=default).

Walter Mariscal, Power-Tech Engineers, presented the VSC-HVDC multi-terminal model descriptions and programming. The committee discussed the new model and high-level controls presented. There was a proposal for a new multi-terminal DC model.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/PTEI%20Multi-terminal%20VSC%20HVDC%20-%20WECC%20Conference.pdf&action=default&DefaultItemOpen=1).

# Day 3—September 23, 2022, 8:30 a.m. to 12:00 p.m. Mountain Time

## Review MVS Member List and Update

Mr. Tucker presented a member list for MVS. The committee discussed whether it is accurate. The committee also discussed the process to become a voting member of a committee.

The document is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/MVS%20members%20list.xlsx&action=default&DefaultItemOpen=1).

## CHVDC2 Model in Base Case Discussion

Mr. Hatton presented the CHVDC2 model base case that is being used for the Pacific DC Intertie. Mr. Hatton informed the committee that it would be ideal to have a fully tested dynamics and power flow data set that we can use when creating base cases. The committee discussed gamma angle and other base cases.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/CHVDC2%20model%20in%20basecase%20discussion%20-%20Hatton%20(002).pdf&action=default&DefaultItemOpen=1).

## MOD-33 Update—Doug Tucker

Mr. Tucker gave a brief update on MOD-33. Reliability Coordinator (RC) West has confirmed that they are planning to put the voltages and angles in their common information model (CIM) format in 2023, which can then be applied by the software vendors. Currently, the Southwest Power Pool (SPP) model is still in use for model validation cases at WECC. The December 6, 2021, event case is posted on the RC West and SPP websites for use.

## Development of a Short-Circuit Model Discussion

Amos Ang, Southern California Edison Company, presented an update for the Short-Circuit Modeling Work Group (SCMWG) tasks. The committee discussed whether the MVS can help support the walk-through processes for model validation.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/MVS%20Meeting%20-%20SCMWG.pdf&action=default&DefaultItemOpen=1).

## Forced Oscillations: Grid Vulnerability Analysis, Source Location, and Mitigation

Mr. Zhu presented an update on the forced oscillations that have been identified by EPRI. Mr. Zhu continued to propose some methods to mitigate forced oscillations, as well as a new forced oscillation localization tool (FOLT). The committee discussed whether to use energy storage to offset the negative effects of oscillations.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/Forced_Oscillation_WECC_MVS_Sep2022_EPRI_Lin.pdf&action=default&DefaultItemOpen=1).

## GridPACK-Wind: High-Performance Modeling and Simulation for Wind Integration

Shrirang Abhyankar, PNNL, presented the new GridPACK-Wind project that PNNL just began. Mr. Abhyankar continued to present the specifications and goals of the project.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/WECC_MVS_0923.pdf&action=default&DefaultItemOpen=1).

## Program Updates

Juan Sanchez-Gasca, GE Energy Consulting Group, provided a brief update on the positive sequence load flow (PSLF) program as well as the aforementioned REGC\_C model as well as a domain analysis. The REPC model was also discussed.

Jay Senthil, Siemens Energy, Inc., was not present to provide an update on the PSSE program.

The presentation is posted to the [WECC website](https://www.wecc.org/_layouts/15/WopiFrame.aspx?sourcedoc=/Administrative/PSSE_Update_MVS_Sept_2022.pdf&action=default&DefaultItemOpen=1).

Saurav Mohaptra, PowerWorld, provided a brief update on the upcoming user group meeting in Arizona.

Jeff Bloemink, Powertech Labs, provided a brief update on the upcoming user group meeting in Nevada. Highlights from the last release include progress of the implementation of REGC\_C, new user define model class called “Supervisory,” added a new modular composite load model, as well as support for PSLF.

## Public Comment

No comments were offered.

## Review New Action Items

* Determine how best to implement fractional frequency response from a specific load. Either move to the modular composite load model or update DER\_A to have an additional (or modified) parameter that causes a fraction of the load to be frequency responsive.
	+ Assigned To: Pouyan Pourbeik and Songzhe Zhu
	+ Due Date: Before next meeting
* Look at the need for benchmarking the motor c (phasor-domain single-phase motor model) model across the four major software tools, and the possibility of having such a benchmark ready by the January meeting to facilitate official approval of the model.
	+ Assigned To: Parag Mitra
	+ Due Date: Before next meeting
* Status update on IEEE421.5-2016 model implementation
	+ Assigned To: Quincy Wang
	+ Due Date: Before next meeting
* Prioritize the various model adoptions including, REPC\_D, REEC\_E, GFM models, multi-terminal VSC-HVDC model, and SVSMO4 model.
	+ Assigned To: MVS
	+ Due Date: Before next meeting

## Upcoming Meetings

January 2023 Salt Lake City; Hybrid

May 2023 Salt Lake City; Hybrid

September 2023 Salt Lake City; Hybrid

## Adjourn

Mr. Wang adjourned the meeting without objection at 11:30 p.m.

## **Exhibit A: Attendance List**

### Members in Attendance

Xiaoyuan Fan Pacific Northwest National Laboratory

Bo Gong Salt River Project

Pouyan Pourbeik Power and Energy, Analysis, Consulting and Education, PLLC

Juan Sanchez-Gasca GE Energy Consulting Group

Spencer Tacke Auriga Corporation

Song Wang Portland General Electric Company

Jessica Boatwright NorthWestern Energy

Kevin Brooks Southern California Edison Company

Daniel Cervantes Los Angeles Department of Water and Power

Ken Che Public Utility District No. 1 of Snohomish County

Jonathan Cichosz Portland General Electric Company

Tuan Dang Public Utility District No. 1 of Snohomish County

Roberto Favela El Paso Electric Company

Jonathon Flores Los Angeles Department of Water and Power

Aaron Hancock Tucson Electric Power

Licheng Jin California Independent System Operator

Robert Jones Seattle City Light

Milad Kahrobaee AES Corporation

Gordon Kawaley Bonneville Power Administration—Transmission

James Keller Western Area Power Administration - Rocky Mountain Region

Dmitry Kosterev Bonneville Power Administration—Transmission

May Le Public Utility District No. 2 of Grant County

Hongtao Ma North American Electric Reliability Corporation

Ron Markham Pacific Gas and Electric Company

Erik Olson Puget Sound Energy, Inc.

Shawn Patterson U.S. Bureau of Reclamation

Sergey Pustovit Bonneville Power Administration

Benjamin Rodriguez El Paso Electric Company

Angel Omar Sandoval Salt River Project

Amanuel Selassie Los Angeles Department of Water and Power

Jayapalan (Jay) Senthil Siemens Energy, Inc.

John Undrill Independent Subject Matter Expert

Xiaofei (Sophie) Xu Pacific Gas and Electric Company

Xiaokang Xu S&C Electric Company

Steve Yang Bonneville Power Administration—Transmission

Jimmy Zhang Alberta Electric System Operator

### Members not in Attendance

Hassan Baklou San Diego Gas and Electric

Tatum Begay Salt River Project

Desmond Chan Seattle City Light

Wonbae Choi Power System Consultants, Inc.

Ben Davis Vestas

Chris Effiong Western Area Power Administration

Abraham Ellis National Nuclear Security Administration - Sandia National Laboratories

Jennifer Galaway Portland General Electric Company

Joseph Gillette Utility System Efficiencies, Inc.

Kody Heppner Turlock Irrigation District

Allison Hidalgo U.S. Bureau of Reclamation

Hamody Hindi Bonneville Power Administration—Transmission

Siraji (Sam) Hirsi Bonneville Power Administration

Emily Hnatishin Puget Sound Energy, Inc.

Lesley Kayser-Sprouse Hetch Hetchy Water and Power

Jonathan Lesage MathWorks

Xi Lin Powertech Labs, Inc.

Saw Linn Los Angeles Department of Water and Power

Peter Mackin GridBright, Inc.

Caroline Marzinzik PowerWorld Corporation

Monte Meredith Utility System Efficiencies, Inc.

Mitchell Miller NorthWestern Energy

Amir Mohammednur Southern California Edison Company

Avinash Narava Tucson Electric Power

Ram Nath Siemens Energy, Inc.

Mark Pigman Tacoma Power

Chris Pink Tri-State Generation and Transmission—Reliability

Nathan Powell Deseret Generation & Transmission Cooperative

Ryan Quint North American Electric Reliability Corporation

Matin Rahmatian Power System Consultants, Inc.

Ramu Ramanathan Maxisys, Inc.

Daniel Ramirez Energy Strategies

Alistair Rennie Salt River Project

Tracy Rolstad Public Utility District No. 2 of Grant County

David Roop Mitsubishi Electric Power Products, Inc.

Slavomir Seman Vestas

Karim Shaarbafi Alberta Electric System Operator

Hari Singh Public Service Company of Colorado (Xcel Energy)

Alejandro Solis El Paso Electric Company

Jonathan Stahlhut TransCo Energy, LLC

Khanh Thai Tacoma Power

Jade Thiemsuwan Sempra Renewables Services, Inc.

Chifong Thomas Thomas Grid Advisor

Chad Thomson Utility System Efficiencies, Inc.

Patrick Truong Sacramento Municipal Utility District

Andres Valdepena Delgado Idaho Power Company

Chong Wang Iowa State University

Jianhui Wang Southern Methodist University

Zhaoyu Wang Iowa State University

Jeffery Watkins NV Energy

David Wiley Arizona Public Service Company

Scott Wilson Avista Corporation

Reza Yousefian S&C Electric Company

Janice Zewe Sacramento Municipal Utility District

Dongbo Zhao Argonne National Laboratory

### Others in Attendance

Maddy Eberhard WECC

Nick Hatton WECC

Slaven Kincic Pacific Northwest National Laboratory

Kwami Sedzro National Renewable Energy Laboratory

Marie Smith WECC

Marie Smith WECC

Doug Tucker WECC

James Weber PowerWorld Corporation

Lin Zhu Electric Power Research Institute

Shri Abhyankar Pacific Northwest National Laboratory

Logan Affleck WECC

Baj Agrawal Arizona Public Service Company

Marcos Alaya Bonneville Power Administration

Amos Ang Southern California Edison Company

Jamie Austin PacifiCorp

Steven Barnes Peregrine Engineering

Jeffery Bloemink Powertech Labs, Inc.

Gregory Brooks U.S. Army Corps of Engineers

Sean Brosig U.S. Army Corps of Engineers

M. Burgamy U.S. Bureau of Reclamation

Jyotsna Chatrati NV Energy

Malati Chaudhary Public Service Company of New Mexico

Chris Corral El Paso Electric Company

Philip Cui British Columbia Hydro and Power Authority

Samir Dahal Siemens Energy, Inc.

Enoch Davies WECC

Wei Du Pacific Northwest National Laboratory

Shruti Dwarkanath Rao GE Energy Consulting Group

Rahimi Ebrahim California Independent System Operator

Donna Enriquez El Paso Electric Company

Evangelos Farantatos Electric Power Research Institute

Tony Farris Bonneville Power Adminstration

Carlos Flores-Lopez U.S. Army Corps of Engineers

K Fraughton Bonneville Power Administration

Bryan Friesen British Columbia Hydro and Power Authority

Jian Fu U.S. Department of Energy

Sylvia Gard Puget Sound Energy, Inc.

Christopher Gilden Tri-State Generation and Transmission—Reliability

Christian Gonzales California Department of Water Resources

Raul Guerro-Perez Nextera Energy

Ryan Hancock Grid Subject Matter Experts

Jesse Harris Grid Subject Matter Experts

Eric Heredia Bonneville Power Administration

Brandon Johnson Grid Subject Matter Experts

robert jones Seattle City Light

Xiao Kang Sand Hill Wind

Bhavana Katyal WECC

Seongtae Kim PacifiCorp

Yuriy Komlev U.S. Bureau of Reclamation

Neeraj Lal Northeast Power Coordinating Council

Sam Li British Columbia Hydro and Power Authority

Andrew Lopez Southern California Edison Company

Shanna love Salt River Project

Olushola Lutalo North American Electric Reliability Corporation

Rajat Majumder Orsted

Walter Mariscal Siemens Energy, Inc.

Ron Markham Puget Sound Energy, Inc.

Stony Martin SERC Reliability Coorporation

Taylor McClain Grid Subject Matter Experts

Christopher McLean California Energy Commission

Elliott Mitchell-Colgan Bonneville Power Administration

Parag Mitra Electric Power Research Institute

Saurav Mohapatra PowerWorld Corporation

Rafael Molano Bonneville Power Administration

Tyson Niemann WECC

William Parker WECC

Akila Perera Grid Subject Matter Experts

Phong Pham U.S. Army Corps of Engineers

Vishal Puppala

Deepak Ramasubramanian Electric Power Research Institute

Chris Scheller U.S. Bureau of Reclamation

Eric See-toh Powertech Labs, Inc.

Liam Segarty British Columbia Hydro and Power Authority

Matt Sehlert Bonneville Power Administration

Chris So

Nak So U.S. Army Corps of Engineers

Ahmed Soliman Siemens Energy, Inc.

Kannan Sreenivasachar ISO New England

Ailin Sun Southern California Edison Company

Askhat Tullegen Tesla

Jerod Vandehey Cowlitz PUD

Louis Vigil El Paso Electric Company

Katy Waechter National Renewable Energy Laboratory

Munish Walia Salt River Project

Quincy Wang British Columbia Hydro and Power Authority

Shawn Wang Enel North America Inc.

Cho Wang AES Corporation

Maggie Watkins U.S. Army Corps of Engineers

Trevor Werho Arizona Public Service Company

Noel Wise U.S. Army Corps of Engineers

Kevin Wu ComEd

Yuguang Xiao British Columbia Hydro and Power Authority

Steve Yang Bonneville Power Administration

Nebiyu Yimer California Independent System Operator

Chelsea Zhu National Grid Renewables Development LLC

Wenchun Zhu Siemens Energy, Inc.