GENERAL SESSION MINUTES OF THE TECHONOLOGY AND SECURITY COMMITTEE MEETING OF ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.

8000 Metropolis Drive (Building E), Suite 100, Boardroom B
Austin, Texas 78744
October 9, 2024

Pursuant to notice duly given and after determination that a quorum was present, the meeting of the Technology and Security (T&S) Committee of the Board of Directors (Board) of Electric Reliability Council of Texas, Inc. (ERCOT) convened on the above-referenced date.

Meeting Attendance:

Committee Members:

Director	Affiliation/Role (if any)	Voting Category
Aguilar, Carlos (Attending via WebEx)	N/A	Voting
Capuano, Linda	N/A	Voting
England, Julie	N/A	Voting
Swainson, John (Chair)	N/A	Voting

Other Board Members:

Director	Affiliation/Role (if any)	Voting Category
Flexon, Bob	N/A, left after Item 5	Voting
Flores, Bill	N/A, left after Item 5	Voting
Heeg, Peggy	N/A, left after Item 5	Voting
Vegas, Pablo	ERCOT President and Chief Executive Officer (CEO)	Non-Voting

Officers and Guests:

Officer/Guest	Role
Berlin, Anna	ERCOT Associate Corporate Counsel
Bonser, Drew	ERCOT Director of Cyber Security
Collins, Keith	ERCOT Vice President of Commercial Operations
Day, Betty	ERCOT Vice President of Security and Compliance and Chief Compliance Officer
Duggirala, Ravi	ERCOT Director of Enterprise Risk Management
Follum, Jim	Power System Research Engineer, Northwest National Laboratory (PNNL)

Gravois, Patrick	ERCOT Operations Engineer Lead
Gwinn, Diane	ERCOT Director of Corporate IT Services
Hobbs, Kristi	ERCOT Vice President of System Planning and Weatherization
Horton, Shana	ERCOT Corporate Counsel
Huang, Fred	ERCOT Director Operations Support
Lassiter, Jason	ERCOT Director of Physical Security & Facilities
Mannepalli, Ajay	ERCOT Senior Director of IT Architecture and Strategy
Martinez, Adam	ERCOT Vice President of Enterprise Risk and Strategy
Mereness, Matt	ERCOT Senior Director Strategic Market Design Programs and Delivery
Parakkuth, Jayapal	ERCOT Senior Vice President and Chief Information Officer
Pokharel, Nabaraj	PUCT Director of Market and Regulatory Policy, attending on behalf of OPUC (entered the meeting at 9:18 a.m.)
Rickerson, Woody	ERCOT Senior Vice President and Chief Operating Officer
Rydell, Brandt	ERCOT Assistant General Counsel
Scheel, Richard	ERCOT Senior Vice President, Chief Financial Officer and Chief Revenue Officer
Seely, Chad V.	ERCOT Senior Vice President, General Counsel and Corporate Secretary
Tirupati, Venkat	ERCOT Vice President of Dev Ops and Grid Transformation
Woodfin, Dan	ERCOT Vice President of System Operations

Call General Session to Order (Agenda Item 1)
John Swainson, T&S Committee Chair, determined that a quorum was present, noted that Committee Member Carlos Aguilar was attending via WebEx, and called the T&S Committee meeting to order at approximately 8:59 a.m.

Chair Swainson highlighted the Antitrust Admonition and addressed the following Agenda Items in the order below.

Notice of Public Comment, if Any (Agenda Item 2)
Chair Swainson announced that on the agenda for the meeting, which was posted publicly on October 2, 2024, ERCOT had provided instructions for members of the public who were interested in commenting in person and that no individuals had expressed interest in commenting, which Shana Horton confirmed.

August 19, 2024 General Session Meeting Minutes (Agenda Item 3)
Chair Swainson entertained a motion to approve the August 19, 2024 General Session Meeting Minutes (Minutes).

Julie England moved to approve the Minutes as presented. Chair Swainson seconded the motion. The motion passed by unanimous voice vote with no abstentions.

August 19, 2024 Notice of Annual Committee Self-Evaluation Questionnaire (Agenda Item 4)

Chair Swainson presented the 2024 Annual Committee Self-Evaluation Questionnaire and indicated ERCOT staff will electronically administer the questionnaire to Committee members following today's meeting and the Committee will review results during the meeting scheduled for December 2, 2024.

Emerging Technology (Agenda Item 5)

Phasor Measurement Units (PMU) and Wide Area Monitoring Systems (WAMS) (Agenda Item 5.1)

Chair Swainson introduced Jim Follum, Power System Research Engineer at the Department of Energy's Pacific Northwest National Laboratory (PNNL). Pursuant to the Committee's request for presentations regarding emerging grid technologies, Dr. Follum presented Phasor Measurement Units (PMU) and Wide Area Monitoring Systems (WAMS). Dr. Follum discussed what PMUs are, where they are being used across the U.S. and around the world, and how they are implemented.

Dr. Follum explained a PMU uses a common clock to take time-stamped measurements of voltage or current across the electric grid. Synchronized measurements allow application of data for Wide Area Monitoring. Recording 30 or 60 times per second, much faster than SCADAs 1-4 second interval, is another advantage (in addition to synchronization). It is also a streaming report, in real time. The data can be used for a variety of analyses of oscillations, such as Natural (Modal) and Forced oscillations. He then described applications by several ISOs, which used the technology to locate the specific piece of equipment causing a drop in voltage on their grid and monitor grid stability/system stress and inertia. He noted even a small number of PMUs can have a big impact, if placed correctly. The cost per PMU installed ranges from $40,000-$180,000. The biggest challenge to broader implementation is getting Transmission Service Providers (TSPs) to invest. Even so, PMUs are widely deployed with an ever-increasing list of applications. Dr. Follum explained integration of Inverter-Based Resources (IBRs) and large loads are driving increased need and interest in advanced measurement systems such as PMUs.

Committee members, other Board members, and Dr. Follum discussed the potential for cybersecurity concerns related to manufacturing of PMUs. Dr. Follum stated there are U.S.-based manufacturers and CIP-compliant installations, mitigating such concerns. Pablo Vegas asked if costs are trending up or down and whether there are unique software requirements to manage the data. Dr. Follum replied there are commercial solutions to bring in PMU data, but in addition to vendor tools, Independent System Operators (ISOs) are adding customization. Dr. Follum said an updated study is needed to determine whether costs are going up or down because it is a complex question.

ERCOT Updates and Future Plans for PMU and WAMS (Agenda Item 5.2)

ERCOT's Director of Operations Support, Fred Huang, led a discussion in response to Dr. Follum's presentation. Mr. Huang described ERCOT's deployment of PMUs beginning in 2010, and in recent years, expanded PMU requirements to handle IBRs and large loads. Mr. Huang

informed the group there are currently 273 PMUs streaming to ERCOT from three transmission operators, which give ERCOT's control room operators useful information for situational awareness so they can take action to stabilize the grid. He noted ERCOT issued a Request for Proposals (RFP) to enhance the PMU applications (adding new capacity and capabilities) in 2024. Mr. Huang described three current major ERCOT use cases: oscillation detection and mitigation; event detection and analysis; and model validation. He cited as major barriers to ideal PMU use: limited geographic coverage; PMU data quality and maintenance; and limited use of PMU data for real-time operation.

Committee members, other Board members, and Mr. Huang discussed why some large transmission operators are not using PMUs. Mr. Huang said the ERCOT region has good PMU coverage in West and Central Texas but could certainly do better with more transmission operators sending data. The group discussed the cost of installing and operating PMUs, which is borne by the TSP, adding to their rate base. The group also discussed how expanding carriage capacity of real-time data streaming would enhance PMU functions and how SCADA plays a role in this function by providing an overview of ERCOT's total system health, in contrast to some other ISOs.

Committee Briefs (Agenda Item 6)

Projects and Technology Update (Agenda Item 6.1)

Jayapal Parakkuth presented the Projects and Technology Update, noting all 60+ projects are generally on track. He presented projected project labor hours through 2025, which will comprise a large amount of work on the Real-Time Co-optimization (RTC) project. He noted upcoming releases include the ERCOT mobile app update redesign; Texas Set; and RIOOS. He reported on vendor software solutions to the Congestion Revenue Rights (CRR) engine issues, which have improved performance dramatically. The Committee and Mr. Parakkuth discussed the reason for the inquiry and potential changes to the process to accommodate the growing grid. Mr. Parakkuth reported on price corrections that happened in August, which was caused by a latent bug in the EMS resulting in all deployed 2,000 MW ECRS to be recalled for two minutes before it was corrected. This, in turn, caused a brief price spike to $5,001/MWh (but no reliability issues). This will need to be corrected to $284/MWh, which Mr. Vegas noted resulted in an impact of approximately $3.5 million.

Real-Time Co-Optimization Implementation Update (Agenda Item 6.2)

Mr. Parakkuth presented the Real-Time Co-Optimization Implementation Update, reporting the second project (PR447-002) gated to execution today, that all parts of the project are tracking to plan, and project go-live is scheduled for December 5, 2025. Mr. Parakkuth highlighted the market trial beginning in May 2025 during which Market Participants (MPs) will be invited to connect to the system and try it out. That means the bulk of the work must be complete by then.

The Committee and Mr. Parakkuth discussed which MPs will be invited to test the system and how they will interact with it. They also discussed the long-term vendor maintenance of the RTC system. Finally, Mr. Parakkuth reported on milestones met and upcoming.

Future Agenda Items (Agenda Item 7)
Mr. Parakkuth presented the Future Agenda Items. Committee members and Mr. Parakkuth discussed future presentations on Small Modular Nuclear development in Texas (in December). Committee member Julie England requested a bi-annual report on software quality trends and ERCOT's activities to test our software quality. Mr. Parakkuth reported he is already working on this.

Other Business (Agenda Item 8)
No other business was discussed at this time.

Executive Session; Vote on Matters from Executive Session; Adjournment (Agenda Items 9-10)
Chair Swainson announced that no voting items from Executive Session were expected; accordingly, he would adjourn the meeting immediately upon conclusion of Executive Session. Chair Swainson adjourned General Session at approximately 10:06 a.m. and convened Executive Session at approximately 10:15 a.m.

There were no voting items from Executive Session.

Chair Swainson adjourned the meeting upon the conclusion of Executive Session at approximately 11:37 a.m.

Committee materials and presentations from the meeting are available on ERCOT's website at https://www.ercot.com/committees/board/tech-security.

Chad V. Seely
Corporate Secretary