OCTOBER 25, 2023

Renewables & BESS Operational Management with the AVEVA™ PI System™

Sobia Naqvi - Arizona Public Service Company

Arizona Public Service Company

Serving ~ 2.7 million people

11 of Arizona's 15 counties

34,646 square mile service area

430 substations

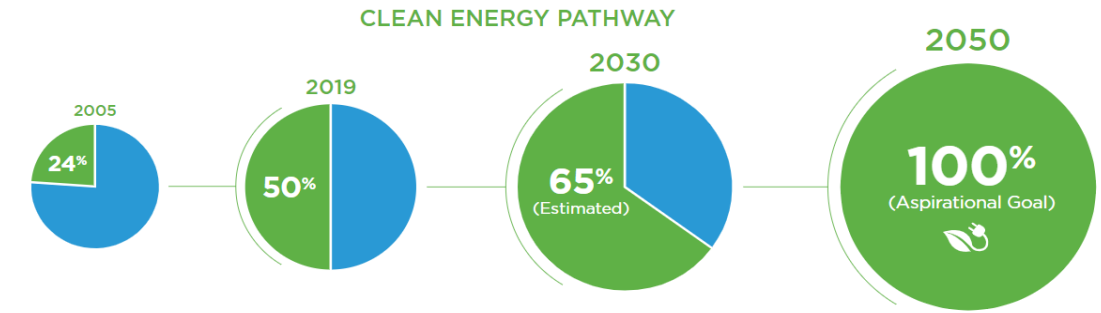
300,000 transformers,

More than 550,000 poles and structures

More than 35,000 miles of transmission and distribution lines

2020 Clean Energy Commitment

APS Clean Energy Commitment



Clean energy commitments

- 100% clean, carbon-free electricity by 2050
- 65% clean energy by 2030 with 45% renewable energy
- Eliminate coal by the end of 2031

A clean economic future

- Meet our responsibility to power a low-carbon economy in Arizona
- Guided by sound science to advance a healthy environment
- Market-driven energy innovation and a strong Arizona economy are critical
- Starting from an energy mix that is 50% clean, including energy efficiency and carbon-free and clean energy from Palo Verde Generating Station

Pathways to 100% Clean

Policy decisions	Support policy decisions that leverage market-based technology and innovation to attract investment in Arizona
Existing power sources	Near-term use of natural gas until technological advances are available to maintain reliable service at reasonable prices
Evolving market-based solutions	Participation in the Energy Imbalance Market provides access to clean energy resources while saving customers money
Electrification	Electrification will drive a cleaner environment and more energy-efficient operations throughout the economy
Modernization of the electric grid	Continue to advance infrastructure that is responsive and resilient while providing customers more choice and control
Energy storage solutions	Storage creates opportunity to take advantage of midday solar generation and better respond to peak demand

Next Steps: Collaboration, alignment and innovation

- Reliability and affordability are foundational
- Collaborate with customers, stakeholders and regulators
- Promote economy-wide electrification of industry, transportation and buildings
- Support innovation, research and development of new technology

Imagine a world with 100% clean energy.

We are.

aps

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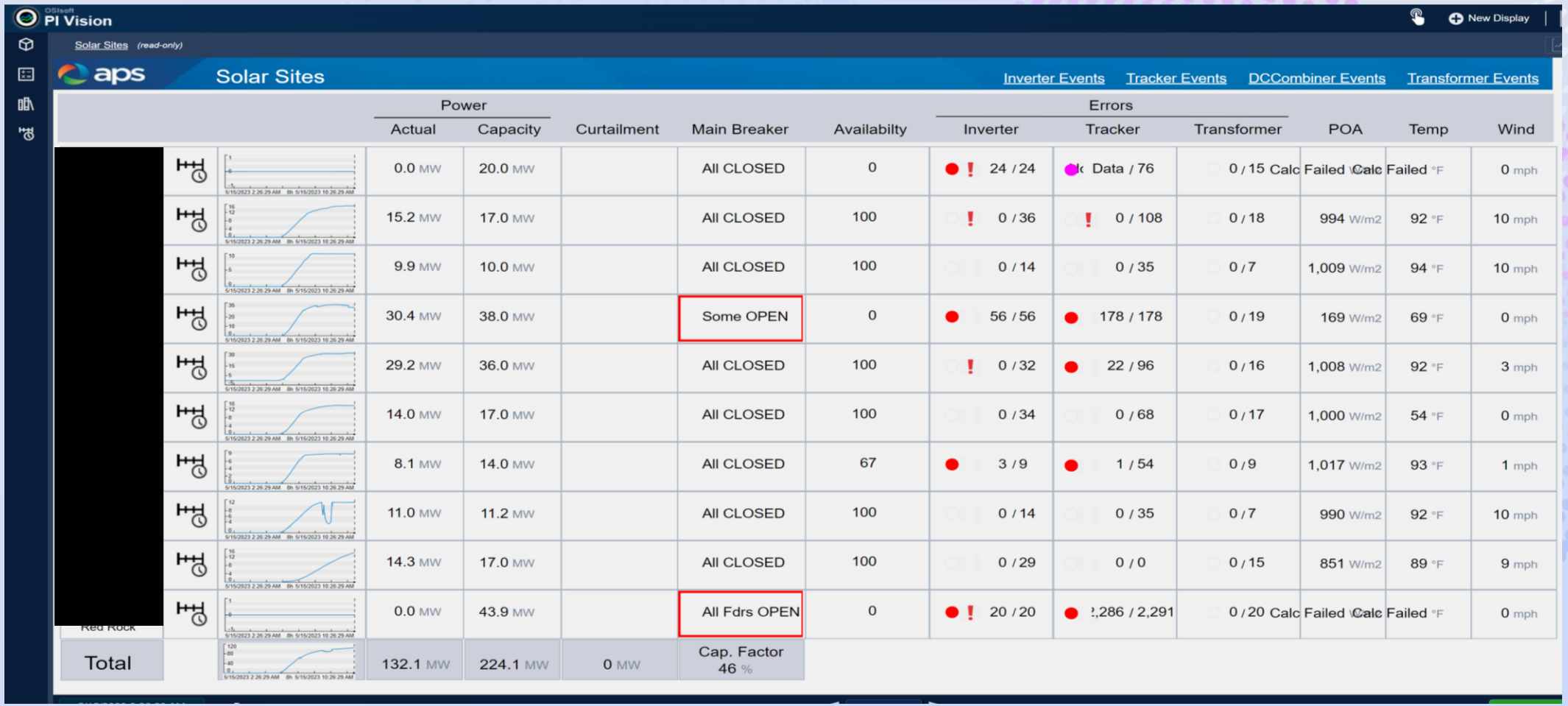
Renewables Operations

- Solar, Wind, Geothermal, Bioenergy, and Hydro
  - ❑ Over 10 years in operations
  - ❑ Metrics
  - ❑ Performance
  - ❑ Preventative & Maintenance
  - ❑ Track & Trend
  - ❑ Off the shelf solutions

Example – Solar Dashboard

- Built on the AVEVA™ PI System™



BESS Operations

- The Next Frontier in a galaxy not so far away

- ❑ Utility scale vs. DERMS
- ❑ Safety
  - ❑ Alarms
- ❑ Sheer amount of data points
- ❑ Fear of Unknown
- ❑ Tracking and trending
- ❑ Lack of Standardization
- ❑ Home grown solutions/systems – no consistency
- ❑ Overlay existing systems

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Operating Batteries

- State of Charge (SoC) = How full is the battery?
- Actual vs Usable
  - Rated Capacity = Usable
  - Overbuild
- Charge Time > Discharge Time
- End of Day (EOD) & End of Hour
- (EOH) SoC = Tools in CAISO and
- SOC Management
- Round Trip Efficiency (RTE) - is the ratio of energy that the battery can discharge relative to the amount of energy injected

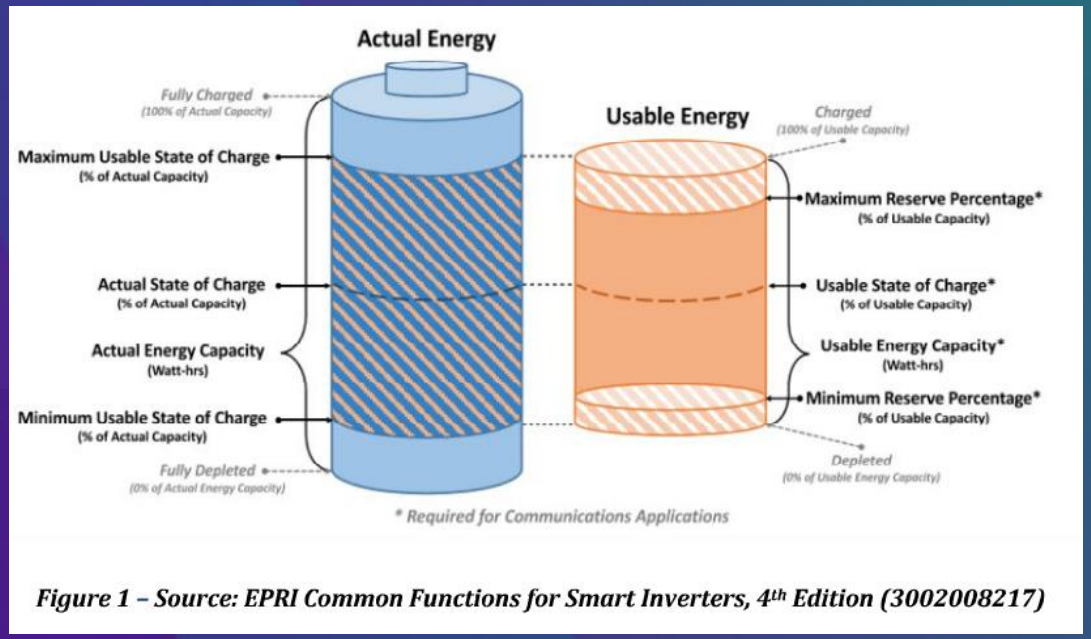

Figure 1 – Source: EPRI Common Functions for Smart Inverters, 4th Edition (3002008217)

BESS Installations

260 MW BESS in operations

- 10 Facilities, PV+Storage
- All APS PV+S Facilities designed as Co-located CAISO resources
- Combination of ownership and PPA

First stand-alone 80 MW/320 MWh BESS operational by Q4 2023

IRA update

- Amending contracts to allow for grid charging of co-located BESS resources

Awarded ~2.5 GW of new resources for 2025 operations (mostly BESS)

All-Source RFP for 1,000 MW of new resources

BESS System

- Many Components

Battery Cell

Battery Rack

Battery Container

Battery System

Rack level monitoring and controls system

BESS Energy Management System

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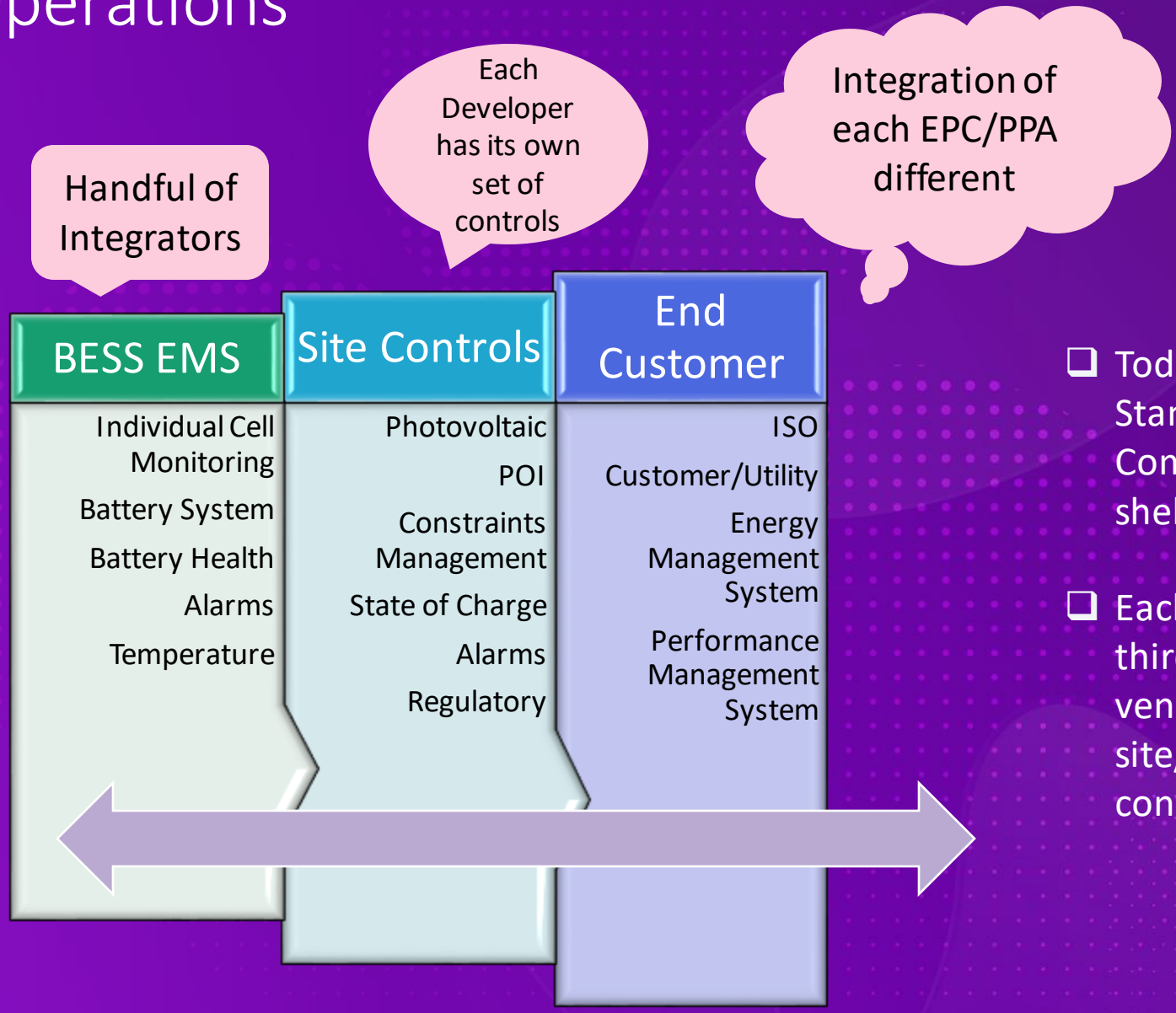
BESS System Operations

- Various levels of expertise/knowledge
- Limited SMEs across organization
- No standardization of data
- Each system is unique and different
- Early solar development days



- Today, there is no Standard Site Controls Commercial off the shelf product
- Each Developer asks a third-party controls vendor to build a site/PPA/EPC specific controls system

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Constraints & Management of BESS

Constraints

- Throughput / Cycles
- Round Trip Efficiency
- State of Charge
- Interconnection Agreement
- Settlements
  - Payments
  - Market settlements

Investment Recovery Act

- Final guidance in process
- Many upfront requirements
- Effective Jan 1, 2023

Regulatory

- Development of reporting requirements

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BESS PI Visualization

Real Tim Facility Operations/Status

- BESS Condition (Charging, Discharging, Stand-By, Off-line)
- State of charge (as a % and MWh, how much is useable)

Alarms & Faults

Battery container status

Facility status

Performance monitoring

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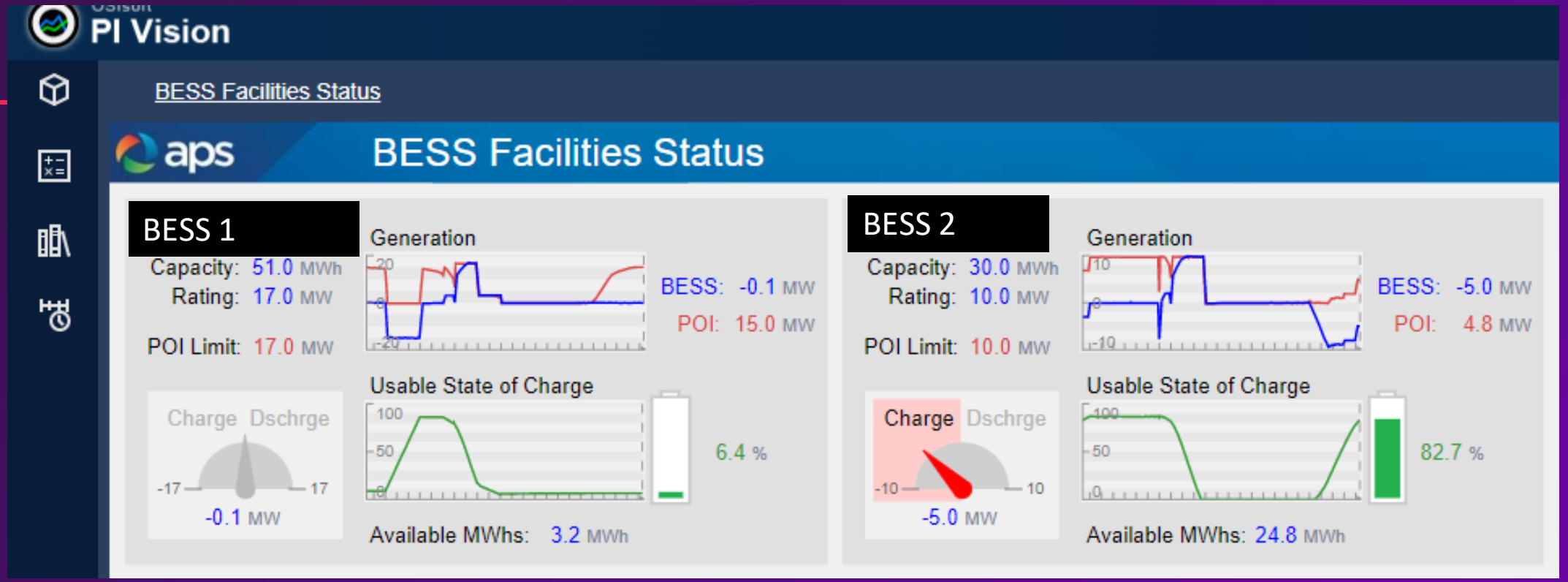
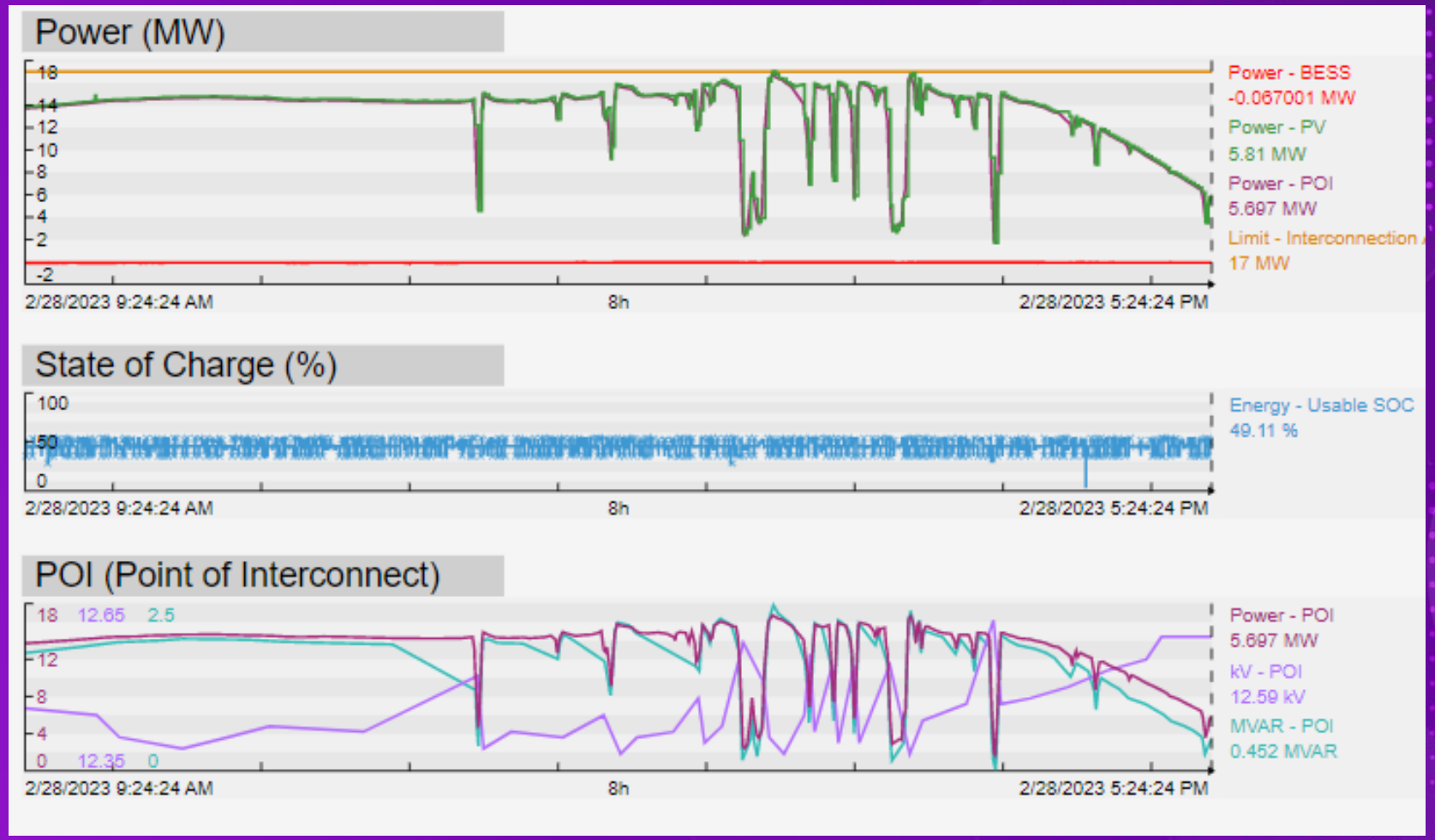
Battery Energy Storage System Operating Status

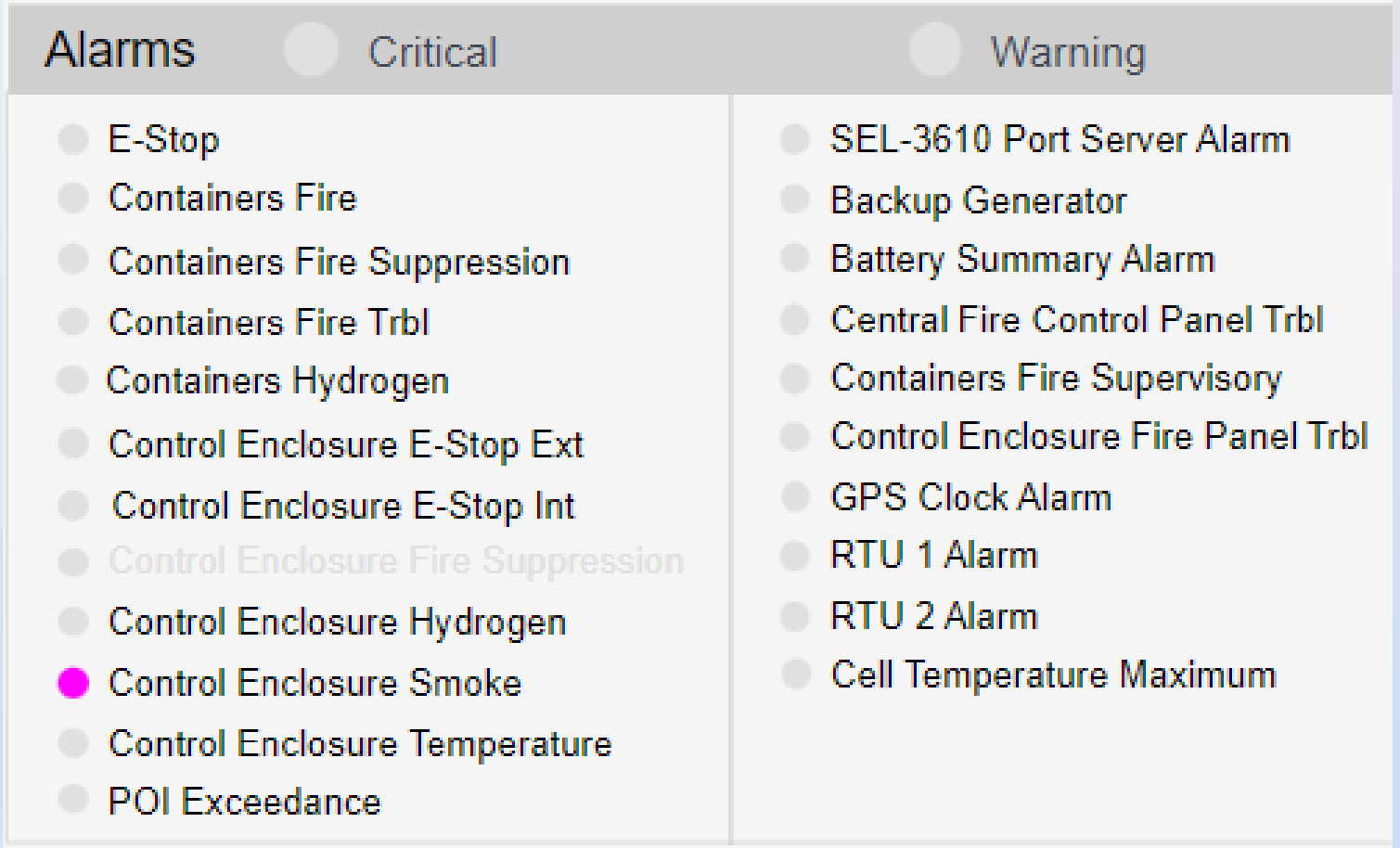


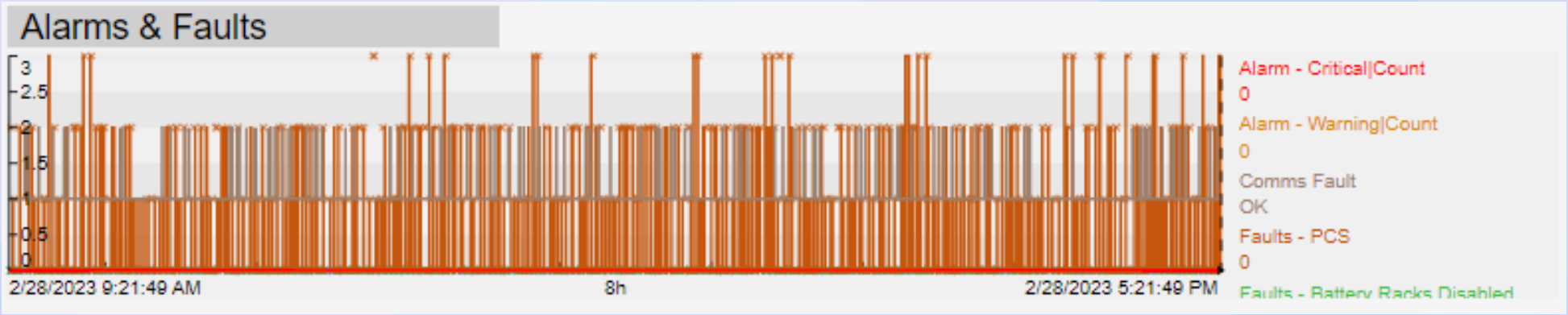
BESS Sites



BESS Sites

- Alarms





BESS Implementation Observations

- State of Charge
  - Each BESS Integrator has different performance characteristics
  - Each Integrator only provides an Actual SOC Calculation needed determine Useable SOC (changes annually with degradation)

- POI
  - For Co-located Facilities, ensuring setpoint signals provided for POI limitation
  - Ensuring all operational systems acknowledge and adhere to POI

- Facility Controls
  - Longest time to integrate Facility Controls during project execution
  - No standardization, each Facility has different control systems
  - Solar curtailment, charging of co-located BESS

- Auxiliary Power / Metering / Station Service
  - Separating charging energy and auxiliary use
  - Each Facility has unique design, including self-cooling, containers and cubes

BESS Implementation

Frequency Regulation

Constant cycling of BESS creates an imbalance of the cells, cells begin to heat leading to possible thermal runway

Inverter issues

Typical inverters, de-rate with extreme weather conditions (hot or cold)

Tools

Lack of standardization for managing, reporting

Stacking Functions

Transmission deferral, capacity, ancillary functions (Blackstart, Frequency Regulation, Response)

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OPERATIONALIZATION OF CLEAN RESOURCES

APS implementation of New Clean Resources

Challenge

- New parameters to measure and manage
- New Industry
- No standardization

Solution

- Used existing PI platform to manage parameters
- PI platform for data analytics and measurement

Results

- Managing operations of resources ensuring reliable operations
- Protecting degradation and augmentation
- Market participation
- Customer Affordability
- Diversification of Resources

SOBIA NAQVI

New Resource Implementation Manager

- Arizona Public Service Company
- Sobia.naqvi@aps.com

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

Thank you!

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