# AVEVAWORLD



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### California ISO

Within its balancing authority area, the California ISO:

- Maintains reliability on the grid
- Manages the flow of energy
- Oversees the transmission
  planning process
- Operates the wholesale electric market

For much of the western U.S., the ISO:

- Operates the Western Energy Imbalance Market (EIM)
- Serves as Reliability Coordinator (RC West)





### Western Energy Imbalance Market (WEIM)

Since its launch in 2014, the WEIM has enhanced grid reliability, generated billions of dollars in benefits for participants, and improved the integration of renewable energy resources.

- 22 participating entities
- Gross benefits exceeds \$6 billion
- Reduced 1,043,034 metric tons of CO<sub>2</sub>
- WEIM Benefit Q4 2024 is \$374.25 Million



### Managing an evolving grid – today in 2025

- Carbon-free power grid by 2045
- ISO avoided curtailment 2,437,182 MWH since Nov 2014
- Renewable generation
  - Wind peak 6,465 MW on May 28, 2022
  - Solar peak 19,650 MW on August 23, 2024
  - Photovoltaic (PV) roof top, behind the meter > 12,000 MW estimate
- Installed battery capacity = 11,454 MW
- Steepest ramp in 3 hours 23,228 MW 129 MW/min average for three consecutive hours on January 20, 2025
- 1.5M electric vehicles out of 14.268M vehicles in California with 700 MW demand



### Electricity grid transformation and energy transition

- In 2025 US electric vehicle sales are expected to increase by 36%, reaching a 11.2% market share
- Electric school bus US sales expected to increase from 1% in 2023 to 35% in 2030 and 60% in 2035
- Distributed energy resources will double in five years
- The Grid needs to adapt to smaller resources with variabilities
- Need better forecast accuracy and data
- Need for more granularity for smaller resources and better modeling
- More than double the amount of storage devices on the grid
- Need for extensive modeling and use of Demand Response and Distributed Energy Resources
- Implementation of Distribution System Operator (DSO)



### **FERC Orders**

- 2222 Aggregate of Distributed Energy Resource (DER)
- 881 Ambient Adjusted Ratings (AAR)
- 841 Remove Barriers to DER Behind the Meter (BTM) Energy Storage
- 760 Submit Market Data to Commission
- 2023 Reduce projects Backlog
- 901 Inverter Based Resources (IBR)



### Distribution System Operator (DSO)

- Distributed Energy Resource (DER) registration
- DER Physical characteristic
- Modeling actual DER types
- Model range of operations capabilities
- Forecasting DER capability with high accuracy
- Aggregate DER resources into a bid offer monotonically increasing/decreasing
- Scheduling Coordinator offering bids to ISO hourly
- Dispatch DER according to awards
- Settlement system



## Artificial Super Intelligent (ASI)

- Neural network (NN) > Machine learning > Specific AI > Artificial generative intelligent (AGI) > Artificial super intelligent (ASI)
- Cusp of revolution. Past is not a good predictor of the future
- Pace is fast because it is not coding or programming
- IT programming moves to data modeling and accuracy and determines which vendor tools are best
- NN is +30 years old with 2 or 3 layers and <100 neurons while ASI needs millions of layers and neurons
- Use cases:
  - Intelligent Alarms
  - SE and RTCA
  - DSO
  - Cyber security
- Preventative maintenance
- Most likely in the cloud heavy computing is required
- Vendors must protect confidential data and should not be able to use it to improve their models to provide a higher service to others



# Changes needed to meet the challenges and convert them to opportunities

- Implement resource adequacy to meet all hours and not just peak hour
- Improve aggregate ramp capabilities several hundred MW/Min
- Redesign the market and EMS to meet the uniqueness of electric storage devices (ESD), distributed energy resources (DER), and variable energy resources (VER)
- Is storage device part of the operating reserve for generation and load?
- Extend the WEIM to the day ahead market Extended Day-Ahead Market (EDAM)
- Improve forecast accuracy of VER, ESD, DER, BTM and net load
- Improve accuracy, robustness, availability, security and reliability by improving detection, correction and recoverability of all issues



### Track grid conditions

On our website or download the ISO Today mobile app from the App Store or Google Play store







# **AVEVA PI SYSTEM ARCHITECTURE AND DATA SHARING**



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### CAISO/RC West – AVEVA PI System Architecture

- Four environments
  - Production (32), Stage (11), Dev, Training/Simulation
  - ->65 Total Servers
  - 2 Site Redundancy (both BCA and Non-BCA)
- Redundant SQL Servers for AVEVA PI Vision (Load Balancers and SQL Always-On)
- Redundant SQL Servers for PI AF Analysis (Load Balancers and SQL Always-On)
- 10 PI Vision Web Servers (Production, Stage, Dev, Training environments)
- RDBMS connections to multiple databases
- PI WebAPI (Rest) connections
- UFL connections for larger data transfers



### CAISO/RC West – Company users and data sharing

- More than 400 Internal Company PI Users
- Making use of AVEVA PI Server Asset Framework (AF) Collections, Event Frames and Tables
- Operations "Display Review Team" over 2000 internal displays
- Sharing PI Vision Displays with 74 External Companies using certificate-based connections
- 24+ Years of Data Archive
- 1.5M Points (1.2 million events/minute)
- Imported the Western Interconnection Transmission Common Information Model (CIM) into the AF Database
  - Roughly 17,000 assets created with calculations based upon 127,000 discrete state tags





## THE EVOLUTION OF PI SYSTEM IN THE CALIFORNIA ISO BALANCING AUTHORITY OPERATIONS



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### Operator needs and challenges

- Needs
  - Situational Awareness
  - -Common Operating Picture (COP)
- Challenges
  - New generators
    - New technologies means:
      - New types of data
      - New operating characteristics
      - New limitations
      - New benefits
  - Managing the data
    - Where is it?
    - What does it mean?



### Resource growth

- Current resources
  - $\sim$  1,400 grid scale generator resource ID's
    - 800+ Wind/Solar/Battery/Hybrid resource ID's
  - ~ 2,500 total active resource ID's (including Demand Response, DER's, & Dynamic interties)
  - ~ 100,000 MW nameplate capacity
- Future resources (according to the ISO's 20-Year Transmission Outlook, 7/31/24)
  - CA estimates needing to add 7,000-8,000 MW/year for next 10 years
  - Current queue
    - 605 generator projects (projects can be 1 or more resource ID's)
    - 236,225 MW nameplate capacity



### August 2020 – a watershed moment



Batteries

Figure B.2: Demand and Net Demand for August 14 and 15

# Yesterday's PI Vision displays were not ready for tomorrow's changes

- Emerging generation technologies
- New market participants
- New ways to monitor resources needed



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## Addressing the challenges – evolution of PI Vision usage

### **Old Ways**

- Static displays manual updates required
  - Version Control issues
    - Wrong information
    - Missing information
- Multi-State
  - Real estate intensive
- Calculations
  - Manual
    - Time consuming
    - Individual updates

### Today

- Dynamic displays automatic updates
  - Version control
    - Everyone has the most up-to-date version
    - Common operating picture
- Event frames
  - Timely/descriptive
  - Enhancing situational awareness
- Advanced analysis
  - AF template based
    - Bulk updates
    - Generator specific calculations
    - Rollup calculations



### Data alchemy – transmute databases to gold



	-	Master File Data			*			EMS				Market Pa	articipant Data	RIMS
UCON	Resource ID	Resource Name	Fuel	PMin	PMax	UPMW	UGMW	%SOC	SOC	MXE	SCID	Turret	SC Phone	Area Sync? COD?
			LESR	-200.0	200.0	0.2	-0.6		0.0	0.0				True False
			LESR	-0.5	0.5	0.0	0.0		0.8	4.0				True False
			SOLR	0.0	150.0	0.0								True False
			WATR	0.0	15.6	6.2	-7.1							True True
			LESR	-10.0	10.0	-0.2	0.0		21.8	22.7				True False
			LESR	-10.0	10.0	-0.2	-0.2		22.2	22.7				True False
			SOLR	0.0	2.7	0.0								True False
			SOLR	0.0	3.0	0.0								True False
			LESR	-99.4	99.4	0.0	0.0		0.0	0.0				True False
			GAS	0.0	64.4	0.0								True False
			GAS	1.0	29.0	0.0								True False
			GAS	16.0	37.1	0.0					_			True False
			LESR	-1.4	1.4	-26.3	0.0		0.0	0.0				True False
			LESR	-1.1	1.1	0.0	0.0		1.8	4.4				True False
			LESR	-69.0	69.0	0.0	0.0		0.0	0.0				
			LESR	-59.7	59.7	0.0	0.0		0.0	0.0				True False
			SOLR	0.0	44.0	0.0	0.0							
			LESR	-185.0	185.0	-0.3	-0.3		0.0	0.0				
			HIBD	-92.0	150.0	-0.0	6.0-		184.0	15.0				
			LESR	-200.0	200.0	0.0	0.0		0.0	8.0				
			LESR	-200.0	60.0	-0.7	-0.0		0.0	0.0				
			LESR	-109.0	109.0	0.0	0.0		191.6	463.0				
			LESR	-110.0	110.0	0.0	0.0		116.9	458.5				
			SOLR	0.0	1.5	0.0								True False
			SOLR	0.0	1.0	0.0								True False
			SOLR	0.0	1.5	0.0								True False
			SOLR	0.0	1.5	0.0								
			SOLR	0.0	1.5	0.0								True False

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### Data alchemy – details to decisions

Raw data (EMS)



#### Unit level (PI Vision collections)



### System summary (AF rollup)





## High level monitoring

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Example: managing generators in an area with limited transmission



#### Full Network Model





PI Vision

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# CAISO navigates the energy transition with AVEVA PI System

#### Challenge

- To empower the reliable and efficient transition to a cleaner, more sustainable grid
- Rapid evolution of the energy landscape requires integration of expanding renewable energy sources and increasing electrification, leading to new complexities
- To enable advanced forecasting, energy storage optimization and enhanced market operations in a dynamic environment

#### Solution

• AVEVA<sup>™</sup> PI System<sup>™</sup> is part of CAISO's data management and situational awareness and helps enhance data collection for forecast accuracy to ensure the reliability and security of the energy grid across much of Western USA.

#### Results

- Enhanced grid reliability across the Western Energy Imbalance Market (WEIM)
- Generated over \$6 billion in gross benefits for WEIM participants since 2014
- Reduced CO2 emissions by 1,043,043 metric tons
- Enabled successful integration of renewable energy sources
- Effective data management and collaboration with 74 external companies





# Questions and comments

# Thank you

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