
AVEVAWORLD

Salt River Project (SRP): Optimizing energy trading with AVEVA PI System. Our journey in the Western Energy Imbalance Market (WEIM)

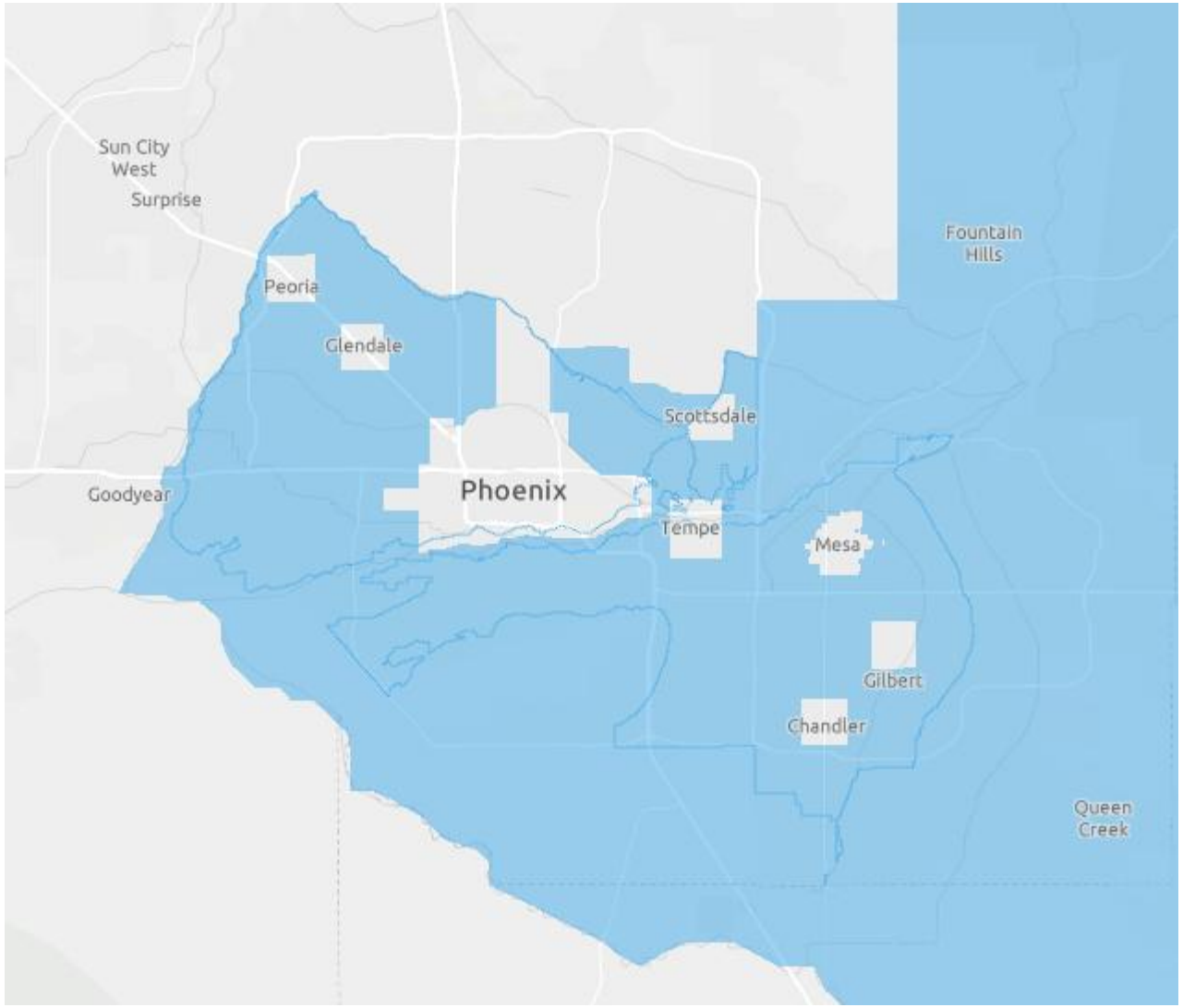
Nick Jacobs

Agenda

- Introduction to Salt River Project (SRP)
- Challenge of Centralized Markets
  - Western Energy Imbalance Market
  - Shift from traditional operations
  - Need for speed and accuracy
- AVEVA PI System as Solution
  - What is a PI system?
  - SRP's PI system
- PI System Data in Supply and Trading
  - PCI
  - PI Vision
- Results
  - Increased operational efficiency and reliability
  - Increased savings for customers
  - More data-driven culture

Salt River Project (SRP)

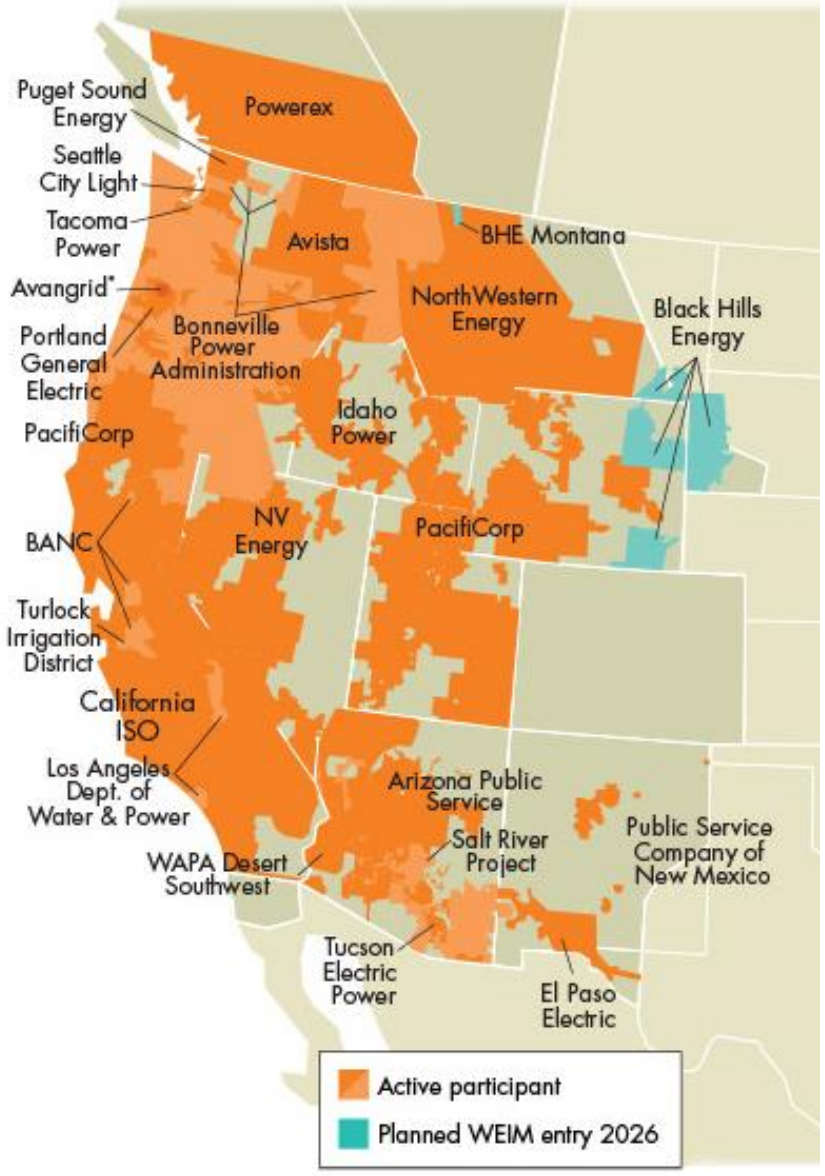
- Service territory and electric load
  - Over 2 million customers
  - 2024 peak load actual >8.2GW
  - 2025 peak load forecast >8.4GW
- Generation fleet
  - Large, diverse fleet: nuclear, natural gas, coal, hydro, solar, batteries, pumped storage, geothermal, and wind
- Supply and Trading
  - Manages economical operation of fleet in coordination with Reliability
- Electric wholesale bilateral market
  - WSPP has over 350 members across the Western Interconnect (CA to MX)



Challenge: Transitioning to a Centralized Market

Western Energy Imbalance Market (WEIM)

- Intra-hour centralized energy market that economically dispatches participants' resources to efficiently balance supply and loads across the market's footprint.
- Automated transactions occur 24/7 every five minutes through economic optimization.
- Designed to meet load requirements at the lowest total production cost to WEIM footprint.



Bilateral Market Compared to WEIM

Bilateral Market	WEIM
One $/MWh price/transaction	Bids contain multiple pricing components
Transactions sourced by any generator	Bids are unit-specific
Purchases/sales contain margin/markup	Bid is both the cost to “buy” or “sell” and typically mirrors production cost closely
Complete flexibility in bid price	Bid components have a price cap
Price and quantity is known at the time of making the deal	Settled price and quantity of transfers is not known until the settlements is finalized

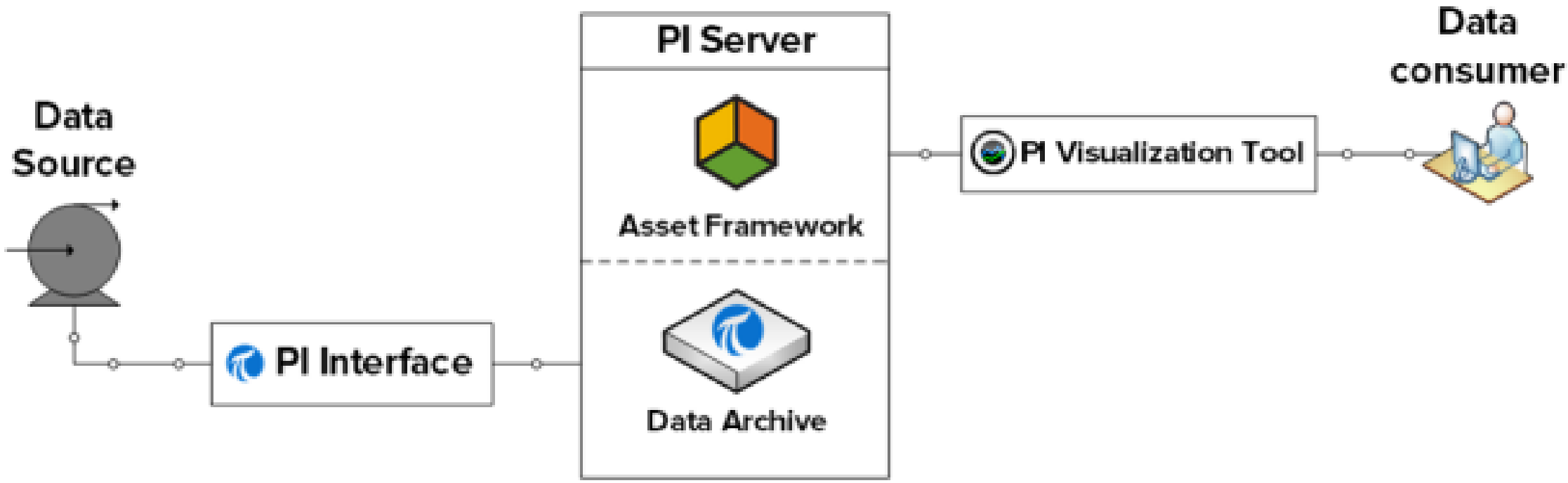
Participating in WEIM

- Successfully participating in WEIM requires that data inputs are accurate and submitted according to CAISO deadlines
  - Operating parameters for every generator
  - Generation outages/derates
  - Transmission outages/derates
  - Load forecasts
  - Variable Energy Resource (VER) forecasts
  - Reserve requirements
  - Bilateral transactions outside WEIM (Net Scheduled Interchange)
- Thousands of data points that must be continuously managed

Solution: AVEVA PI System

Data Flow in a PI System

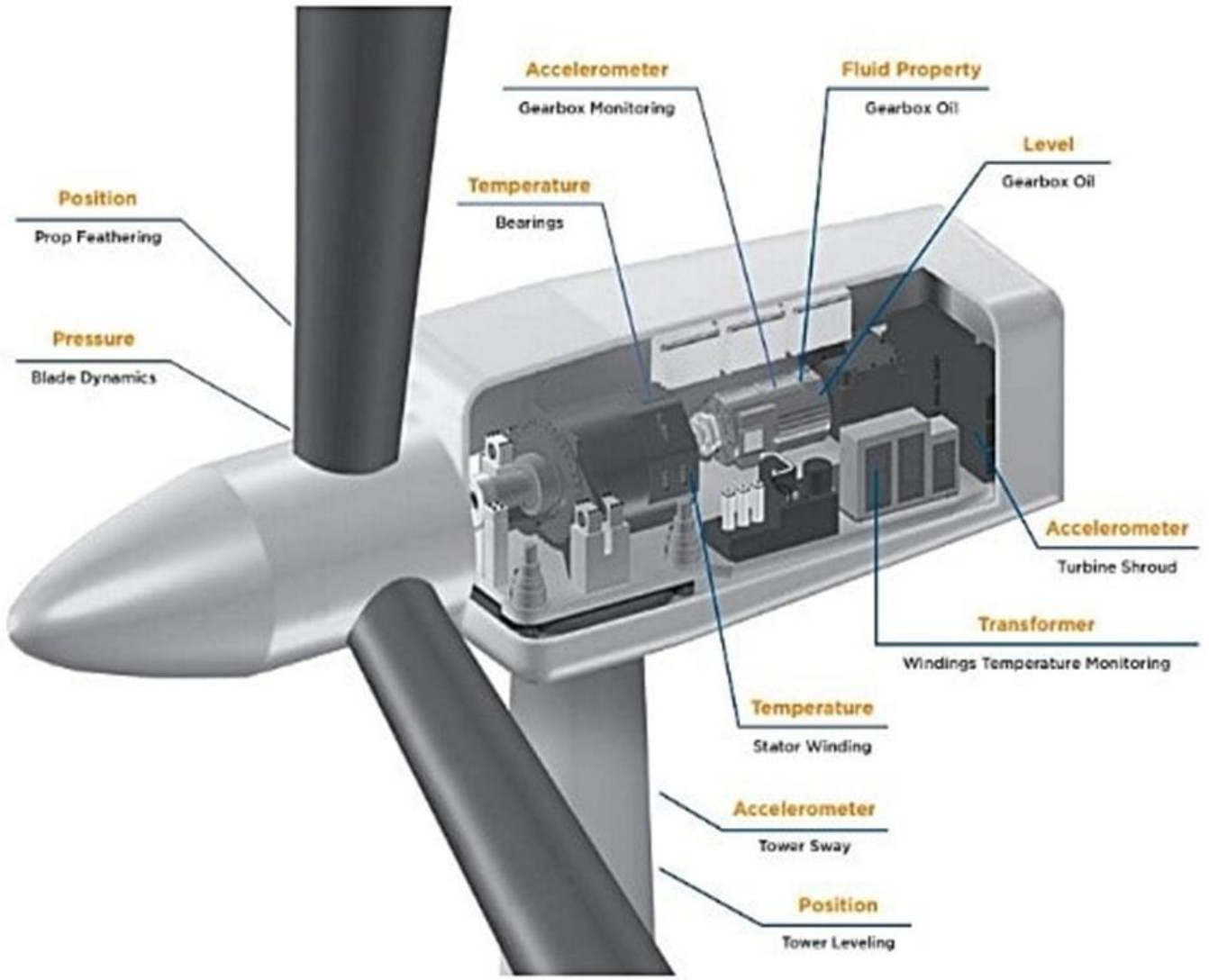
COLLECT ***STORE & ENHANCE*** ***DELIVER***



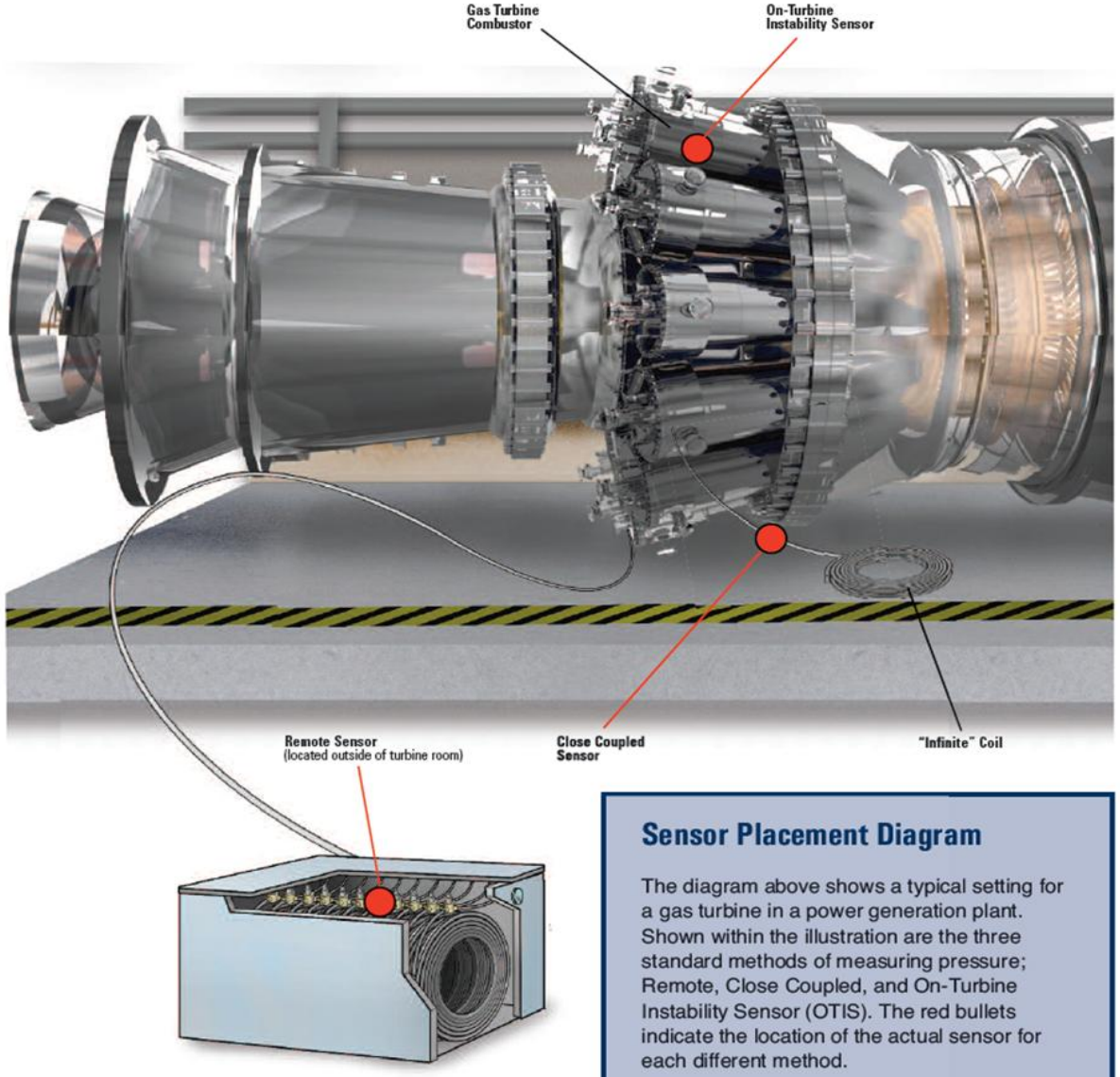
PI Interfaces

- Connections to raw data sources
  - Plant meters
  - Forecast data
  - Weather stations
  - Control systems
  - Other sensors and instruments

Types of Plant Data



Types of Plant Data

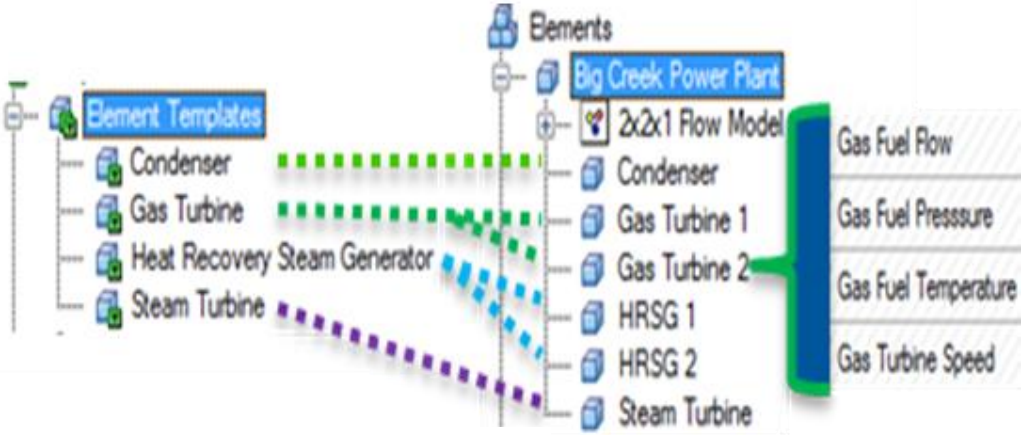


Sensor Placement Diagram

The diagram above shows a typical setting for a gas turbine in a power generation plant. Shown within the illustration are the three standard methods of measuring pressure; Remote, Close Coupled, and On-Turbine Instability Sensor (OTIS). The red bullets indicate the location of the actual sensor for each different method.

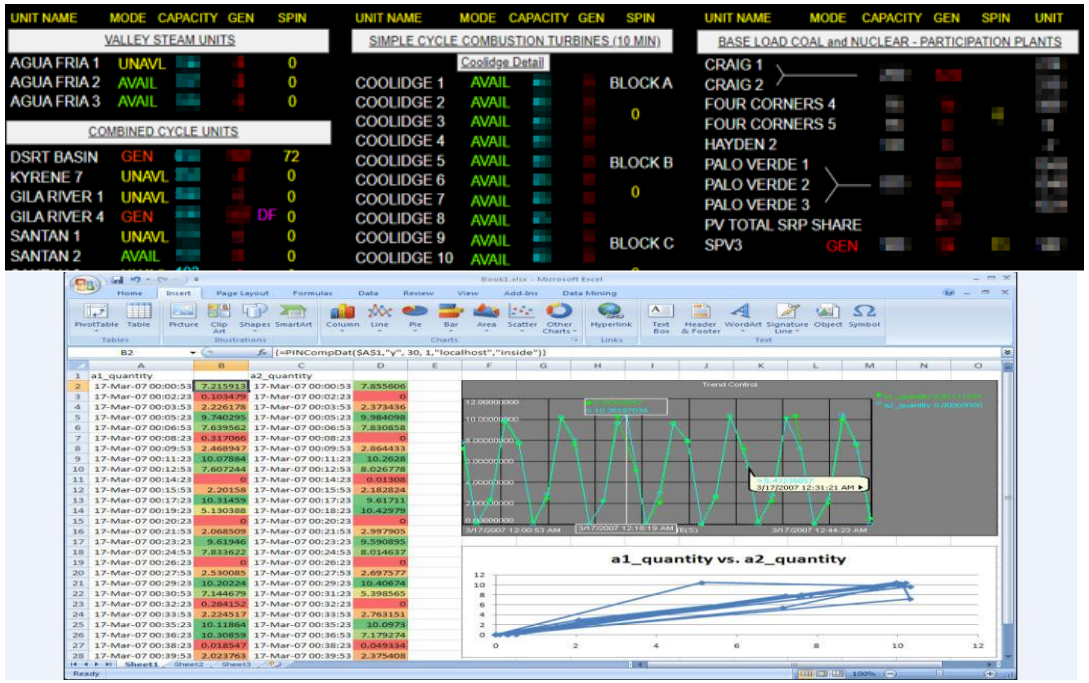
SRP's PI System

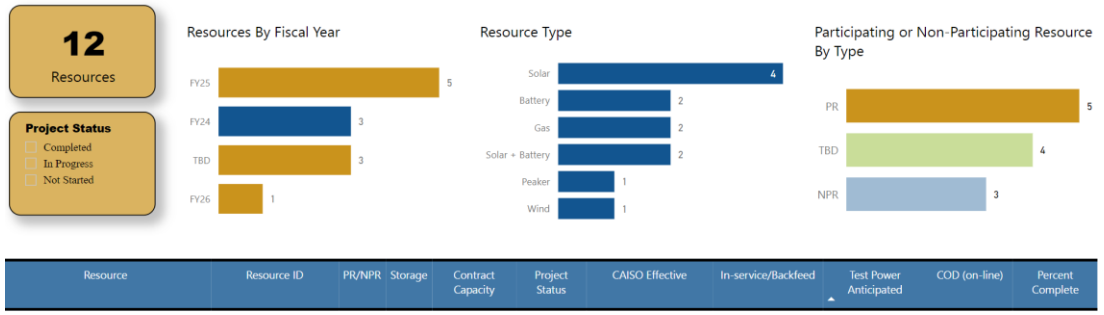
- Hundreds of displays
- Numerous reports and custom applications
- >60 servers
- >440 interfaces
- >900k tags



PI Visualization Suite

- PI Vision
  - Web browser-based
  - Save and share displays for future use
  - Visualization of PI System data
- PI DataLink
  - Microsoft Excel add-in
  - Pulls data directly into worksheets
  - Analysis of PI System data
- Power BI
  - Web browser-based
  - Clean, shape, model PI System data in visualizations and dashboards
  - Analysis and creating detailed reports





PI System Data in Supply and Trading

PI System Data in PCI Solutions

- PI System data is the backbone of our PCI optimization engine
  - Validates data quality
  - Provides initial conditions
  - Generation meter data
  - Generator operating parameters
  - Load forecast/actuals
  - VER forecasts
  - Fuel costs
  - Battery initial SOC
  - Hydro lake levels
  - Calculates hourly gas data
- Incorporates all this data and calculates optimal solution to economically meet load

PI System Data in PCI Solutions

- Gas Usage and Estimation Screen
  - PCI converts PI data from MCF to Dth
  - Calculates and updates estimated gas burn with each new optimization study
  - Helps gas traders monitor burns and stay within pipeline tolerance

Gas Usage and Estimation

StartDate : 01/11/2025 08:00

Actual (From PIAF x DTH Conversion Factor)

Forecast (From GenTrader study)

Name	Total	HE9	HE10	HE11	HE12	HE13	HE14	HE15	HE16	HE17	HE18	HE19	HE20	HE21	HE22	HE23	HE24	HE1	HE2	HE3	HE4
Total(A + B+ C)	272670	13713	8534	5888	5262	5526	5551	5623	7103	9267	14270	13740	13314	13314	13314	13240	13247	13892	13892	13892	13961
- A	170973	8833	6028	4826	4222	4235	4240	4311	5361	6688	10479	7786	7786	7786	7786	7720	7720	8068	8068	8068	8137
+ KY_6_BLK7	1800	1600	169	25	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
+ MEE_5_BLK1	68383	3832	2506	1457	890	908	923	947	975	2261	3334	3334	3334	3334	3334	3334	3334	3749	3749	3749	3818
+ HAR_5_BLK1	100790	3401	3353	3344	3331	3326	3316	3363	4385	4425	7145	4452	4452	4452	4452	4386	4386	4320	4320	4320	4320
- B	39138	1809	1454	1049	1030	1278	1292	1295	1298	1406	1819	1819	1819	1819	1819	1819	1819	1812	1812	1812	1812
+ ST_2_BLK5	66	7	6	6	5	2	7	10	11	11	0	0	0	0	0	0	0	0	0	0	0
+ ST_2_BLK6	39017	1796	1441	1037	1019	1270	1279	1279	1280	1388	1819	1819	1819	1819	1819	1819	1819	1812	1812	1812	1812
+ ST_2_UNIT1-4	55	6	6	6	6	6	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0
C	28	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0

PI Vision

- Powerful tool used in Supply and Trading to visualize and analyze real-time data
  - Real-time market analysis
  - Monitor generator and system health
  - Monitor external conditions
  - Manage energy storage and renewable resources
  - Optimize energy consumption

- Provides critical insights that empower energy traders to make data-driven decisions, optimize operations, and enhance market strategies

AVEVA™ PI Vision™

Trader Quad Auto (a) *(read-only)*

ACE w/BAA

ACE w/BAAL -34

ACE GRAPH.Average
-35
EMS_AGC.SRP ACE MW.AV
-34
ZERO LINE GRAPH.Value
0
BAAL HI LIMIT GRAPH 2.Value
80.8737
BAAL LO LIMIT GRAPH 2.Value
-154
EMS_AGC.ACE MW.AV
-35.74384

81

BAAL LIMITS

-154

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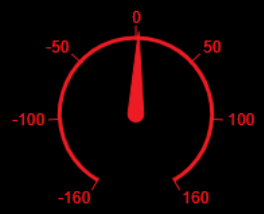
-28
MW/10min



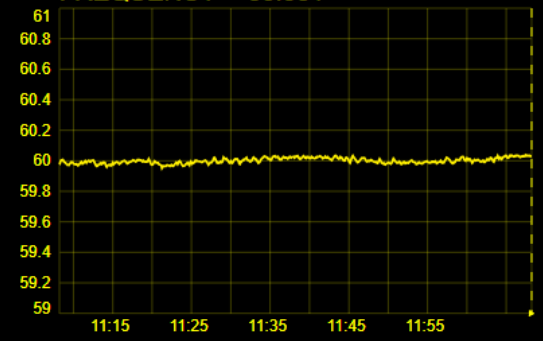
2
MW/20min

LOAD △ -19

YESTERDAY 3617
TODAY 3595

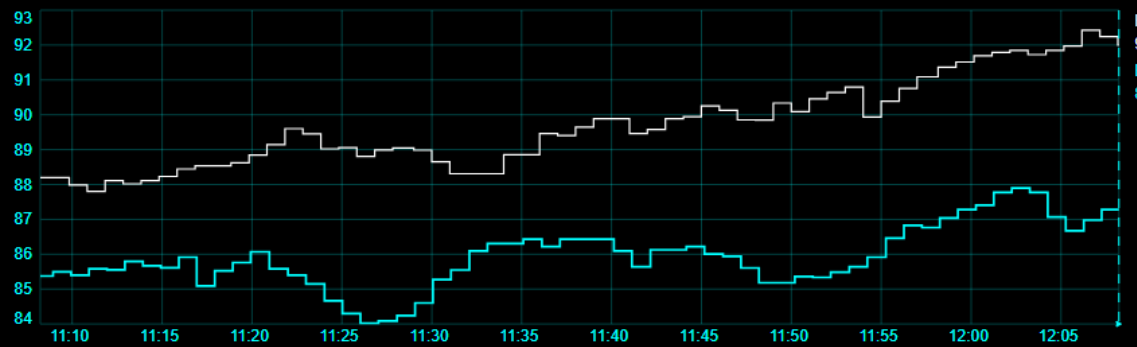
EMS_AGC.SRP LOAD MW.AV
3,595
SRP LOAD.Yesterday
3617.67

FREQUENCY 60.031



EMS_APAGCC.ACTFRE.I5
60.03100 MW

YESTERDAY 92 TODAY 87



PERA 1 DAY LATE.Value
91.9987
EMS_PERA.MAIR TEMPERATURE.AV
87.281

SYSTEM RESERVES

722	SPINNING
833	AVERAGE

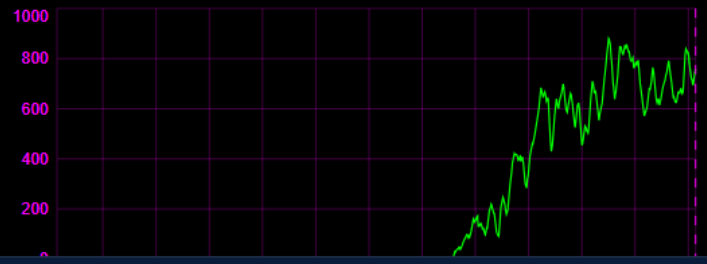
1455	CONTINGENT
190	REQUIREMENT
1574	AVERAGE

WATER ORDER 407

WARNINGS / MESSAGES

ARCADIA	85
PALO VERDE	86
FALCON	86
FOUNTAIN	87
STEWMTN	85

VARIABLE GEN 758 COOLIDGE GEN 0 AUX 1



EMS_COOLDGEN.U AUX CMW.AV
1
COOLIDGE NET - SUM OF ABC GROUPS.Value
0
EMS_AFAN_TotalVarGen
757.88910

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AVEVA™ PI Vision™
Popup Trend
EMS_AGC.SRP LOAD MW.AV
3,582
SRP LOAD.Yesterday
3619.92
3,650
3,600
3,550
3,500
3,450
3,400
3,350
11:10
11:15
11:20
11:25
11:30
11:35
11:40
11:45
11:50
11:55
12:00
12:05
3/26/2025 11:08:58 AM
1h
Now
3/26/2025 12:08:58 PM


AVEVA™ PI Vision™
Popup Trend
3/26/2025 12:00:28 PM
3/26/2025 12:05:11 PM
3,619.34419
3577.53
3,564.92344
3608.21
EMS_AGC.SRP LOAD MW.AV
3,592.63208
SRP LOAD.Yesterday
3619.92
3,650
3,600
3,550
3,500
3,450
3,400
3,350
11:10
11:15
11:20
11:25
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11:55
12:00
12:05
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GENERATION SUMMARY

GENTREND | GAS BURN ACTUALS

Last Modified 11/01/2024

VALLEY STEAM UNITS

UNIT NAME	MODE	CAPACITY	GEN	SPIN
AGUA FRIA 1	UNAVL			
AGUA FRIA 2	AVAIL			
AGUA FRIA 3	UNAVL			

COMBINED CYCLE UNITS

UNIT NAME	MODE	CAPACITY	GEN	SPIN
DSRT BASIN	UNAVL			
KYRENE 7	UNAVL			
GILA RIVER 1	GEN			
GILA RIVER 4	UNAVL			
SANTAN 1	AVAIL			
SANTAN 2	UNAVL			
SANTAN 3	AVAIL			
SANTAN 4	AVAIL			
SANTAN 5	GEN			
SANTAN 6	AVAIL			
MESQUITE 1	GEN			
HARQUAHALA				
HARQ 1				
HARQ 2				
HARQ 3				

BASE LOAD COAL GENERATION (SRP OWNED)

UNIT NAME	MODE	CAPACITY	GEN	SPIN
CORONADO 1	GEN			
CORONADO 2	GEN			
SPV 4	AVAIL			

SIMPLE CYCLE COMBUSTION TURBINES (10 MIN)

Coolidge Detail

UNIT NAME	MODE	CAPACITY	GEN	SPIN
COOLIDGE 1	AVAIL			BLOCK A
COOLIDGE 2	AVAIL			0
COOLIDGE 3	AVAIL			
COOLIDGE 4	AVAIL			
COOLIDGE 5	AVAIL			BLOCK B
COOLIDGE 6	AVAIL			0
COOLIDGE 7	AVAIL			
COOLIDGE 8	AVAIL			
COOLIDGE 9	AVAIL			BLOCK C
COOLIDGE 10	AVAIL			0
COOLIDGE 11	AVAIL			
COOLIDGE 12	AVAIL			
KYRENE 5	AVAIL			0
KYRENE 6	AVAIL			Normal
DSRT BASIN 4	UNAVL			0
DSRT BASIN 5	UNAVL			0
AGUA FRIA 7	AVAIL			0
AGUA FRIA 8	AVAIL			0
COPPER XG 1	AVAIL			
COPPER XG 2	AVAIL			

SIMPLE CYCLE COMBUSTION TURBINES (30 MIN)

UNIT NAME	MODE	CAPACITY	GEN	SPIN
AGUA FRIA 4	UNAVL			0
AGUA FRIA 5	UNAVL			0
AGUA FRIA 6	UNAVL			0
KYRENE 4	AVAIL			Normal

BASE LOAD COAL and NUCLEAR - PARTICIPATION PLANTS

UNIT NAME	MODE	CAPACITY	GEN	SPIN	UNIT
CRAIG 1					
CRAIG 2					
FOUR CORNERS 4					
FOUR CORNERS 5					
HAYDEN 2					
PALO VERDE 1					
PALO VERDE 2					
PALO VERDE 3					
PV TOTAL SRP SHARE					
SPV3	GEN				

SALT RIVER HYDRO PUMPBACK - HOOVER

HOOVER	GEN			
ROOSVLT 1	AVAIL			
HM1	AVAIL			
HM2	AVAIL			
HM3	UNAVL			
HM4	UNAVL			
MF1	AVAIL			
MF2	COND			

WATER ORDER HYDRO

STEWART MT	AVAIL	0.0
SOUTHCON	AVAIL	0.0
AZ FALLS	AVAIL	0.0
CROSSCUT	UNAVL	Scan Off

RENEWABLES 2

UNIT NAME	CAPACITY	GEN	UNIT
APPLE-BONNYBROOKE			
DRY LAKE EAST			
DRY LAKE WEST			
COPPER X-ING			
SWMP			
HUDSON RANCH			
QUEEN CREEK SOLAR			
COVE FORT			
SANDSTONE SOLAR			
EAST LINE SOLAR			
CENTRAL LINE SOLAR			
WEST LINE SOLAR			
BOLSTER BATTERY			
SIERRA ESTRELLA BATT			
SUPERSTITION BATT			
BABBITT RANCH WIND			
RANDOLPH SOLAR			

RENEWABLES 1

COLLOCATED RESOURCES

ELEVEN MILE SOLAR			
ELEVEN MILE BATTERY			
PINAL BATTERY			
PINAL SOLAR			
PINAL POI			

HYBRID RESOURCES

SONORAN HYBRID			
STOREY HYBRID			
SAINT HYBRID			

RATE OF CHANGE - LOAD

IN 20 MIN	116
IN 10 MIN	50

LOAD 3685 | FREQ 60.013 | TEMP 86 F

ACE -22 | HUMID 12%

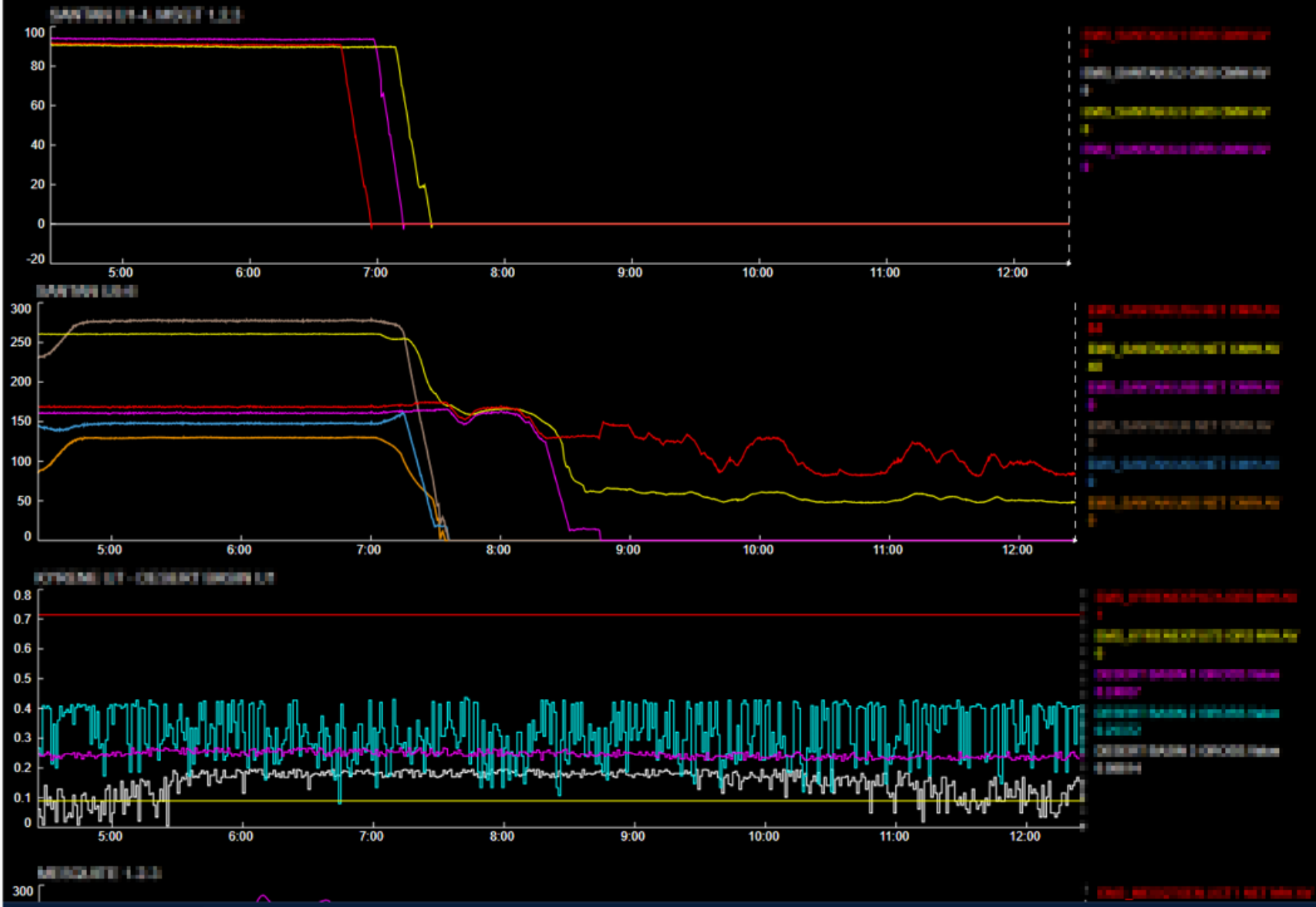
1464	CONTINGENT
194	REQUIREMENT
1464	AVERAGE

AVEVA™ PI Vision™

COMBINED CYCLE UNITS *(read-only)*

GENERATION SUMMARY

COMBINED CYCLE UNITS



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Now

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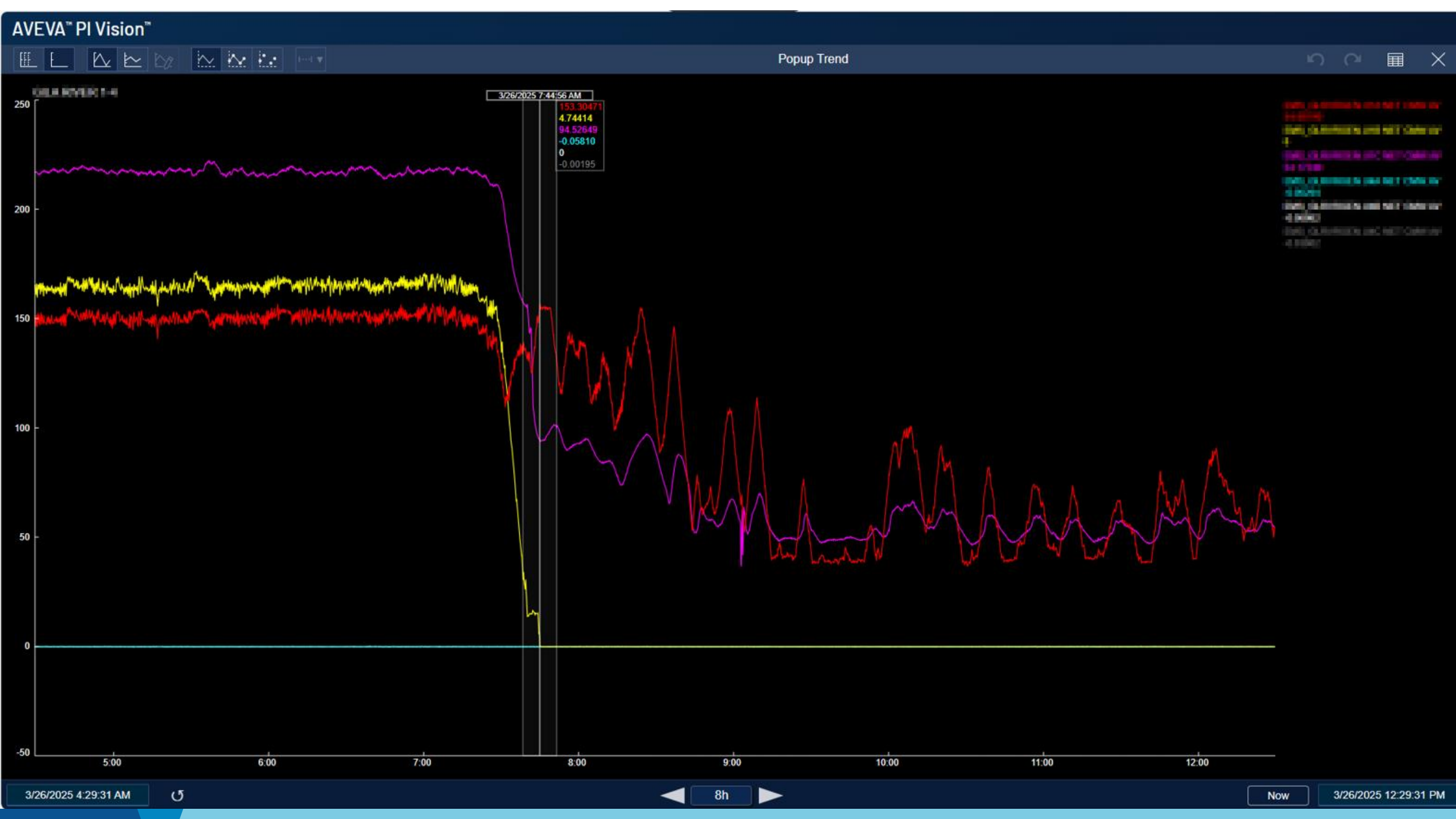

AVEVA™ PI Vision™
Popup Trend
3/26/2025 7:44:56 AM
153.30471
4.74414
94.52649
-0.05810
0
-0.00195
250
200
150
100
50
0
-50
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
3/26/2025 4:29:31 AM
8h
Now
3/26/2025 12:29:31 PM

AVEVA™ PI Vision™

BESS *(read-only)* Asset: [redacted] ▼

GENERATION SUMMARY

BESS

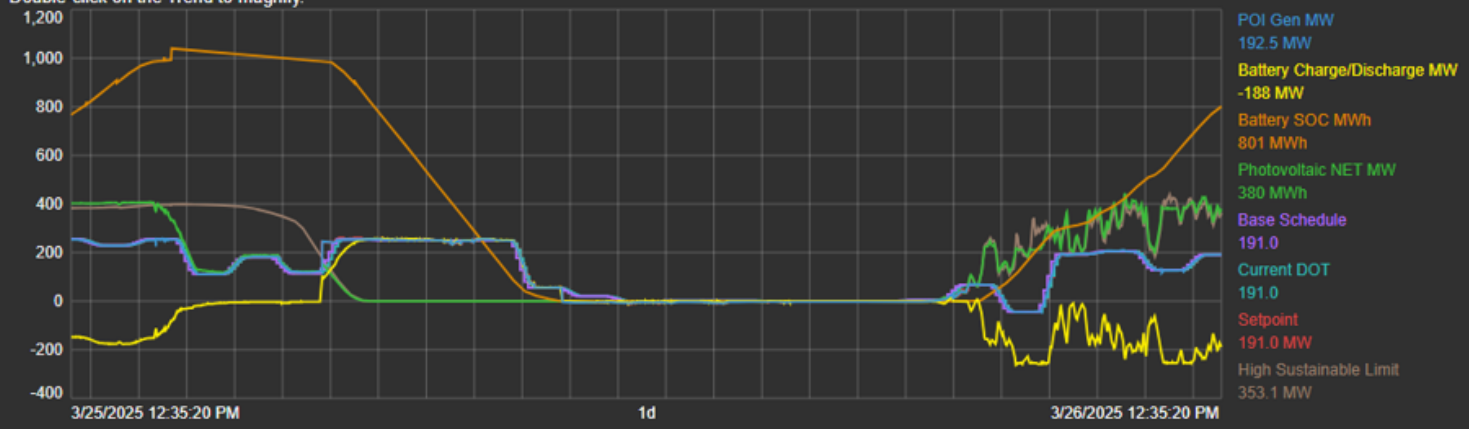
SOC 801 MWh 77.1 %

Status	CHARGING
Charge/Disch	-188 MW
Online Inverters	73 of 75
Battery Capacity	260 MW/1040 MWh
Solar Capacity	468 MW
POI Limit	260 MW

Click on the Trend column to see the trace.

Description ▲	Name	Value	Trend
Actual 5Min	[redacted] Unit Actual 5Min	190.0	
Battery Charge/Discharging	[redacted] Battery Charge/Discharge MW	-188.2	
Charge Capacity	[redacted] Battery Charge Capacity	-260.0	
Current Base Schedule	[redacted] Base Schedule	191.0	
Current DOT	[redacted] Current DOT	191.0	
Discharge Capacity	[redacted] Battery Discharge Capacity	260.0	
High Sustainable Limit	[redacted] High Sustainable Limit	353.1	
NonSpin Reserve	[redacted] Unit NonSpin Reserve	0.0	
Point of Interconnection	[redacted] POI Gen MW	192.5	
Resource Name	[redacted] Resource	[redacted]	
Setpoint	[redacted] Setpoint	191.0	
Solar Gen	[redacted] Photovoltaic NET MW	379.8	
Spin Reserve	[redacted] Unit Spin Reserve	0.0	
State of Charge %	[redacted] Battery SOC PCT	77.1	
State of Charge MWh	[redacted] Battery SOC MWh	801.2	

Double-click on the Trend to magnify.



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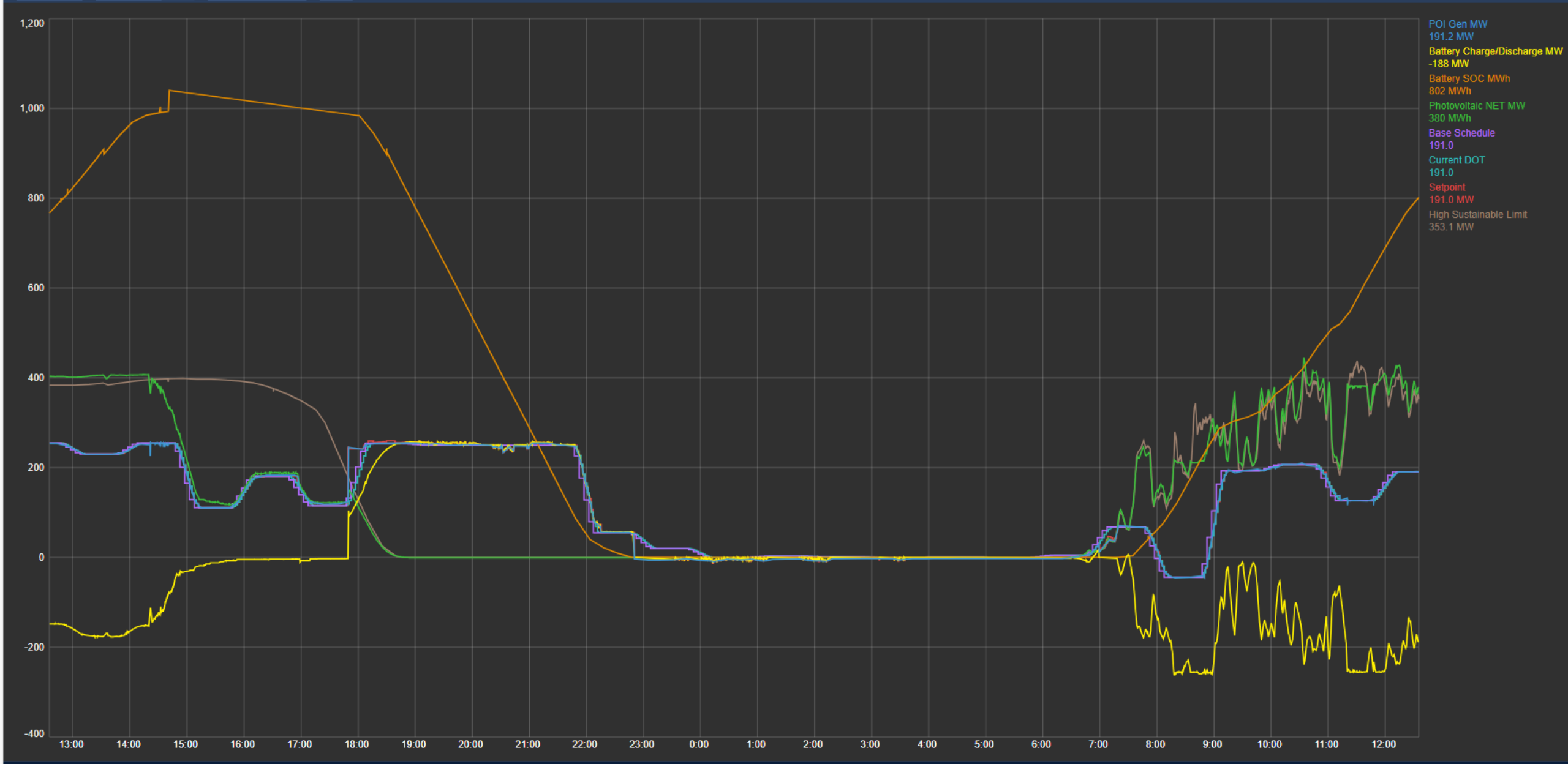
AVEVA™ PI Vision™

Popup Trend



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1d

Now

3/26/2025 12:35:20 PM

GAS ACTUALS *(read-only)*

Name ▲	Value	Trend
EMS_ U1,2,3 GAS FM.AV	No Data	
EMS_ U1-5 GAS FM.AV	No Data	
EMS_ U4 GAS FM.AV	0	
EMS_ U5 GAS FM.AV	0	

Name	Value	Trend
EMS_ U7 GAS FM.AV	9	

Name ▼	Value	Trend
EMS_ 1-12 GAS HC TW.AV	No Data	
EMS_ 1-12 GAS HC EP.AV	No Data	
EMS_ 1-12 GAS FM.AV	0	
EMS_ 1-12 GAS FM TW.AV	No Data	
EMS_ 1-12 GAS FM EP.AV	No Data	
EMS_ FUEL GAS BTU HR.AV	No Data	

Name ▲	Value	Trend
EMS_ GAS FM.AV	1,117	
EMS_ GAS FM.AV	1,109	
EMS_ GAS FM.AV	0	
EMS_ GAS FM.AV	954	
EMS_ GAS FM.AV	952	
EMS_ GAS FM.AV	0	
EMS_ GAS FM.AV	957	
EMS_ GAS FM.AV	0	
EMS_ GAS FM.AV	0	
EMS_ GAS FM.AV	0	

Name	Value	Trend
EMS_ U1&2&3 GAS FM.AV	1	
EMS_ U4&5&6 GAS FM.AV	0	
EMS_ U7 GAS FM.AV	0	
EMS_ U8 GAS FM.AV	0	

Name	Value	Trend
EMS_ U1 GAS FM.AV	0	
EMS_ U2 GAS FM.AV	0	

Name	Value	Trend
EMS_ N.U1 GAS FM EP.AV	843	
EMS_ N.U1 GAS FM TW.AV	0	
EMS_ N.U1 GAS FM.AV	No Data	
EMS_ .U2 GAS FM EP.AV	No Data	
EMS_ .U2 GAS FM TW.AV	No Data	

Name	Value	Trend
EMS_ .U1 GAS FM.AV	1	
EMS_ .U1,2,3 GAS FM 2.AV	No Data	
EMS_ .U1&2&3 GAS FM.AV	4	
EMS_ .U1,2,3,4 GAS FM 2.AV	No Data	
EMS_ .U1&2&3&4 GAS FM.AV	6	
EMS_ .U2 GAS FM.AV	3	
EMS_ .U3 GAS FM.AV	0	
EMS_ .U4 GAS FM.AV	2	
EMS_ .U5 GAS FM.AV	1,105	
EMS_ .U6 GAS FM.AV	1	

Name	Value	Trend
EMS_ .U1 GAS FLOW.AV	0	
EMS_ .U1 GAS PRES.AV	18	
EMS_ .U1 GAS TEMP.AV	105	
EMS_ .U2 GAS FLOW.AV	0	
EMS_ .U2 GAS PRES.AV	388	
EMS_ .U2 GAS TEMP.AV	108	
EMS_ .U3 GAS FLOW.AV	0	
EMS_ .U3 GAS PRES.AV	393	
EMS_ .U3 GAS TEMP.AV	110	

ST5 Gas Burn Now
1,104.8
3/26/2025 12:46:29 PM

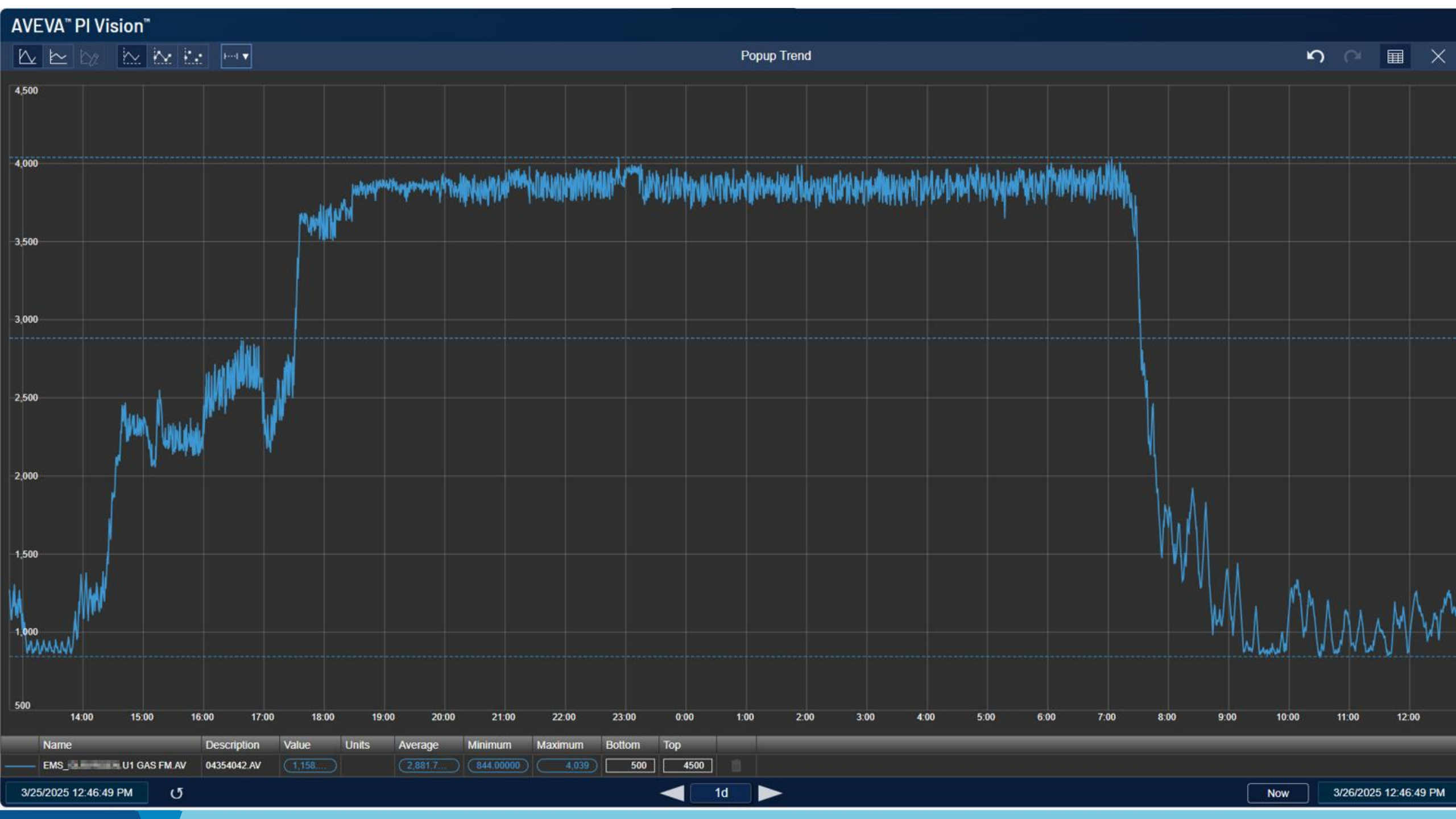
ST5 Gas Burn - This Gas Day
6,865.4
3/26/2025 12:46:29 PM

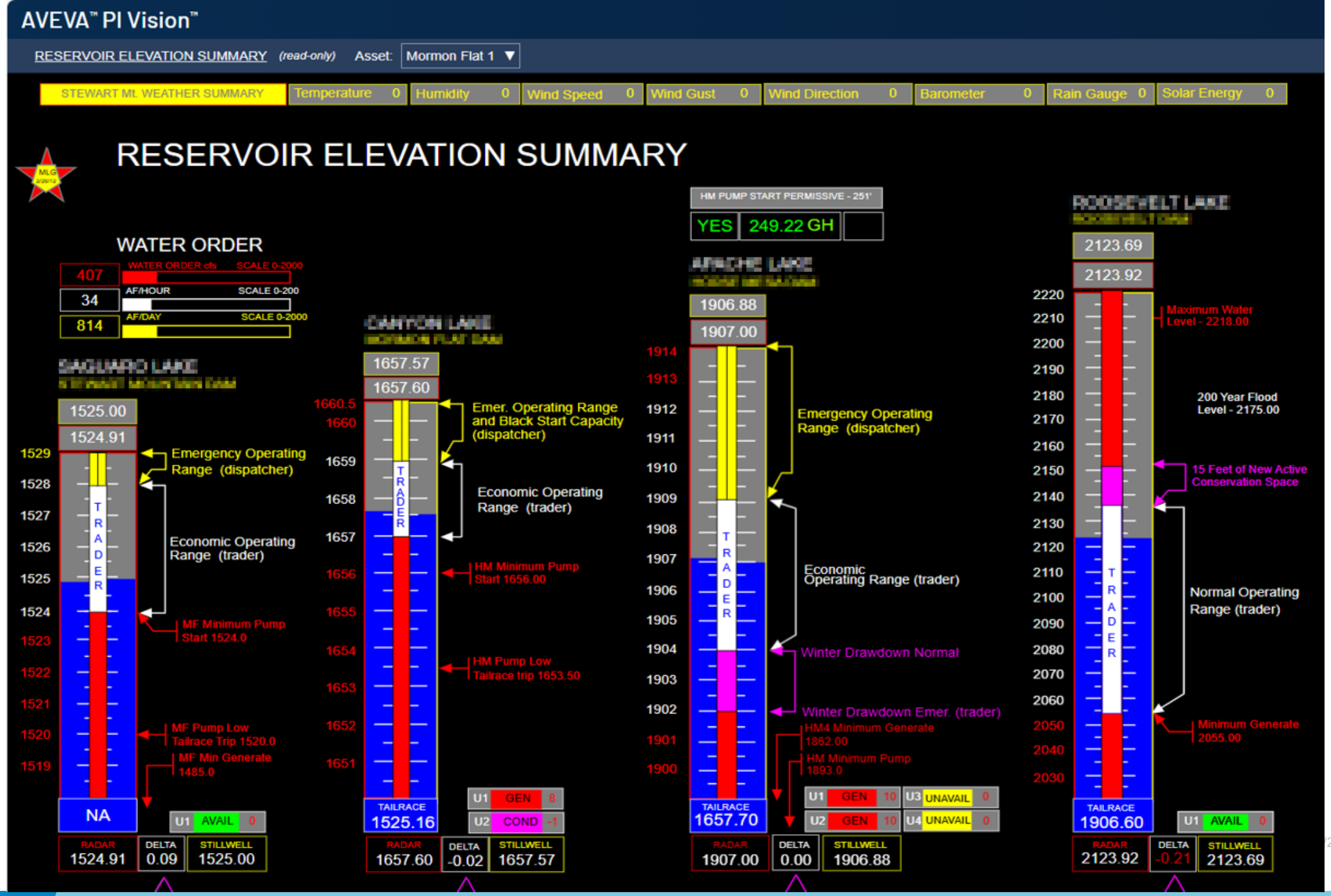
ST5 Gas Burn Last 60 min
46.4
3/26/2025 12:46:29 PM

ST6 Gas Burn Now
0.61525
3/26/2025 12:46:29 PM

ST6 Gas Burn - This Gas Day
2.9
3/26/2025 12:46:29 PM

ST6 Gas Burn Last 60 min
0.0
3/26/2025 12:46:29 PM


AVEVA™ PI Vision™
Popup Trend
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
Name
Description
Value
Units
Average
Minimum
Maximum
Bottom
Top
EMS_ U1 GAS FM.AV
04354042.AV
1,158....
2,881.7....
844.00000
4,039
500
4500
3/25/2025 12:46:49 PM
1d
Now
3/26/2025 12:46:49 PM


AVEVA™ PI Vision™
RESERVOIR ELEVATION SUMMARY (read-only) Asset: Mormon Flat 1
STEWART Mt. WEATHER SUMMARY
Temperature 0
Humidity 0
Wind Speed 0
Wind Gust 0
Wind Direction 0
Barometer 0
Rain Gauge 0
Solar Energy 0
RESERVOIR ELEVATION SUMMARY
WATER ORDER
407
WATER ORDER cfs SCALE 0-2000
34
AF/HOUR SCALE 0-200
814
AF/DAY SCALE 0-2000
SAGUARO LAKE
1525.00
1524.91
Emergency Operating Range (dispatcher)
Economic Operating Range (trader)
MF Minimum Pump Start 1524.0
MF Pump Low Tailrace Trip 1520.0
MF Min Generate 1485.0
TRADER
NA
U1 AVAIL 0
RADAR 1524.91
DELTA 0.09
STILLWELL 1525.00
CANYON LAKE
1657.57
1657.60
Emer. Operating Range and Black Start Capacity (dispatcher)
Economic Operating Range (trader)
HM Minimum Pump Start 1656.00
HM Pump Low Tailrace trip 1653.50
TRADER
TAILRACE 1525.16
U1 GEN 8
U2 COND -1
RADAR 1657.60
DELTA -0.02
STILLWELL 1657.57
HM PUMP START PERMISSIVE - 251'
YES 249.22 GH
APACHE LAKE
1906.88
1907.00
Emergency Operating Range (dispatcher)
Economic Operating Range (trader)
Winter Drawdown Normal
Winter Drawdown Emer. (trader)
HM4 Minimum Generate 1862.00
HM Minimum Pump 1893.0
TRADER
TAILRACE 1657.70
U1 GEN 10
U2 GEN 10
U3 UNAVAIL 0
U4 UNAVAIL 0
RADAR 1907.00
DELTA 0.00
STILLWELL 1906.88
ROOSEVELT LAKE
2123.69
2123.92
Maximum Water Level - 2218.00
200 Year Flood Level - 2175.00
15 Feet of New Active Conservation Space
Normal Operating Range (trader)
Minimum Generate 2055.00
TRADER
TAILRACE 1906.60
U1 AVAIL 0
RADAR 2123.92
DELTA -0.21
STILLWELL 2123.69

Result: Efficient Market Operations

More Efficient Market Operations = Increased Savings and Reliability for SRP's Customers

- Efficient management of our complex generation and transmission system
  - Collects and aggregates data from complex data sources and systems
  - Improves visibility into generator and system health
  - Improves management of energy storage and renewable resources
- PI System enables successful participation in the Western EIM
  - Provides the backbone of our optimization engine
  - Critical for submitting accurate data by strict deadlines
  - Increases optimization of generation dispatch and fuel consumption
- Resulted in a more data-driven culture
  - Traders can quickly find and understand key data
  - Improved situational awareness and more informed decision-making
  - Increased visibility and transparency into financial impacts of energy trading

POWER AND UTILITIES | UNITED STATES

SRP successfully transitions to and operates within the Western EIM

Challenge

- Shifting from a traditional bilateral market to the complexities of a centralized and dynamic energy imbalance market (EIM)
- Accurate and timely submittal of vast amounts of data within the CAISO deadlines required a new system
- Thousands of data points that must be continuously managed

Solution

- Deployed AVEVA™ PI System™ to streamline data collection, visibility, and analysis across a diverse range of generation and transmission assets

Results

- **Successful integration and operation within the WEIM**
- **Increased operational efficiency and reliability**
- **Increased savings for customers**
- **More data-driven culture**