
AVEVAWORLD

ORMAT

EQUIPMENT MONITORING IMPROVEMENTS WITH THE AVEVA PI SYSTEM AND STANDARDIZATION OF COMPLEX ANALYTICS

60 YEARS OF POWERING A SUSTAINABLE FUTURE

ORMAT

SAFE HARBOR STATEMENT AND NON-GAAP METRICS

THIS PRESENTATION INCLUDES FORWARD-LOOKING STATEMENTS, AND THE DISCLAIMER SHOULD BE READ CAREFULLY

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This presentation, and information provided during any discussion accompanying this presentation, may contain "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995. These statements involve estimates, expectations, projections, goals, objectives, assumptions and risks, and activities, events and developments that may or will occur in the future. When used in or during the course of this presentation, the words "may", "will", "could", "should", "expects", "plans", "anticipates", "believes", "estimates", "predicts", "projects", "thinks", "forecasts", "guidance", "continue", "goal", "outlook", "potential," "prospect" or "target", or the negative of these terms or other comparable terminology are intended to identify forward-looking statements, although not all forward-looking statements contain such words or expressions. Such forward-looking statements include, but are not limited to: statements about Ormat Technologies, Inc.'s and its affiliates' ("Ormat") business strategy; statements about Ormat's competitive strengths; statements about Ormat's development and operation of electricity generation, storage and energy management assets, including distributed energy resources; statements about Ormat's other plans, expectations, objectives and targets; statements about Ormat's views on market and industry developments and economic conditions, and the growth of the markets in which Ormat conducts its business; and statements about the growth and diversification of Ormat's customer base and Ormat's future revenues, expenses, earnings, capital expenditures, regional market penetration, electricity generation, and other operational performance metrics, including statements about "target" or "targeted" amounts for 2025 growth (MW) and 2023 operational performance metrics such as growth (MW) and adjusted EBITDA, among others.

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NON-GAAP METRICS

RECONCILIATION TO US GAAP FINANCIAL INFORMATION

This presentation includes certain "non-GAAP financial measures" within the meaning of Regulation G under the Securities Exchange Act of 1934, as amended, including EBITDA and Adjusted EBITDA. The presentation of these non-GAAP financial measures is not intended as a substitute for financial information prepared and presented in accordance with GAAP and such non-GAAP financial measures should not be considered as a measure of liquidity or as an alternative to cash flow from operating activities, net income or any other measures of performance prepared and presented in accordance with GAAP. Such non-GAAP financial measures may be different from non-GAAP financial measures used by other companies.

The appendix slides in this presentation reconcile the non-GAAP financial measures included in the presentation to the most directly comparable financial measures prepared and presented in accordance with U.S. GAAP .

SPEAKER BIOS

Yehiel Viner
VP Technical and Maintenance
Ormat

Rachel Huberman
Performance Engineer Lead
Ormat

Sarah Rappaport
Manager, R&D
Casne Engineering

A LEADING RENEWABLE ENERGY PROVIDER

WITH A PROVEN TRACK RECORD IN GEOTHERMAL AND ENERGY STORAGE

With

60

Years of experience

Own & operate

1.5GW

Geothermal, Storage, Solar PV & REG[1]

~1,500

Employees

CD4, Mammoth Complex, NV, USA, 65MW

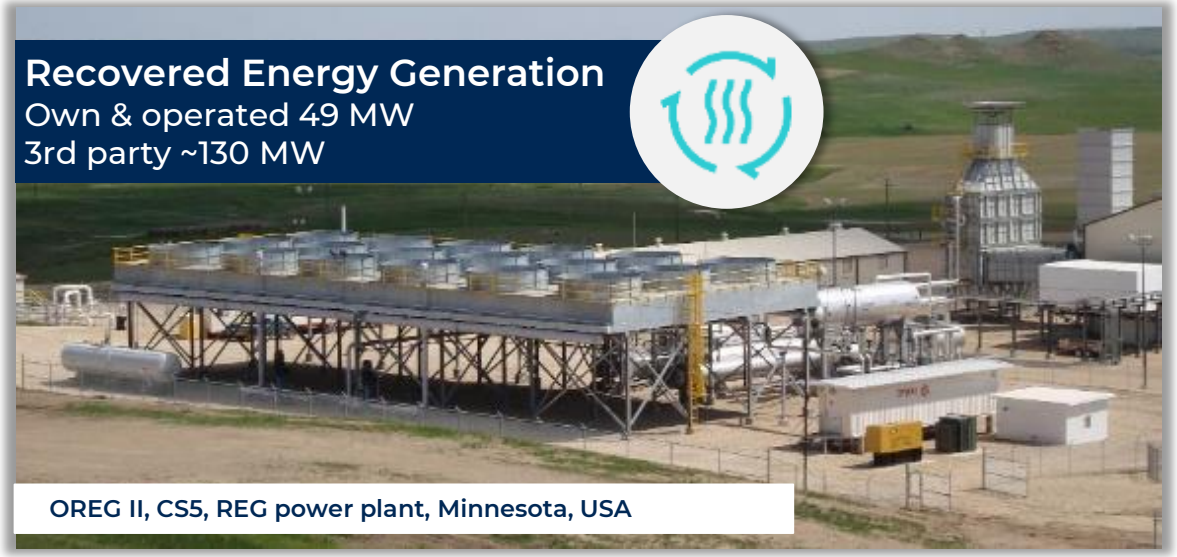
(1) REG – Recovered Energy Generation
(2) See appendix for reconciliation of non-GAAP financial measures.
(3) Net income attributable to the company stockholders

60 YEARS OF ORMAT: SUCCESSFUL TRACK RECORD, WORLDWIDE

Geothermal Power Plants
Own & operated 1,059 MW
3rd party ~2,200 MW

Sarulla geothermal power plant, Indonesia

Recovered Energy Generation
Own & operated 49 MW
3rd party ~130 MW



OREG II, CS5, REG power plant, Minnesota, USA

Energy Storage
Own & operated 270 MW / 638 MWh
Under construction 6 projects

Vallecito Battery Energy Storage Facility, CA, USA

Solar PV
Own & operated 122 MW
Under construction 3 projects

Tungsten Solar, Nevada, USA

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GLOBAL PRESENCE

MEETING THE NEEDS OF CUSTOMERS WORLDWIDE

- Geothermal Projects / complexes
- REG (Waste Heat) Projects
- Energy Storage Projects
- Solar Projects
- Manufacturing shop
- Office

Chart Source : ThinkGeoEnergy - “Geothermal Market Analysis September 2024” by Alexander Richter; Data is presented at gross installed capacity.

#1

Ormat - the largest geothermal owner & operator

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OUR CORE COMPETENCIES

THE WORLD'S ONLY VERTICALLY INTEGRATED GEOTHERMAL COMPANY

	Development and/or exploration	Drilling	Engineering	Manufacturing	Construction	Operation
ELECTRICITY	✓	✓	✓	✓	✓	✓
PRODUCT			✓	✓	✓	
STORAGE	✓		✓		✓	✓

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GEOTHERMAL OPERATIONAL CHALLENGES

Scaling and Corrosion: Mineral deposits and aggressive geothermal fluids causing equipment damage.
Well Performance and Degradation: Decline in productivity requiring regular maintenance and well rehabilitation.
Equipment Reliability and Maintenance: Harsh conditions impacting equipment lifespan, requiring predictive maintenance.
Reservoir Sustainability: Balancing extraction and reinjection to prevent depletion or cooling.
Injection Management: Managing injection-related seismic risks and reservoir cooling.
Plant Availability and Reliability: Minimizing downtime and quickly addressing operational disruptions.
Workforce and Skills Management: Need for specialized, well-trained operational personnel.
Operational Efficiency: Optimizing equipment performance to reduce costs and increase output.
Environmental and Regulatory Compliance: Ensuring continuous adherence to environmental and safety standards.

Real-time data analytics and predictive insights for early detection and resolution of operational issues.

Optimize performance
Reduce downtime
Improve reliability

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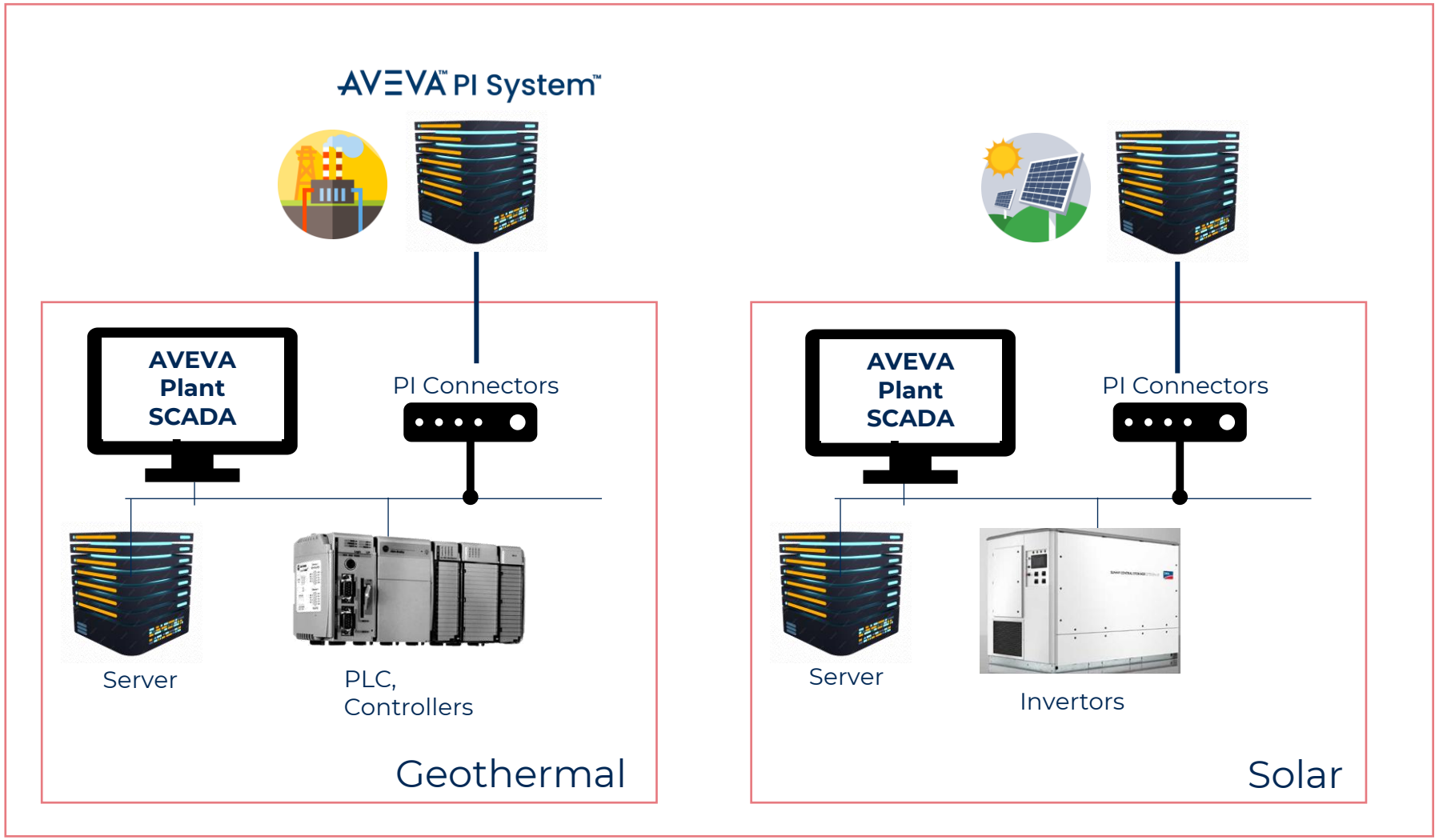
GOAL: DATA FLOW FROM EDGE TO ENTERPRISE



PowerOptix®

Power BI

SAP

Seeq®

APERIO Superior Data

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CHALLENGE: ANALYTIC EFFICIENCY AND ACCURACY

Time-Consuming & Error-Prone Calculations
Manual data collection and calculations increase workload and risk of errors

Delayed Insights & Reactive Maintenance
Lack of real-time tracking slows issue detection and response

Inconsistent & Unstandardized Monitoring
Different units follow non-uniform methodologies, making benchmarking difficult

Limited Performance Comparison
No structured way to compare actual vs. expected performance in real time, it restricts the ability to fully understand the performance potential

No Foundation for Predictive Maintenance –
Lack of structured performance data makes advanced analytics difficult

Lose Generation

THE ASSET-BASED APPROACH ADVANTAGES

Standardized Asset Modeling

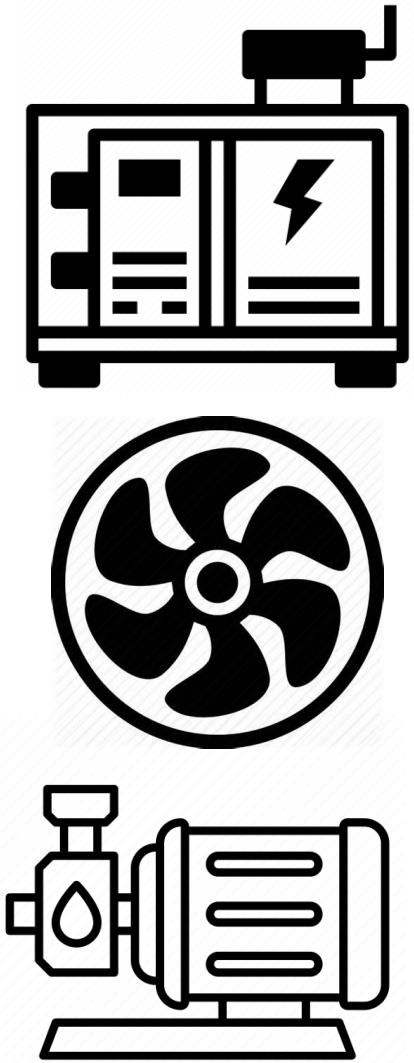
- Scalability: Templated structures for generators, turbines, pumps, heat exchangers, etc.
- Consistency: Ensures uniform monitoring and benchmarking across all units.
- Interoperability: Lays the groundwork for an Advanced Analytics Layer
- Visualization: Integration with SCADA, Historian, BI Tools

Advanced Analytics & Performance Monitoring

- Automation: Standardized KPIs, Out of Range Detection
- Online Calculations: Performance calculations, trend analysis

Enabling Faster Decision Making

- Digital twin: Simulate behavior
- Condition-based monitoring: Catch anomalies early
- Predictive Maintenance: Fix before failure



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ARCHITECTURE AND DESIGN APPROACH

ARCHITECTURE AND DESIGN APPROACH

- Organize and sort tags by component
- Ensure flexible deployment across different plan setups
- AVEVA Historian/Plant SCADA Integration

AVEVA™ Plant SCADA

AVEVA Historian

AVEVA
PI Server

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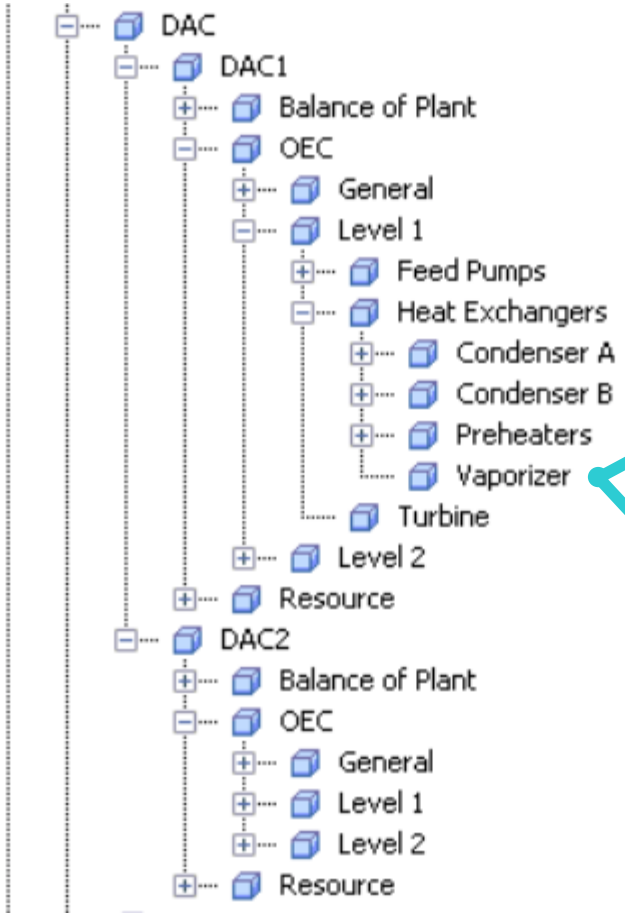
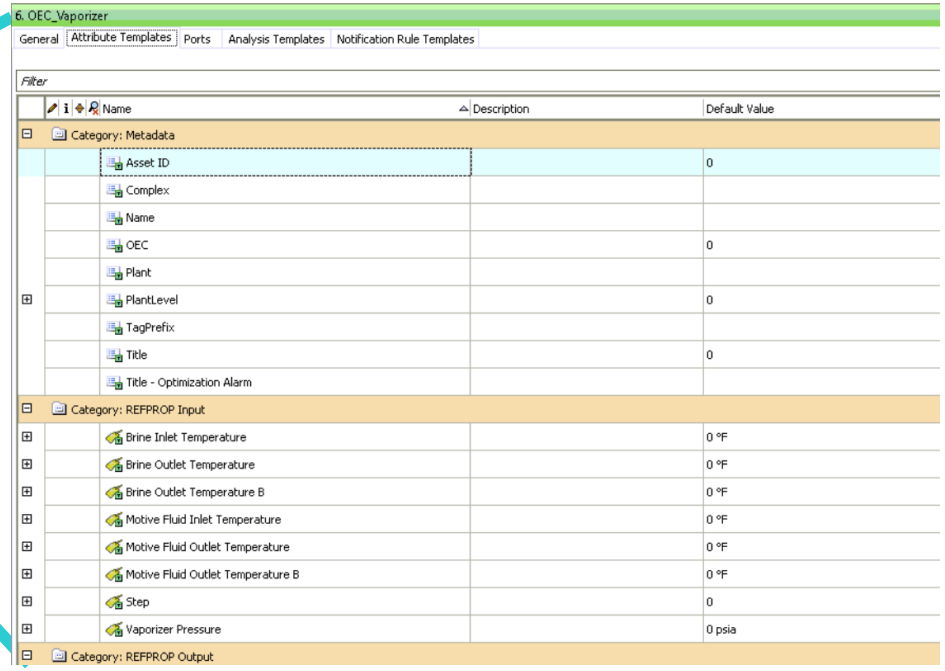
ARCHITECTURE AND DESIGN APPROACH

- **AF hierarchy definition**
  - Define unit hierarchy
  - Define data points from field (~200 tags per OEC)
  - Identify key components to analyze per each asset (8-12 assets per plant)
    - OEC, Resource
    - Monitor for key metrics/KPIs
    - Enable thermodynamic calculations to measure asset performance

IMPLEMENTATION: ASSET FRAMEWORK



- AF Hierarchy
  - AF implementation details
  - AF Templates for easy scaling



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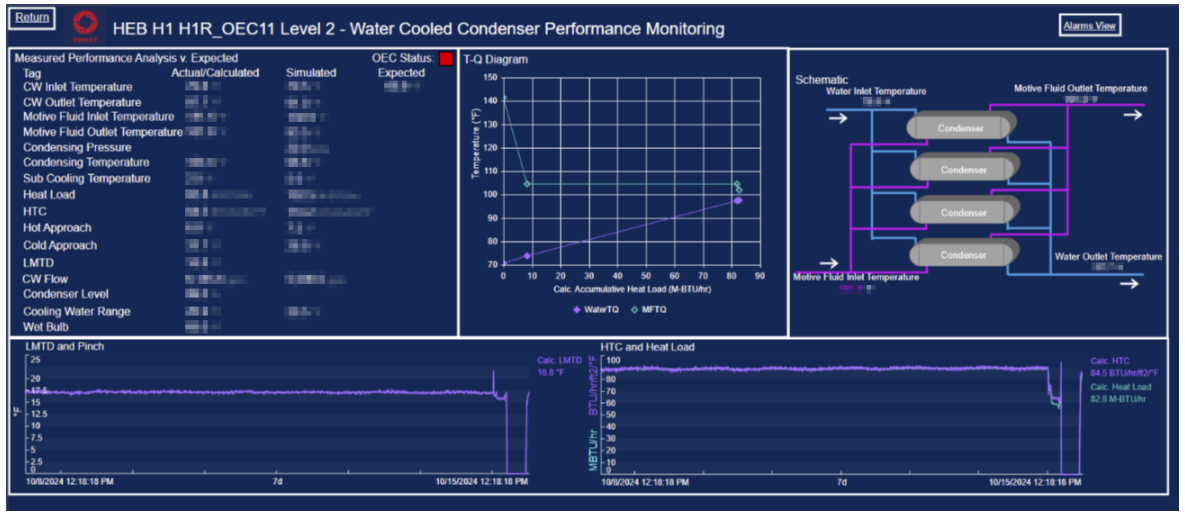
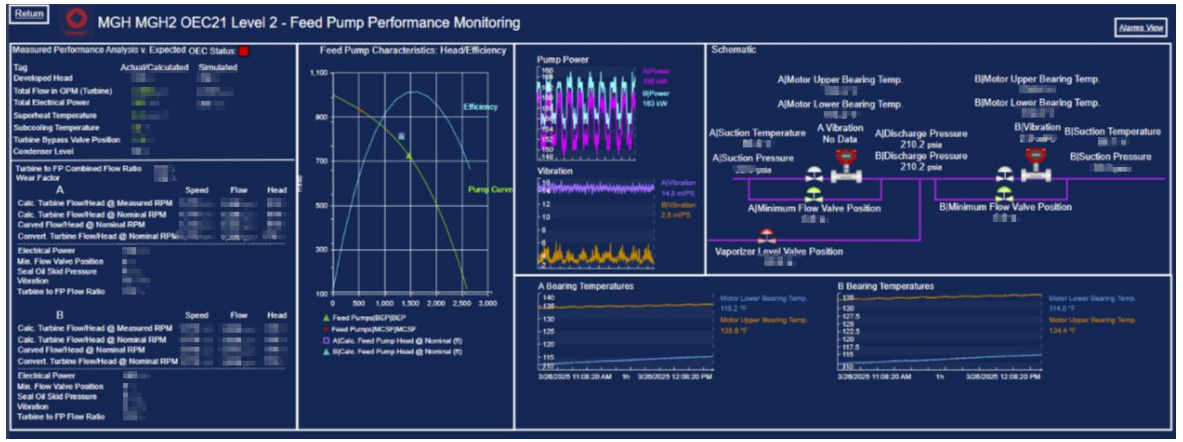
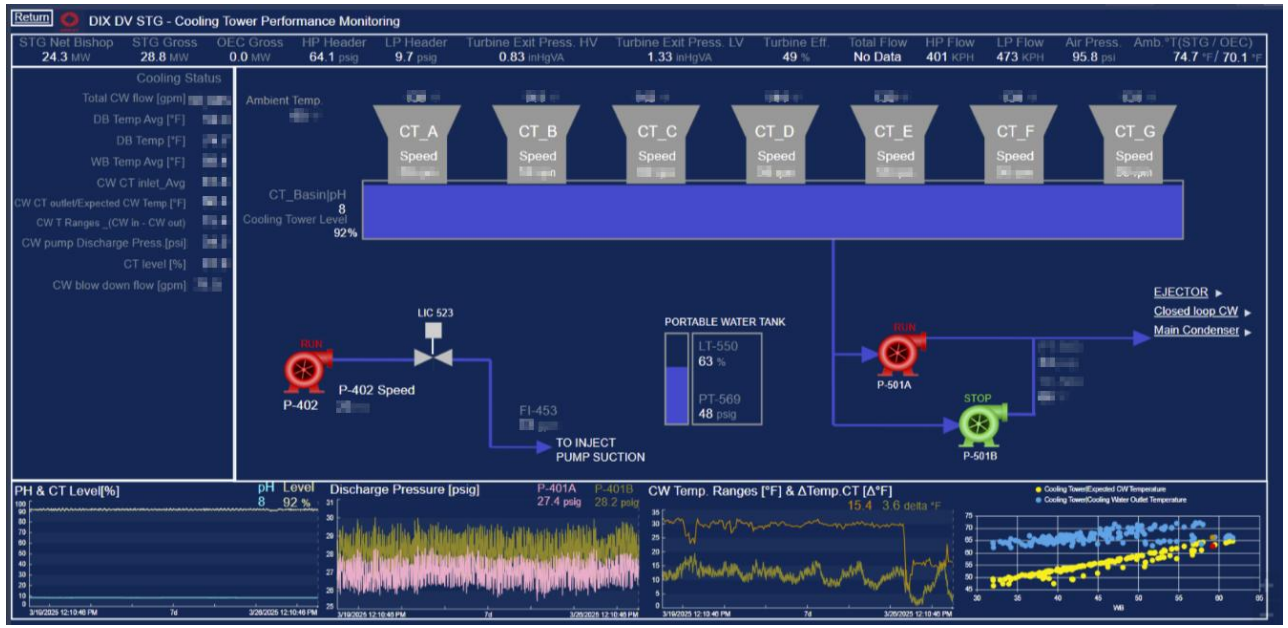
ARCHITECTURE AND DESIGN APPROACH

- Templated dashboards for each piece of equipment
- Summary screens for each plant and unit
- Display critical KPIs, calculation results, and process values for ease of monitoring

ARCHITECTURE AND DESIGN APPROACH







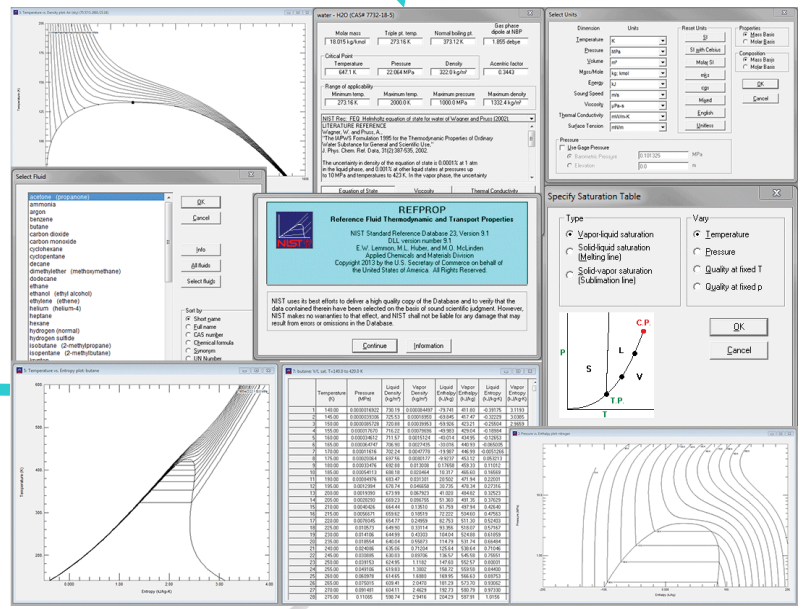
ARCHITECTURE AND DESIGN APPROACH

- **Performance Analysis**
  - Automate manual calculations into an online system
  - Store results as tags for continues tracking
- **Simulation-based Comparison**
  - Generate simulation tags using internal tool
  - Compare actual vs. expected performance for deeper insights
- **Performance Curve Automation**
  - Continually update expected vs actual performance trends
  - Enable proactive decision making with real time insights

IMPLEMENTATION: PERFORMANCE ANALYSIS

- Custom implementation using AFSDK
- Advanced Analytics: Custom calculations of Enthalpy, Entropy, etc. that are challenging to accomplish
- Scalable: Hooks into AF templates for quick deployment
- Efficiency improvements: live calculations rather than manual calculations in Excel

Category: REFPROP Input	
Inlet Pressure	psia
Inlet Pressure from Vaporizer	psia
Inlet Temperature	°F
Outlet Pressure	psia
Outlet Temperature	°F
Step	
Vaporizer Pressure	psia
Category: REFPROP Output	
Calc. Calculated Work	MW
Calc. Efficiency	%
Calc. Inlet Entropy	Btu/(lb °R)
Calc. Isentropic Work	MW
Calc. Motive Fluid Flow	KPH
Calc. Outlet Entropy	Btu/(lb °R)
Calc. Turbine Calculated Flow Total	gpm
Vaporizer Calc. Superheat	delta °F



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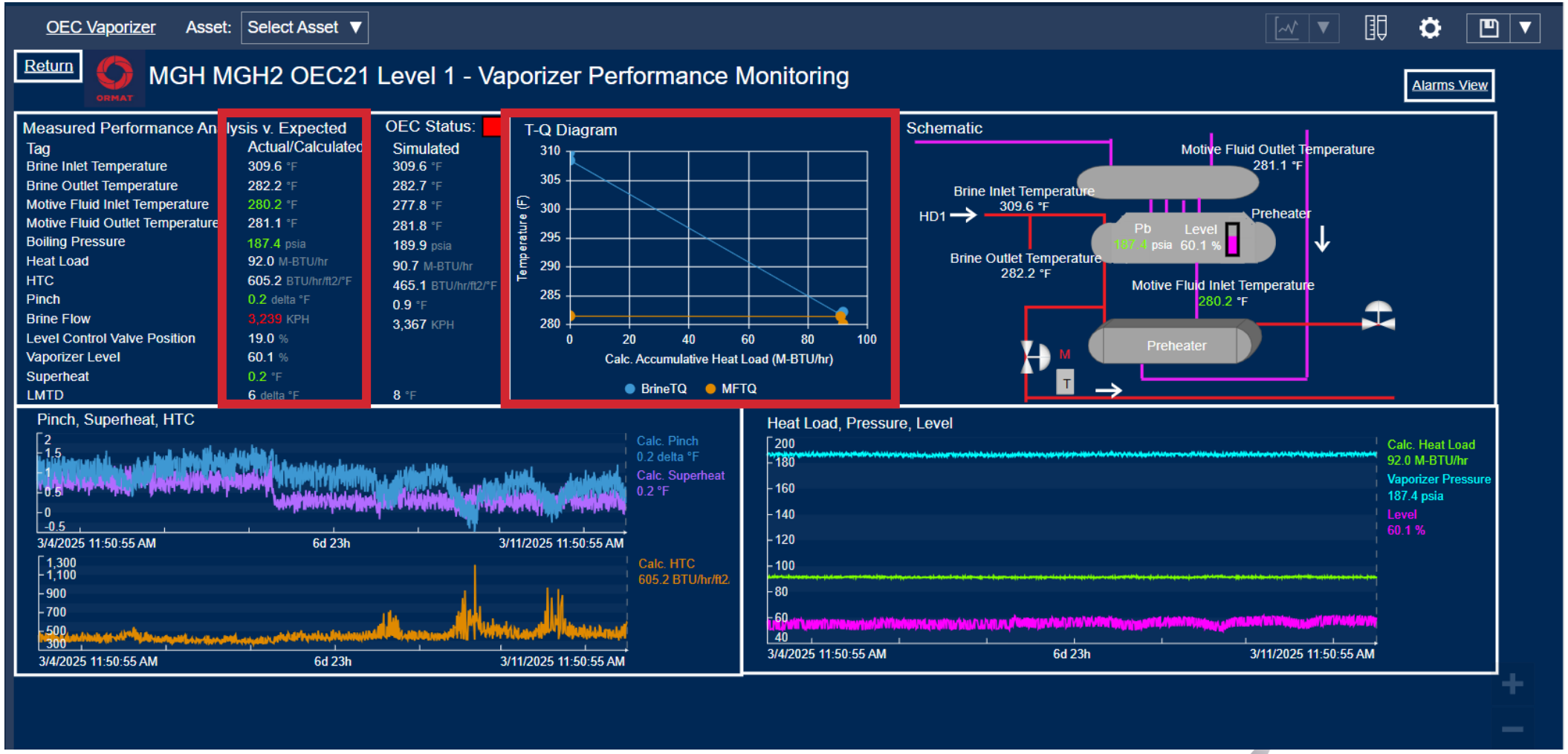
VAPORIZER PERFORMANCE MONITORING



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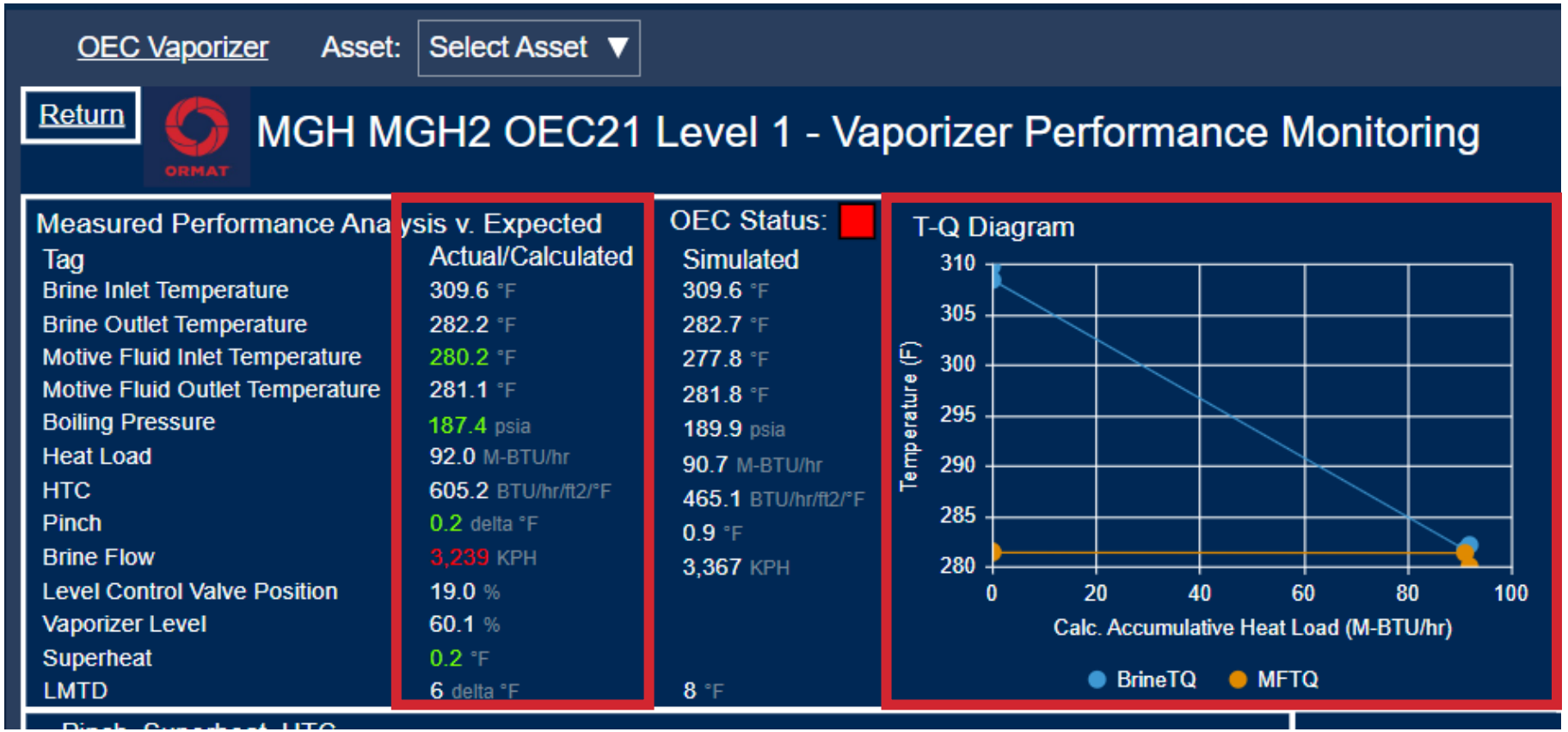
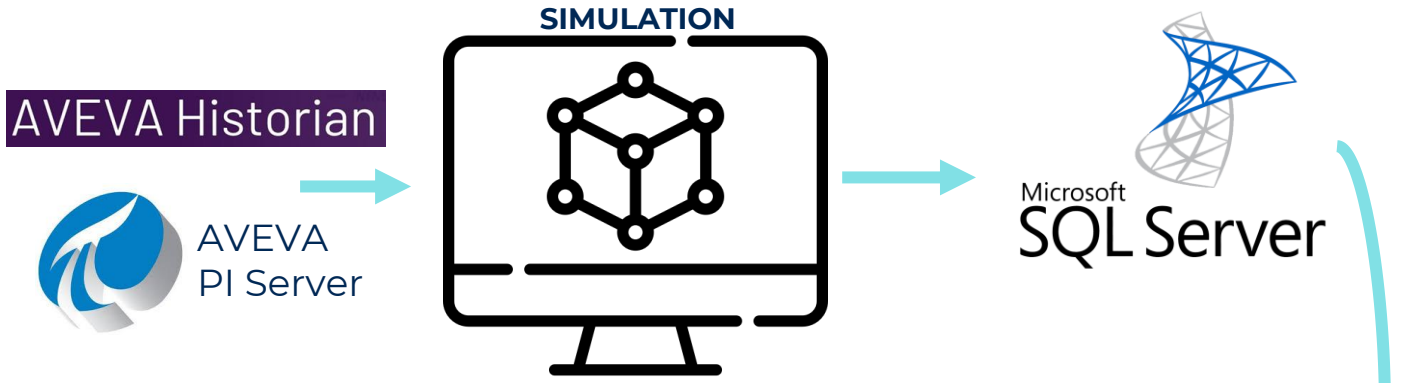
VAPORIZER PERFORMANCE MONITORING



SIMULATION-BASED COMPARISON

- Integrated custom simulation into PI *via* RDBMS interface
- Allows comparison between expected performance and calculated performance



Category: Simulation Calculation		
	Sim Efficiency	[redacted] %
	Sim Gross Power	[redacted] MW
	Sim Inlet Pressure	[redacted] psia
	Sim Inlet Temperature	[redacted] °F
	Sim MF Flow	[redacted] KPH
	Sim Outlet Pressure	[redacted] psia
	Sim Outlet Temperature	[redacted] °F

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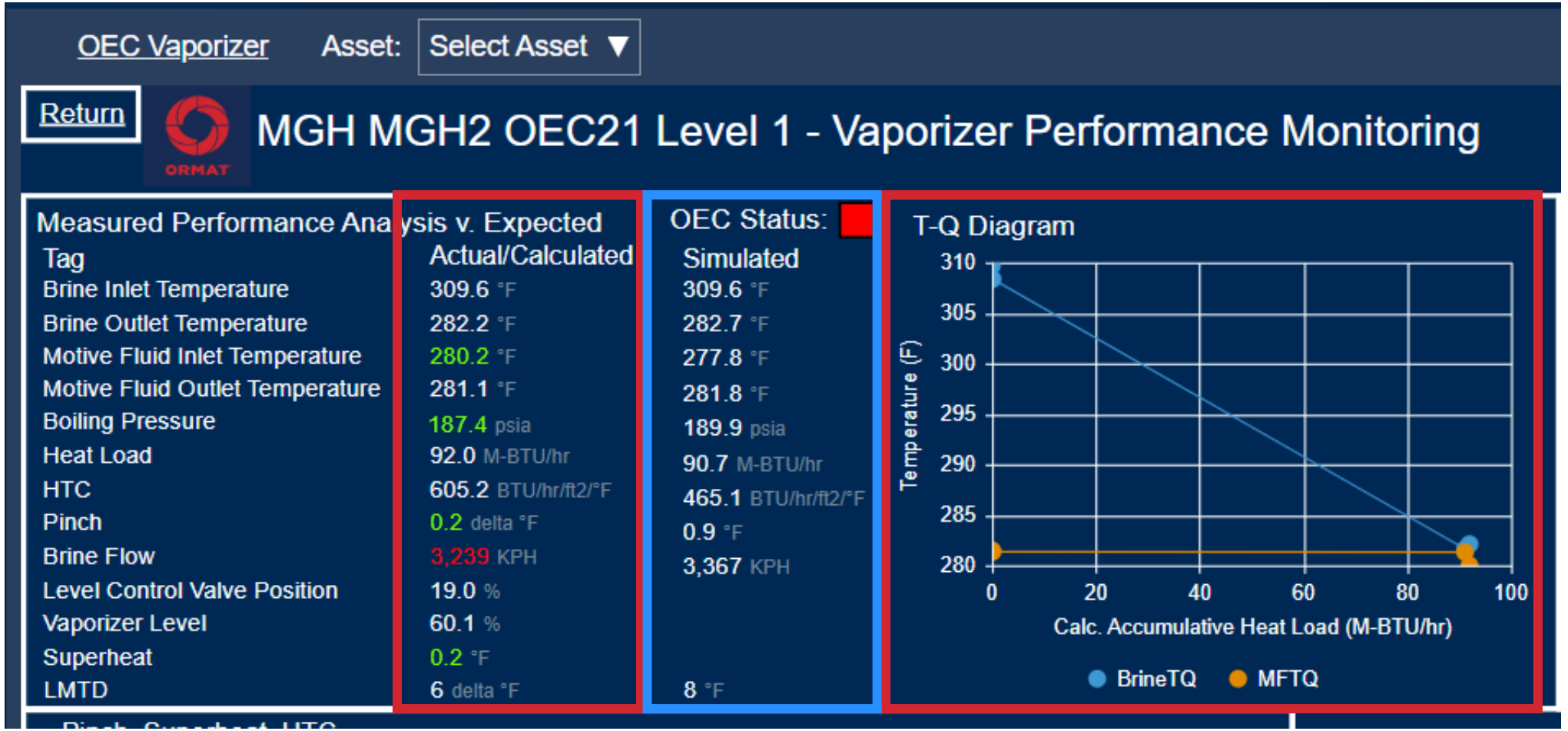
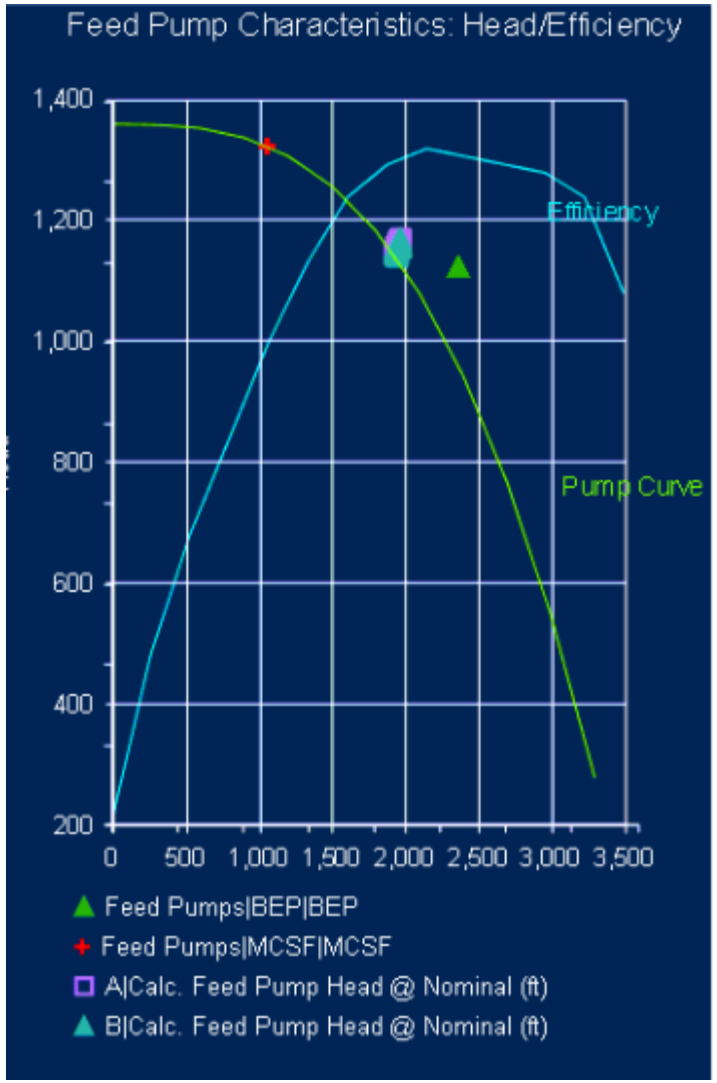
VAPORIZER SIMULATED PERFORMANCE



PERFORMANCE CURVES



- Plotted idealized efficiency and pump curves
- Plotted calculated head for each feed pump
- Catch performance drift

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ARCHITECTURE AND DESIGN APPROACH

Data Collection → **AF Hierarchy** → **Visualization** → **Performance Analysis and Simulation** → **Out Of Range Detection**

Using multistate to identify online out of range values to optimize performance

Vaporizer Superheat [°F]	0.4	0.2	0.9	0.1	3.4	0.9
Vaporizer Pinch [°F]	1.0	3.2	2.4	4.9	5.1	5.7
Vaporizer Level [%]	59.6	36.3	56.7	56.1	56.7	50.3
Preheater Pinch [°F]	3.7	7.5	5.0	6.2	14.9	12.2
Condenser Cold Approach [°F]	48.3	44.4	48.7	42.8	46.3	45.4
Condenser Subcooling Temp. [°F]	26.5	22.3	8.9	13.7	18.2	21.3
Condenser Level [%]	50.0	85.3	46.0	66.1	70.0	65.3
Generator Cooling AVG Temp [°F]	40.8		42.2		42.2	
Level control valve [%]	18.0	24.0	24.0	28.0	26.0	23.0

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BENEFIT: TUBE LEAKS DETECTION

Optimization Table	OEC21 Level 1	OEC21 Level 2	OEC22 Level 1	OEC22 Level 2	OEC23 CW	OEC23 CCW
OEC Actual Gross Power [MW]	18.9		19.0		12.1	
OEC Cycle Efficiency [%]	17.2		17.6		12.2	
Average Turbine Efficiency [%]						
Turbine Inlet Pressure [psia]						
Turbine Exit Pressure [psia]						
Turbine Efficiency [%]						
Turbine to FP Flow Ratio [%]						
Vaporizer Superheat [°F]	0.4	0.2	0.9	0.1	3.4	0.9
Vaporizer Pinch [°F]	1.0	3.2	2.4	4.9	5.1	5.7
Vaporizer Level [%]	59.6	36.3	56.7	56.1	56.7	50.3
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Generator Cooling AVG Temp [°F]	40.8		42.2		42.2	
Level control valve [%]	18.0	24.0	24.0	28.0	26.0	23.0

Quickly combining Thermodynamic KPIs with Ormat expertise to identify and mitigate tube leaks in the Vaporizer

BENEFIT: TURBINE OPTIMIZATION

Optimization Table	OEC21 Level 1	OEC21 Level 2	OEC22 Level 1	OEC22 Level 2	OEC23 CW	OEC23 CCW
OEC Actual Gross Power [MW]	18.9		19.0		12.1	
OEC Cycle Efficiency [%]	17.2		17.6		12.2	
Average Turbine Efficiency [%]						
Turbine Inlet Pressure [psia]						
Turbine Exit Pressure [psia]						
Turbine Efficiency [%]						
Turbine to FP Flow Ratio [%]						
Turbine Vibration [mIPS]						
Vaporizer Superheat [°F]	0.4	0.2	0.9	0.1	3.4	0.9
Vaporizer Pinch [°F]	1.0	3.2	2.4	4.9	5.1	5.7
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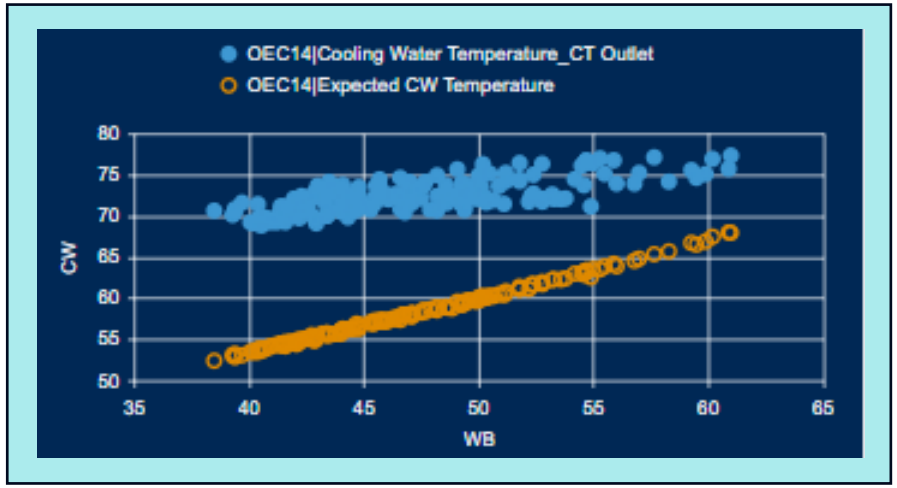
Generator Cooling AVG Temp [°F]	40.8		42.2		42.2	
Level control valve [%]	18.0	24.0	24.0	28.0	26.0	23.0

Monitoring turbine efficiency and interactions with feed pumps to look for imbalance in systems

BENEFIT: COOLING TOWER REPAIR

- Identified about 1 MW potential additional generation
- Sped up repair based on performance analytics



GEOTHERMAL ENERGY PRODUCTION | GLOBAL

Ormat increases generation by 1-3.5 MW per Plant

Challenge

- Time-consuming data access
- Critical thermodynamics calculations done manually in Excel
- Needed integrated platform for data analytics and visualization

Solution

- Deployed AVEVA™ PI System™ to streamline data collection, access, analysis, and visualization
- Developed custom analytics to allow for real-time thermodynamic analysis

Results

- Developed asset hierarchy, dashboards, and custom thermodynamics calculation platform to improve situational awareness and enable real-time analysis of critical plant processes
- Generated 1-3.5 MW additional power per plant, driving average of $1 Million in added revenue per plant per year
- Additional anticipated cost savings in predictive maintenance

THANK YOU

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