
# *OptiRamp* Predictive Maintenance



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Overview

Analytics

Use

## *OptiRamp* Digital Twin: The Missing Puzzle Piece

- Mirrors actual process
- Goes beyond merely mimicking unit operating characteristics
- Virtually “lives” in server as virtual representation of reality
- Allows for real-time advanced analytics

## *OptiRamp* Advanced Performance Monitoring

- Accurate virtual models of units
- Track, assess, & predict process equipment degradation
  - Reduce equipment downtime
  - Improve reliability & availability
- Optimize at the unit level up
- Develop maintenance schedules based on
  - Equipment state
  - Current operating conditions
- Sustain optimal performance
- Balance costs with lost revenue & energy costs




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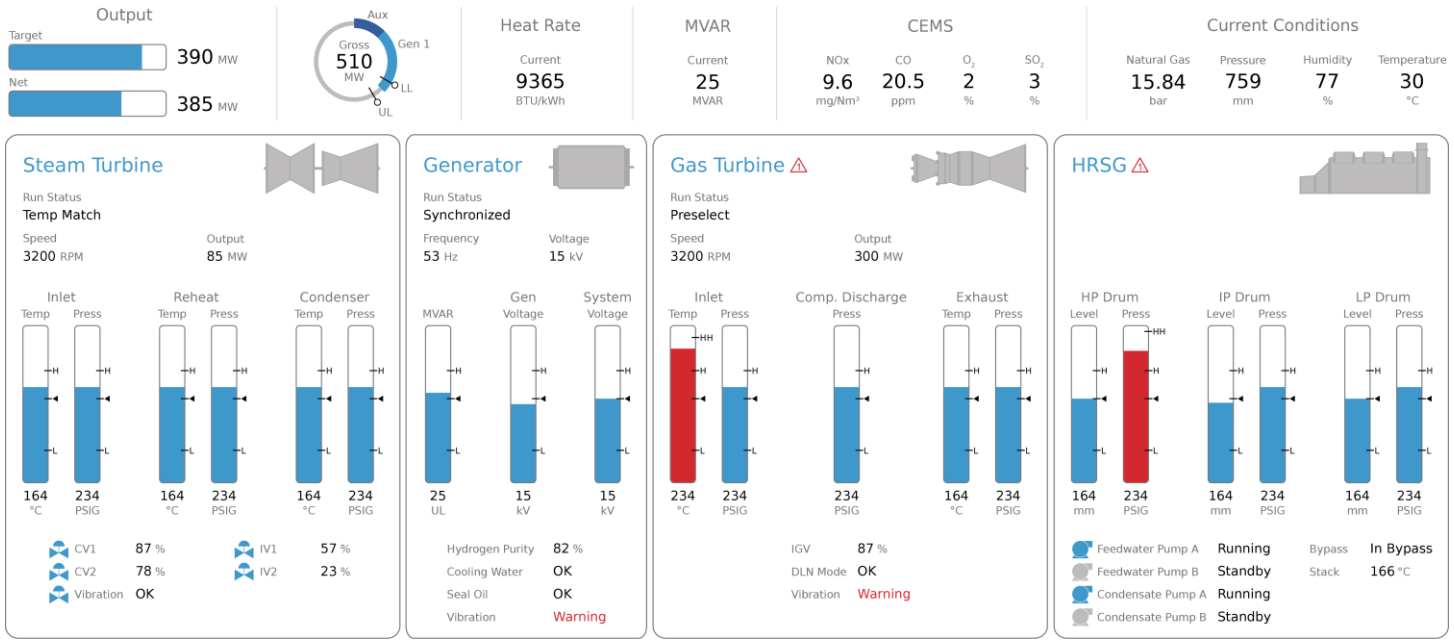
# Types of Units

- Steam Turbines
- Gas Turbines
- Electrical Generators
- Electrical Motors
- Centrifugal Compressors
- Reciprocating Compressors
- Internal Combustion Engines
- Pumps
- Heat Exchangers
- Furnaces
- Steam Generators Heat Recovery
- Steam Generators
- Boilers
- Wells



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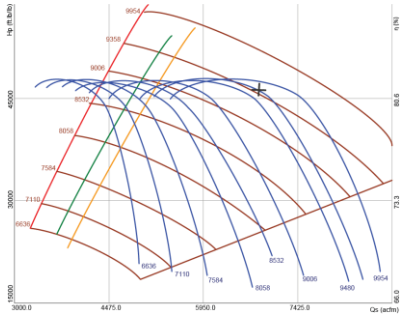
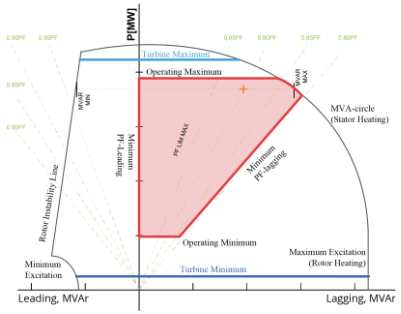
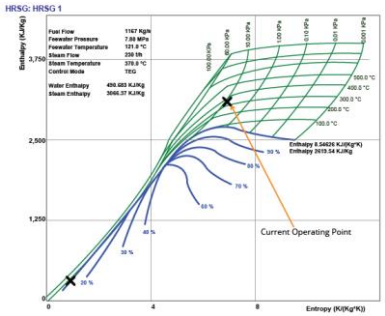
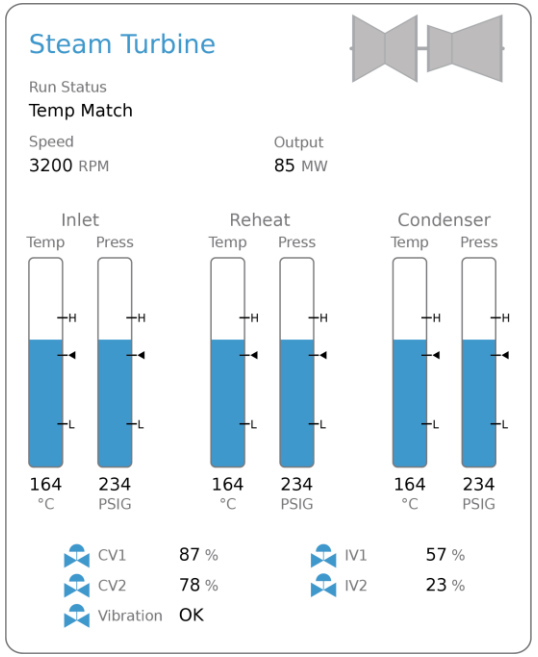
# *OptiRamp* Predictive Maintenance Concept






- Modeling - Construct load and engine models based on manufacturer-provided performance characteristics.
- Monitoring - Real Time data collection and displaying the operating point relative to the operating envelope and limiting lines.
- Auto Tuning - Continuously auto-tune the process model and adjust model coefficients.
- Trend Analysis - Calculate turbomachinery unit key performance indicators (KPIs) and conduct a trend analysis to monitor equipment degradation. Analyze KPIs with Lean Six Sigma.
- Notifications - Provide notifications for declining machine efficiency, abnormal events, and monitoring by exception.



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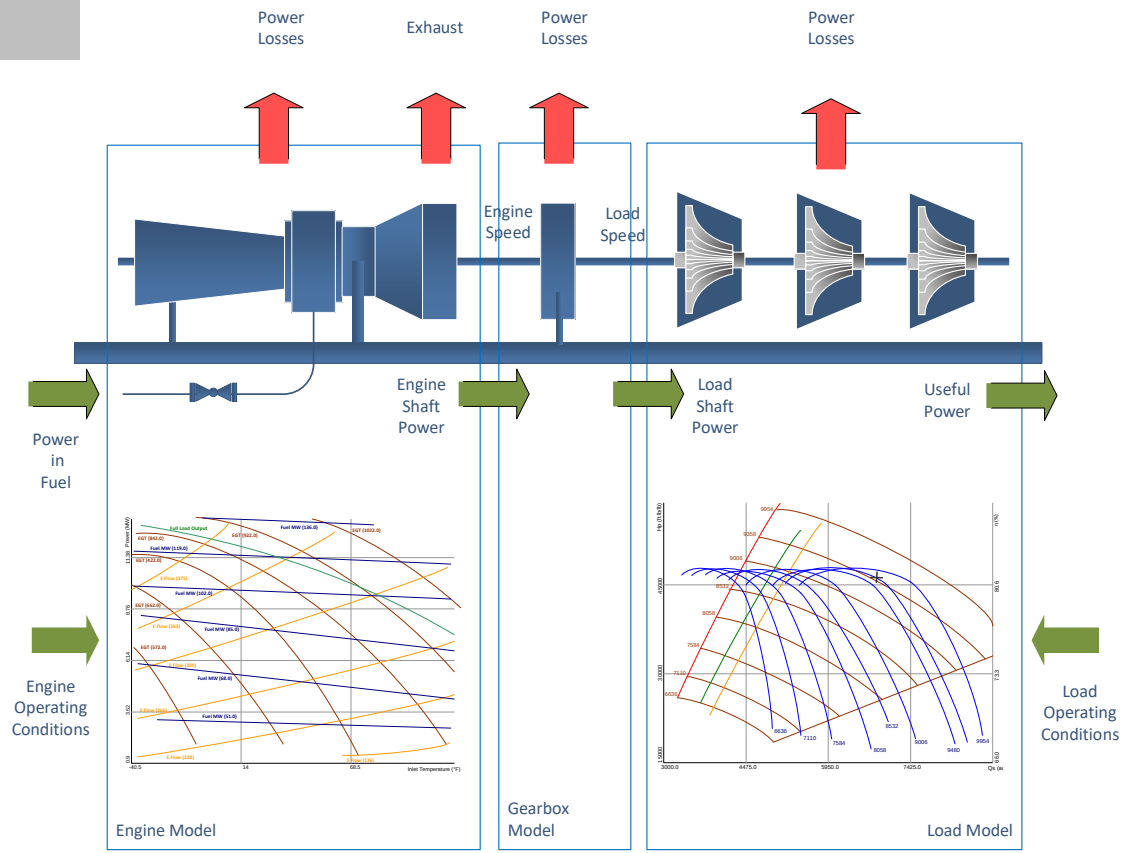
# Predictive Maintenance (Example: Gas Turbine Driven Compressor)




- The *OptiRamp* system builds turbounit model relative to a reference manufacturer predicted performance map. Gas turbine shows performance characteristics that distinctly depend on ambient and operating conditions, and degradation over the lifetime.
- The performance of centrifugal compressors is a model of polytrophic efficiency and polytrophic head as a function of the actual inlet flow, with the compressor speed (or inlet guide vanes position) as a parameter.
- For gas turbine driven compressors the efficiency of a unit is defined by comparing the amount of power contained in the fuel fed into the engine with the amount of power yielded.
- Actual volumetric compressor flow is calculated as function of gas properties and measured process variables.



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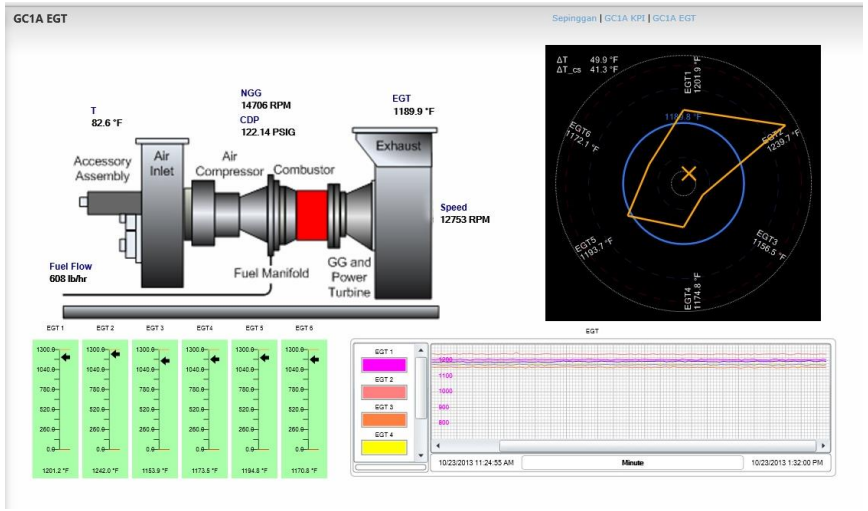
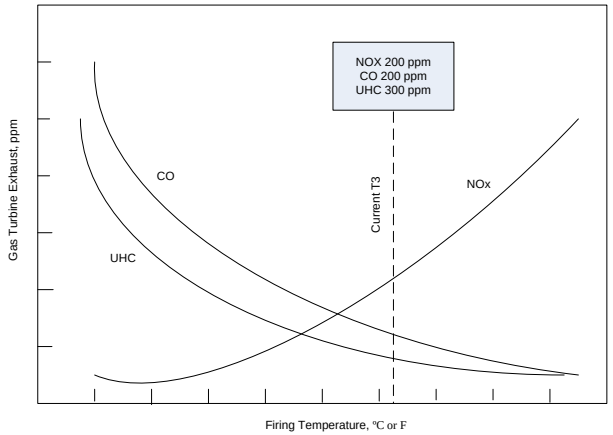
# Continuous Emissions Monitoring System CEMS

CEMS continuously monitors pollutants, such as CO2, NOx, and unburned hydrocarbons, emitted to the environment in the exhaust gases from industrial processes. Concept:

- Engine / Boiler emissions model construction based on manufacturer-provided performance characteristics.
- Models auto-tuning and continuous model's coefficient adjustment based on emission test records.
- Displaying the operating line relative to the operating envelope as well as the limiting lines.
- Emission Key Performance Indicators calculations and trend analysis to monitor pollutants emitted to the environment.



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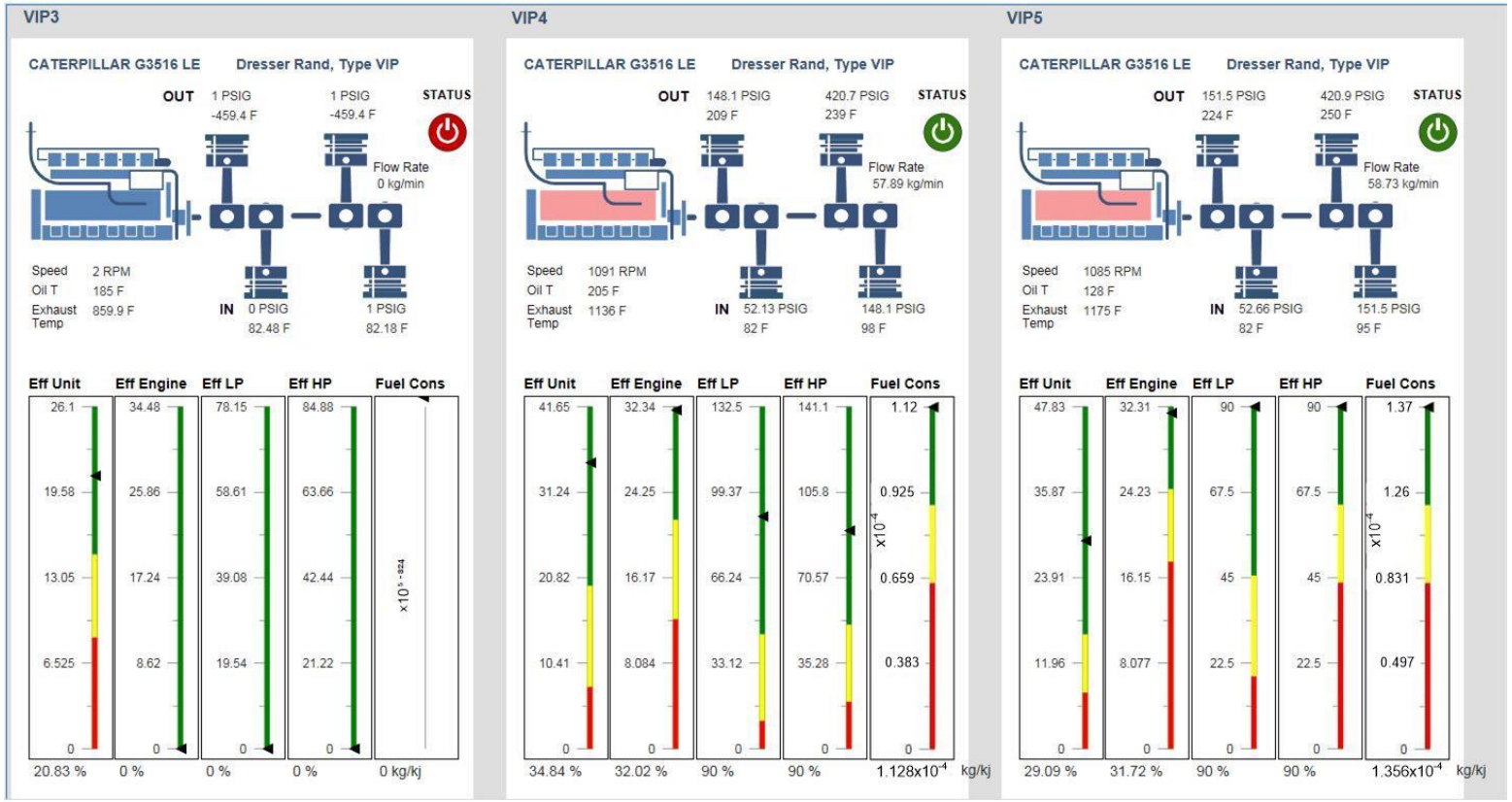
# Predictive Maintenance (Example Reciprocating Compressor and Motor)

Unit analytics can provide the following functions:

- Field data for engine operation, Indicated Power & Speed calculations
- Calculates flow rate from live data for engine & compressor
- Engine operating envelope
- EGT box plot
- Speed, fuel flow, oil temp., & manifold pressure statistical analysis
- Engine efficiency decline analysis
- Fuel consumption decline analysis



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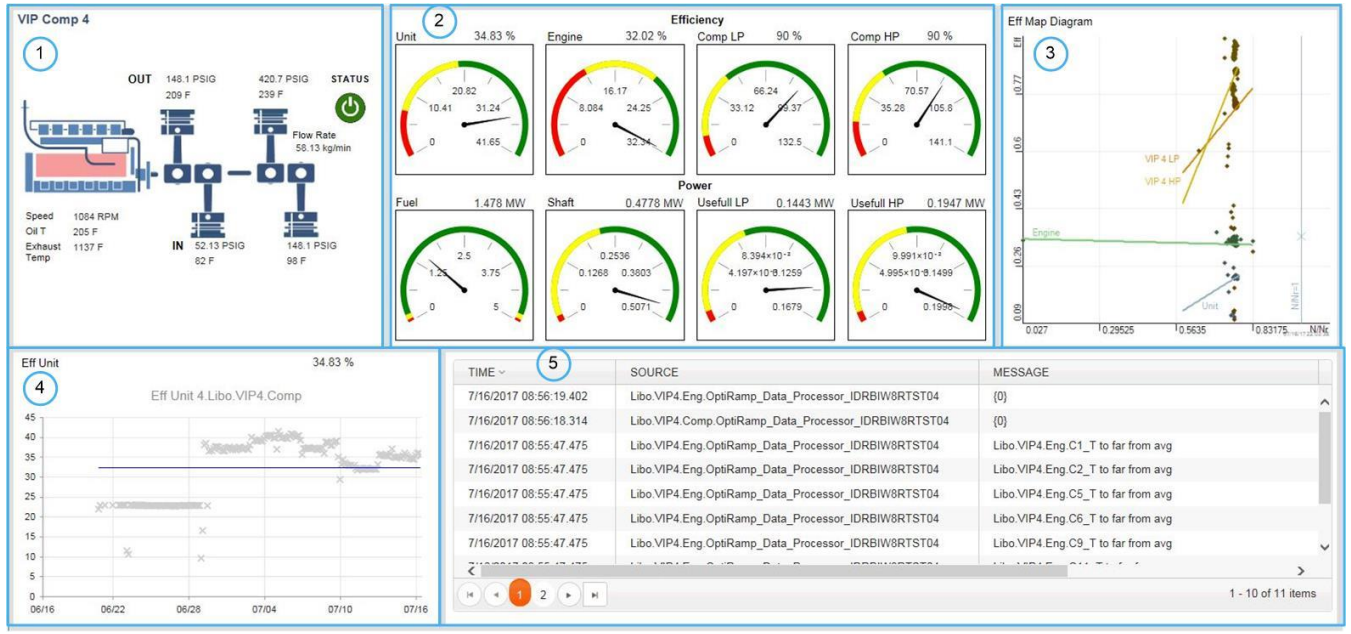
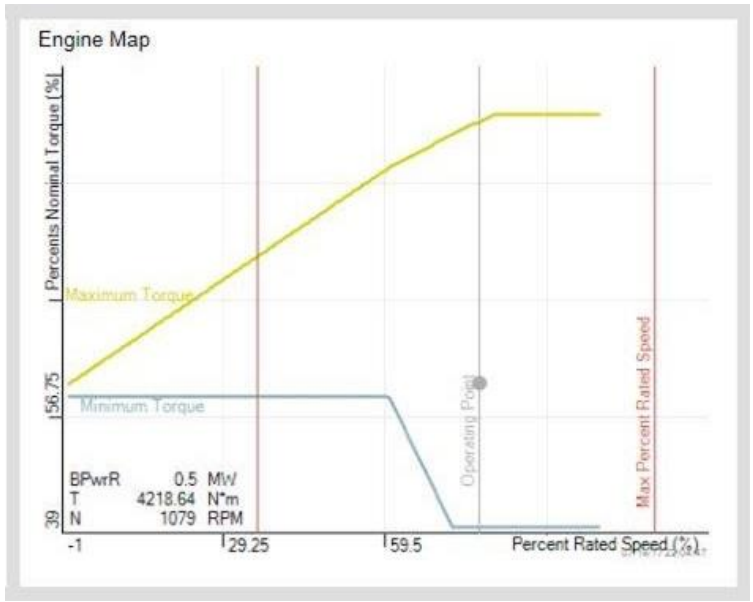
# Sample Unit Dashboard

1. Field data for compressor & engine operation
2. Efficiency & power maintenance analysis
3. Unit efficiency map
4. Unit efficiency decline analysis
5. Alarms and events




Engine Operating Envelope Diagram

1. Illustrates engine current operating conditions
2. Shows minimum & maximum torque curves
3. Displays current power, torque, & speed calculation



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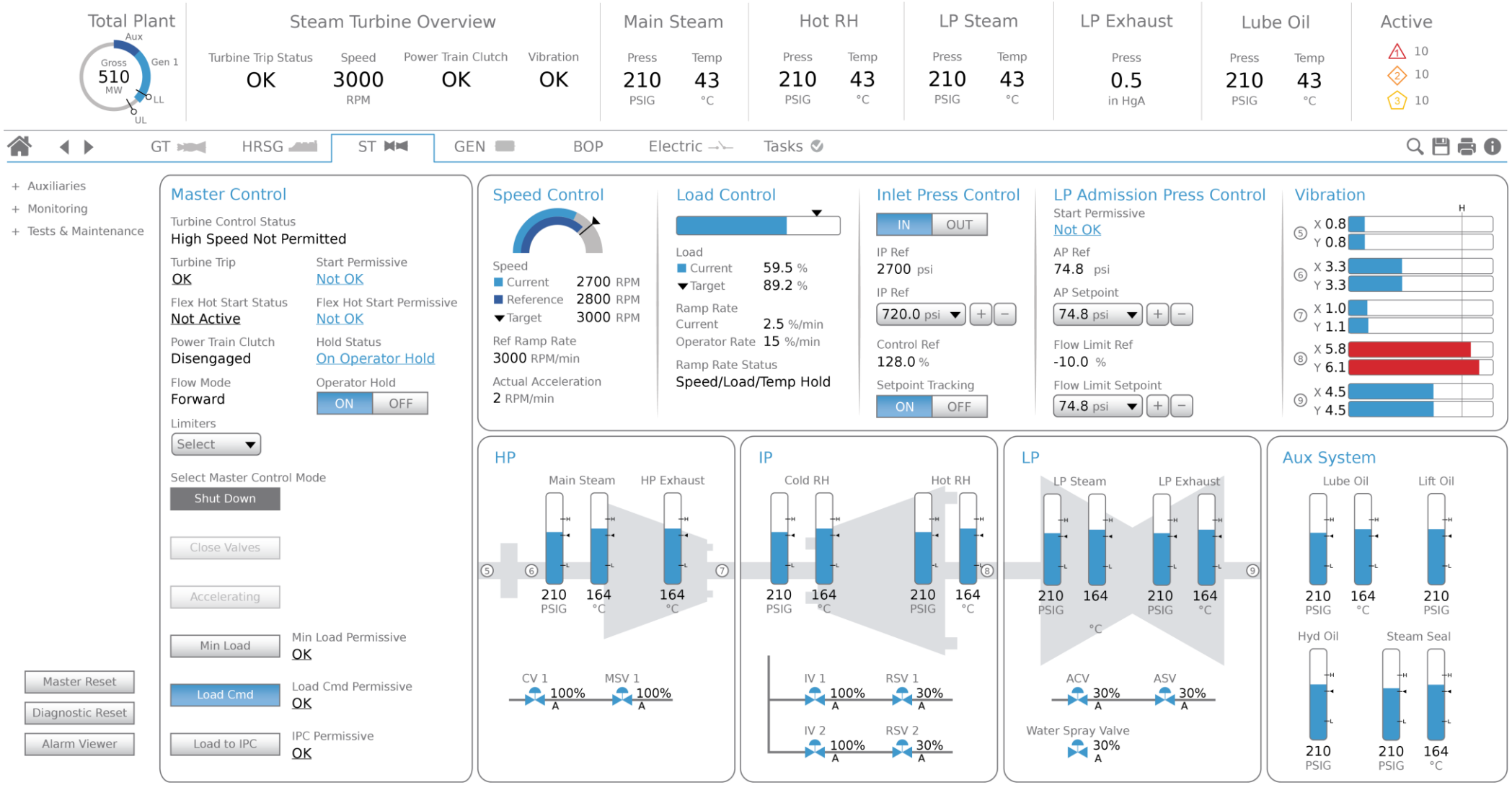
# Web Analytics Examples



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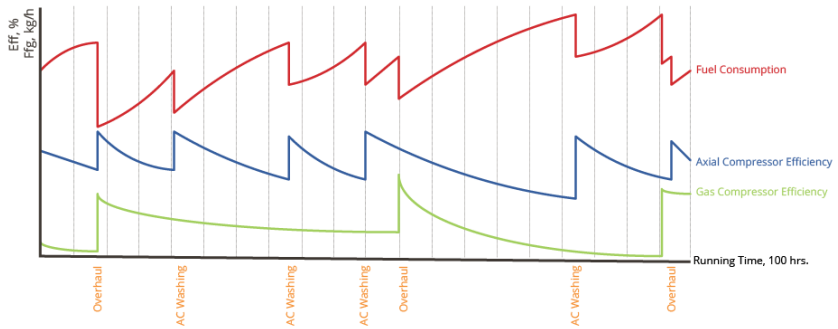
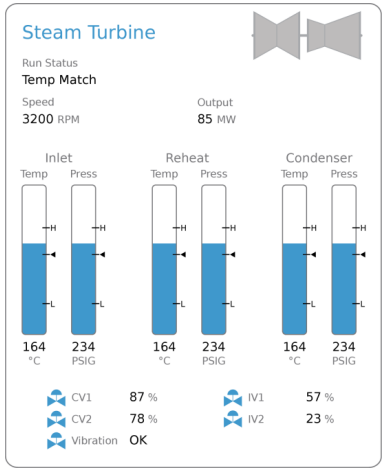
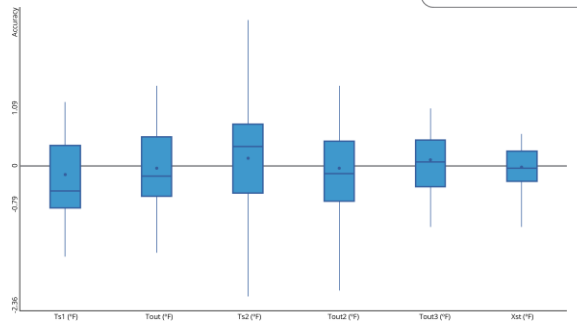
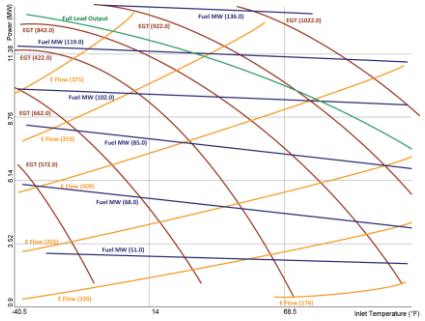
# Analytics Tools in *OptiRamp* Web Analytics

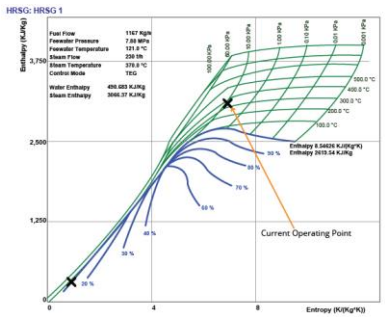
1. Trend Analysis
2. KPIs
3. Decline Curves
4. Performance Maps and Capabilities Diagrams
5. Maintenance Analysis
6. Statistical Analysis







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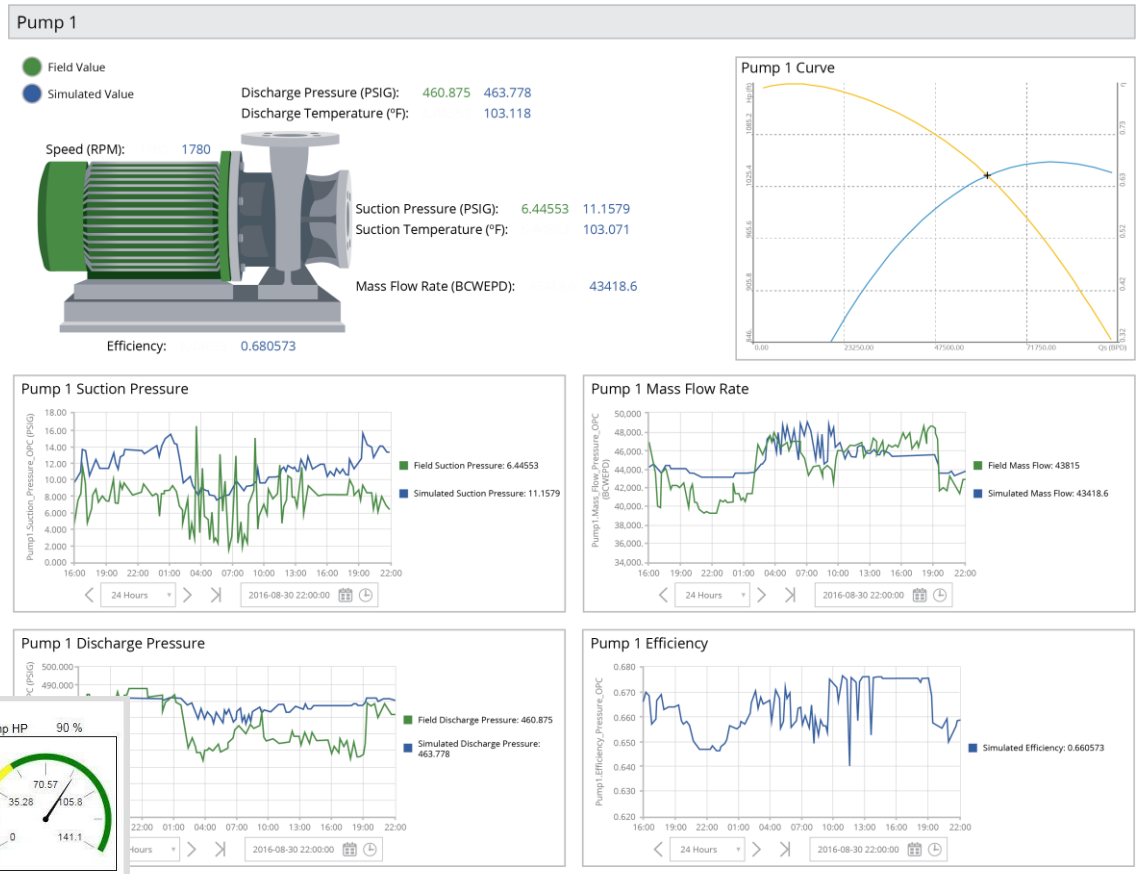
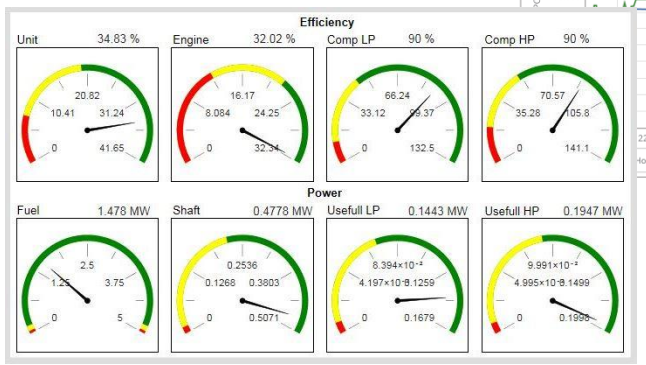
# Maintenance Analysis Examples




1. Maintenance analysis
   - Maintains equipment at high levels
   - Generates maintenance request if KPI falls below historical average
   - Includes predictive set points through short- and long-term analysis to generate predictive maintenance schedules
2. Set points configured for specific notifications when efficiency, power output falls below certain threshold



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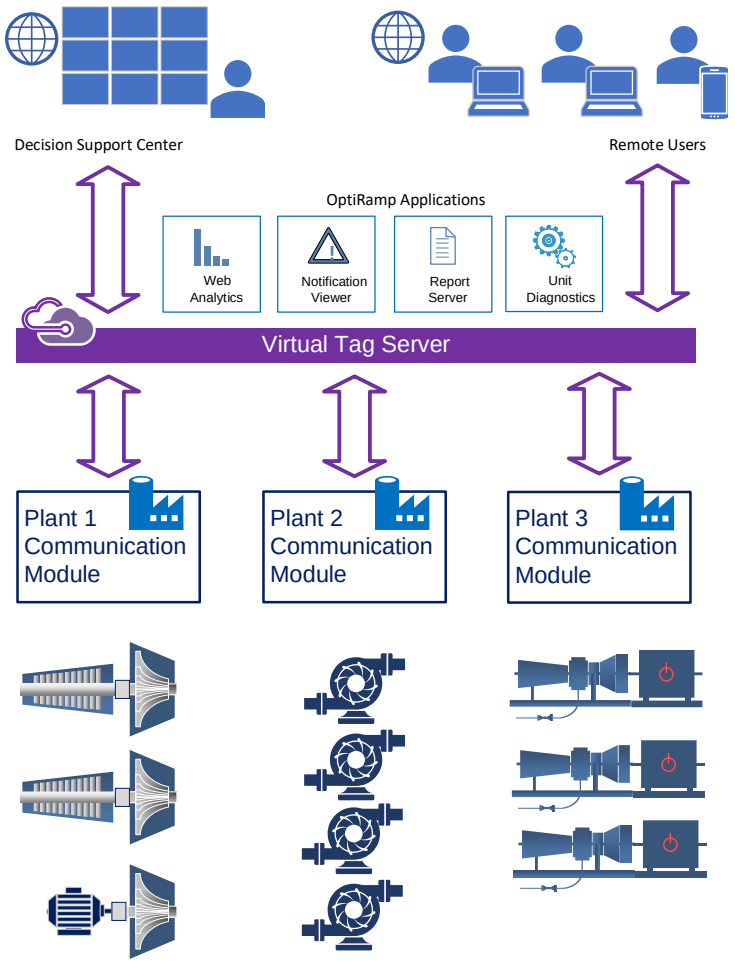
# Cloud-based Fleet Management System




**Web Access**

**Corporate or Public Cloud**

**On premise Communication Modules**

**Equipment Control Systems**

- *OptiRamp* allows a company's subject matter experts and operators to track all turbomachinery and other equipment states from a central location.
- Equipment operation is monitored for potential problems and efficiency, helping the overall efficiency of the company and protecting profitability.
- *OptiRamp* creates a unified cloud repository of data collected by on-premise modules from control systems and other data sources. This data set enables cloud-based Unit Analytics applications.
- *OptiRamp* software suite can be installed on private or corporate clouds, or on-premise server.
- Web Applications create a real-time data infrastructure and collaboration environment that centralize process and enterprise knowledge and experience, streams energy analysis using configurable KPIs, benchmarking, and advanced visualizations.
- VTS is a central information hub for parallel access of Unit Analytics application to data sources at different geographical locations.



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