Smart Buildings: Driving Resilience, Efficiency and Change

Five Part Webinar Series

Episode Five

The PI System as the engineering command center of a complex cogeneration power plant

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Smart Building: Driving Resilience, Efficiency, and Change

Episode 1 Holistic Facility Optimization –Utilizing machine learning for dispatch, fault detection and M&V

Episode 2 Smart & Secure Facilities Operations: A Data-Driven Framework

Episode 3 Achieving Savings through Improved Thermal Energy Storage Dispatch and Data Science at UC Davis

Episode 4 Smart Buildings meet High Performance Buildings - Staying Ahead of the Pack - Duquesne University

Recorded @ https://explore.osisoft.com/2020-q2-facilties

Operational Data Infrastructure: Sensor to Community

OSIsoft®

Sensors	Assets	Plant/Building	Enterprise	Community
Millions of Smart Devices	Multiple Sensors	Multiple Assets	Campus	Stakeholders

OSIsoft Built on 40 Years of Experience

2B+ Streams
20,800+ Installations,
4,000+ Customers
in 140+ Countries

Facilities & Data Centers
Over **135 million square feet** of facilities are monitored by the PI System

- Eli Lilly
- Roche
- Pfizer
- National Institute of Health
- Milwaukee Medical Center
- Harvard Medical School
- NASA
- Massachusetts Institute of Technology
- University Of Massachusetts
- University of Connecticut
- Department of Defense
- Purdue University
- University of Vermont
- Harvard University
- Carnegie Mellon University
- University of Rochester
- US Department of Navy
- Toronto Pearson Airport
- Veolia
- Toyota
- Kellogg
- University of California, Davis
- University of Maryland
- Lawrence Livermore National Laboratory
- Department of Defense/Intelligence
- US Army
- United Nations
- eBay
- PayPal
- HPE
- vXchnge
- Aligned Energy
- @Tokyo
- Softbank
- Qualcomm

The PI System as the engineering command center of a complex cogeneration power plant

Steven Lemay, Plant Manager, University of Massachusetts
Priscila Gameiro, Automation Engineer, Radix Engineering and Software

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Topics in Agenda

- A little about the University of Massachusetts
- Business Challenges
- Technical Challenges
- Cybersecurity Concerns
- Work Carried Out
- Results Obtained And Business Impact

The University of Massachusetts

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University of Massachusetts

+28,000 **students**

Approximately
1,300 **faculty members**
5,000 **staff members**

Since 2004, expansion projects have **added $1 billion** in **new facilities, buildings, and infrastructure to the campus.**

85% Building Energy Use

06% Steam Distribution Heat Loss

09% In-Plant Steam Use for Process Loads

The University of Massachusetts

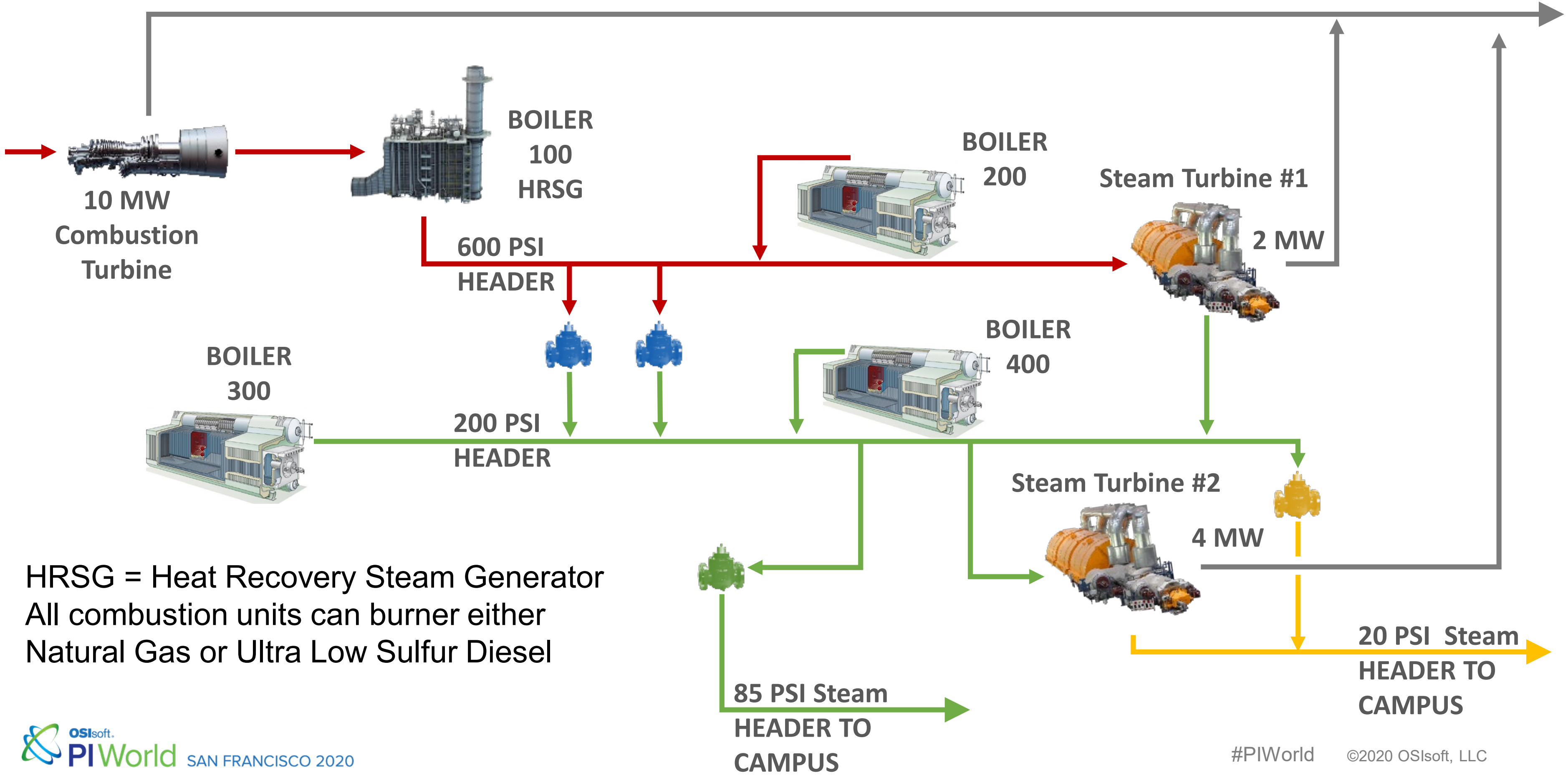
The CHP provides all steam for the campus, which has a peak demand of **330,000 lbs/hr**

The total electrical generating capability is **16.5 MW**

Steam demand can be met with the HRSG and **2 of the 3 package** boilers

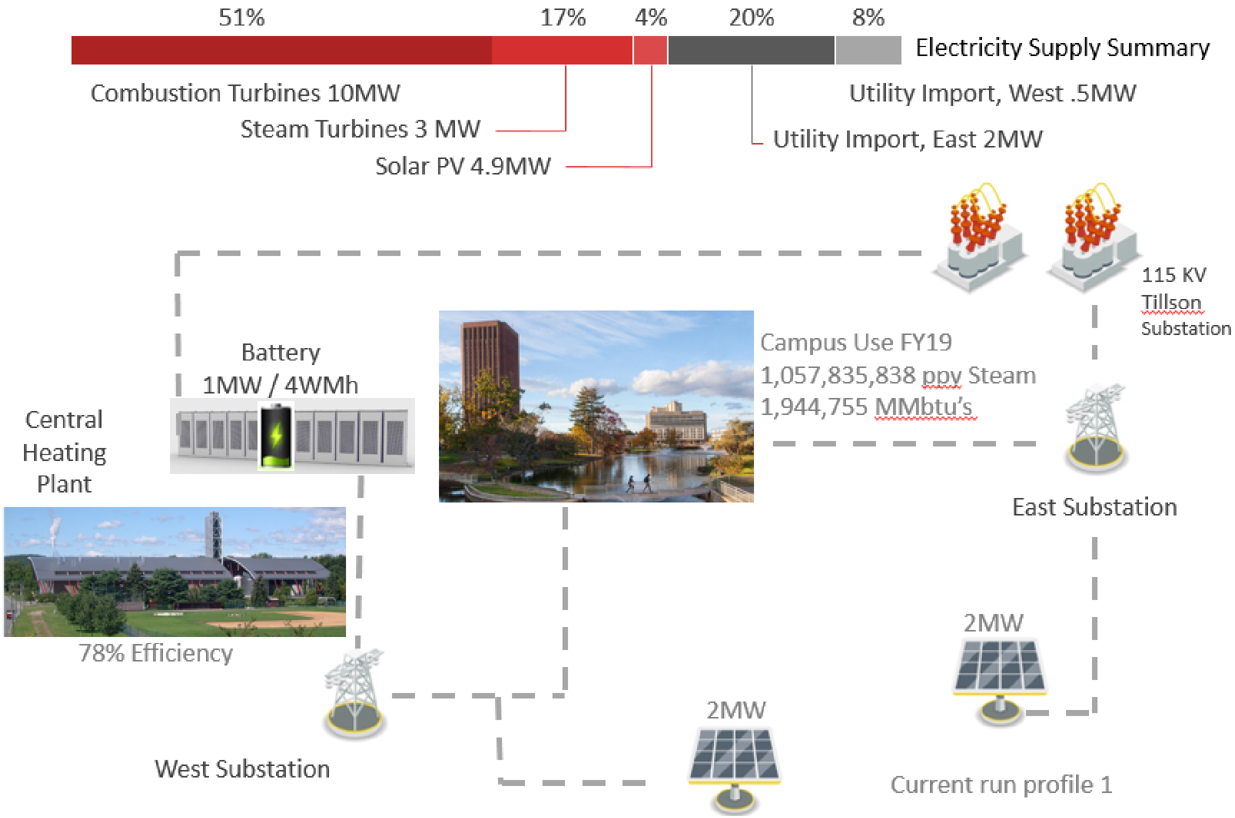
- Campus peak electrical demand is ~ **28 MW.**
- Generally the CHP produces 10-12 MW of power, and output is closer to **capacity in the winter** *(16.5MW)*

Inside the Central Heating Plant



HRSG = Heat Recovery Steam Generator
All combustion units can burner either Natural Gas or Ultra Low Sulfur Diesel

The Big Picture - Energy Command Center

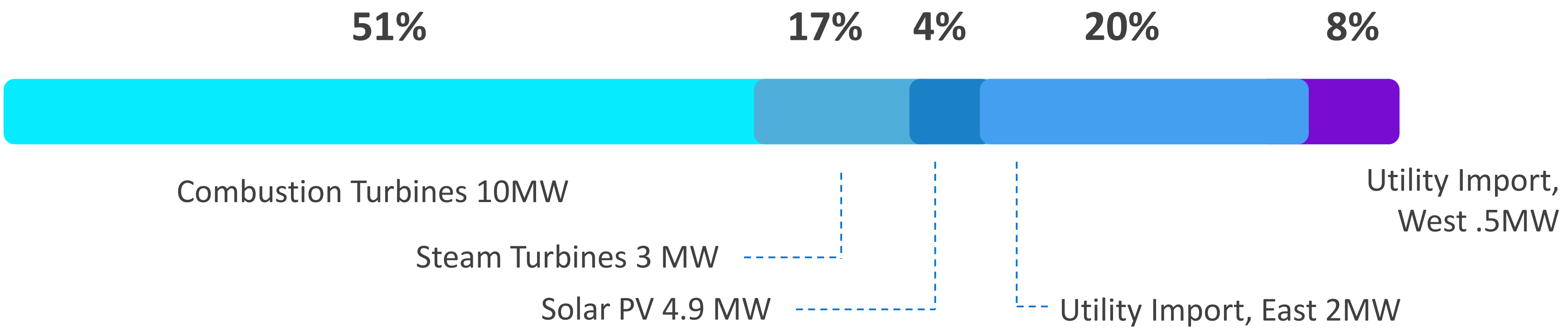


Micro Grid

Electrical FY19
Produced 67%
Solar 4%
Purchased 29%

The Big Picture - Energy Command Center

Electricity Supply Summary



Business Challenges

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Business Challenges

The **fast-growing** student body* and new building projects continue to increase demand for steam and electricity

**Over the last decade, the campus has seen a 17% increase in enrollment*

Wide variety of control systems, instrumentation, and multiple network challenges feeding a data driven approach to optimize operations

Data is difficult to visualize outside of the CHP control room due to cybersecurity concerns

Various **plant configurations, fluctuations in demand**, weather, and fuel prices make decision making a complex task

Technical Challenges

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Technical Challenges

Data comes from **multiple systems**, networks and physical locations:

Plant Instrumentation

Energy Production and Meters

Price Information

BMS Information

Turbine Information

Technical Challenges

Deliver **better visibility** to Operators

Building **a set of dashboards** that properly reflect the needs of engineers and management teams

Predict operating conditions that **optimize costs and production** given dozens of possible plant configurations

Add **value to student education** while maintaining campus cybersecurity

Identifying instrument tags, KPIs, and organizing them into **an intuitive framework**

Tracking fuel cost information in **real time**

Operate plant **more effectively and efficiently** considering fluctuations in demand, weather, and fuel prices

Work Carried Out

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Work Carried Out

Phase 1

Process Monitoring and Asset

- *Major Process Equipment*
- *Support equipment*
- *Collect data from a variety of systems and historize*
- *Model the data*
- *Visualize the process*

Phase 2

Process and Cost Optimization

- *Real time price data*
- *Energy production*
- *Steam generation*
- *Optimization*

Solution

Phase 1

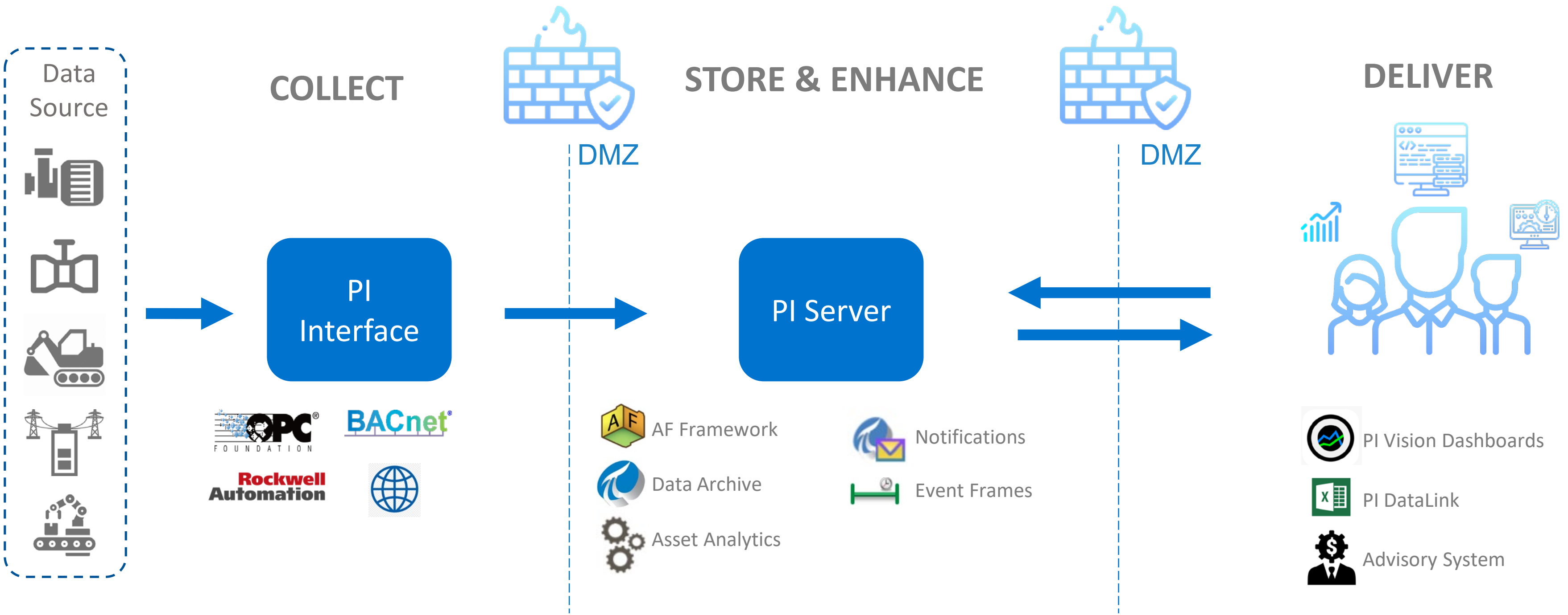
- *Leverage OSIsoft PI suite of interfaces*
- *An intuitive hierarchy for each piece of equipment*
- *Use of PI Asset Framework to store tags, calculations, templates, analyses, and events*
- *PI Vision dashboards to integrate with AF and provide real time trend data and analytics to end users*

Phase 2

- *Using Thermoflex to improve efficiency and identify opportunities in the plant*
- *Use engineering analyses, PI Analytics and PI event frames to assist plant engineers and management.*

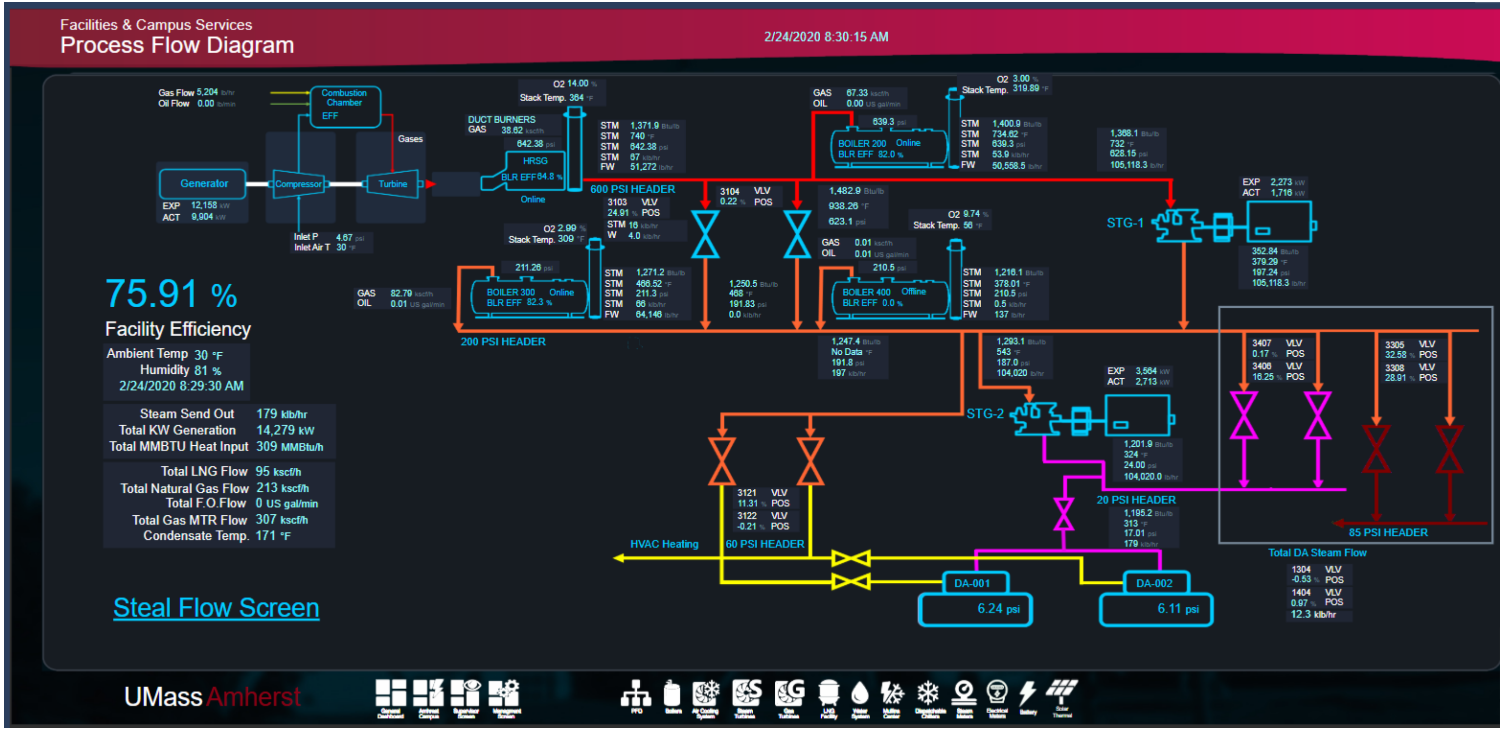
Phase 1 – Architecture and Cybersecurity

The PI System limits the direct access to critical system while expanding the use of information the **Topology** used to allow the data security



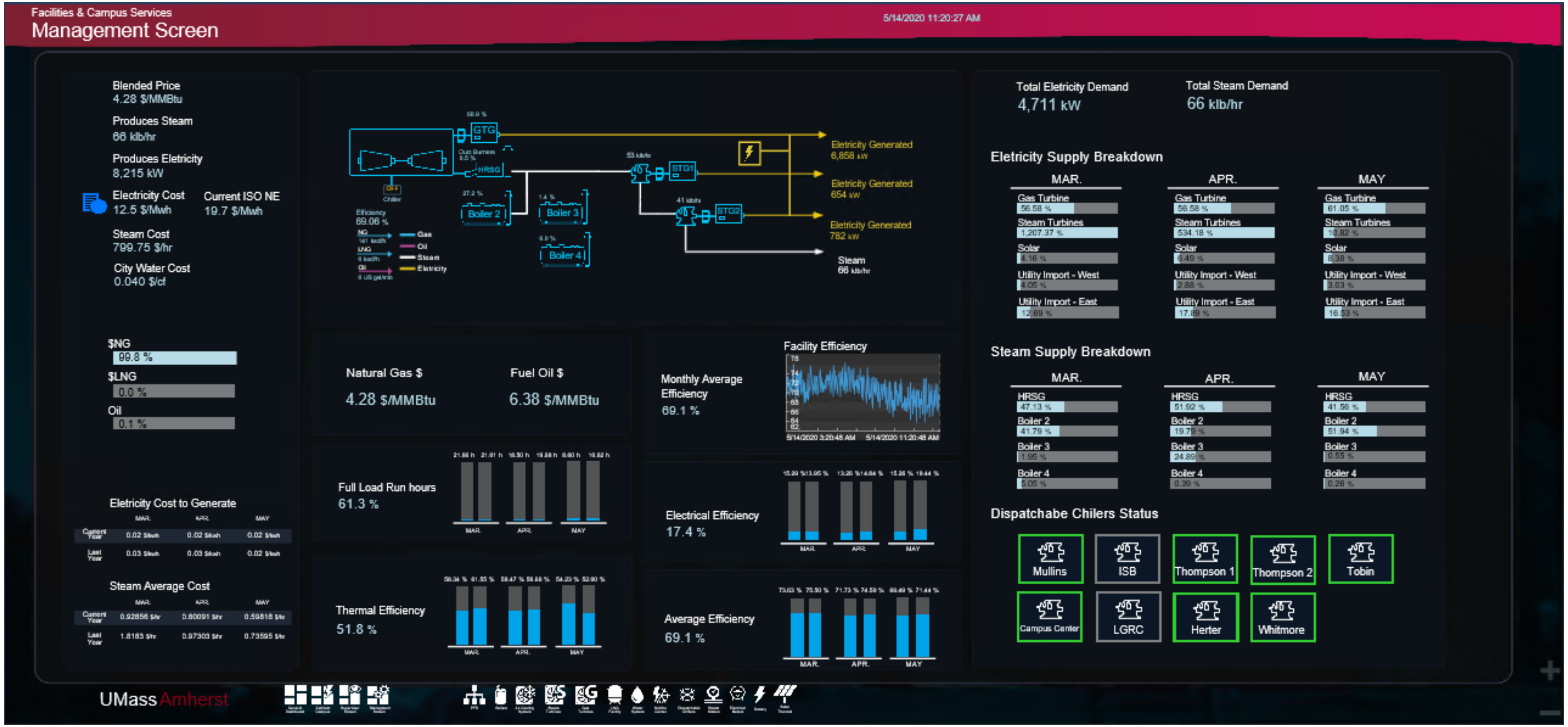
Phase 1 - Dashboard

CHP Process Visalization Displays



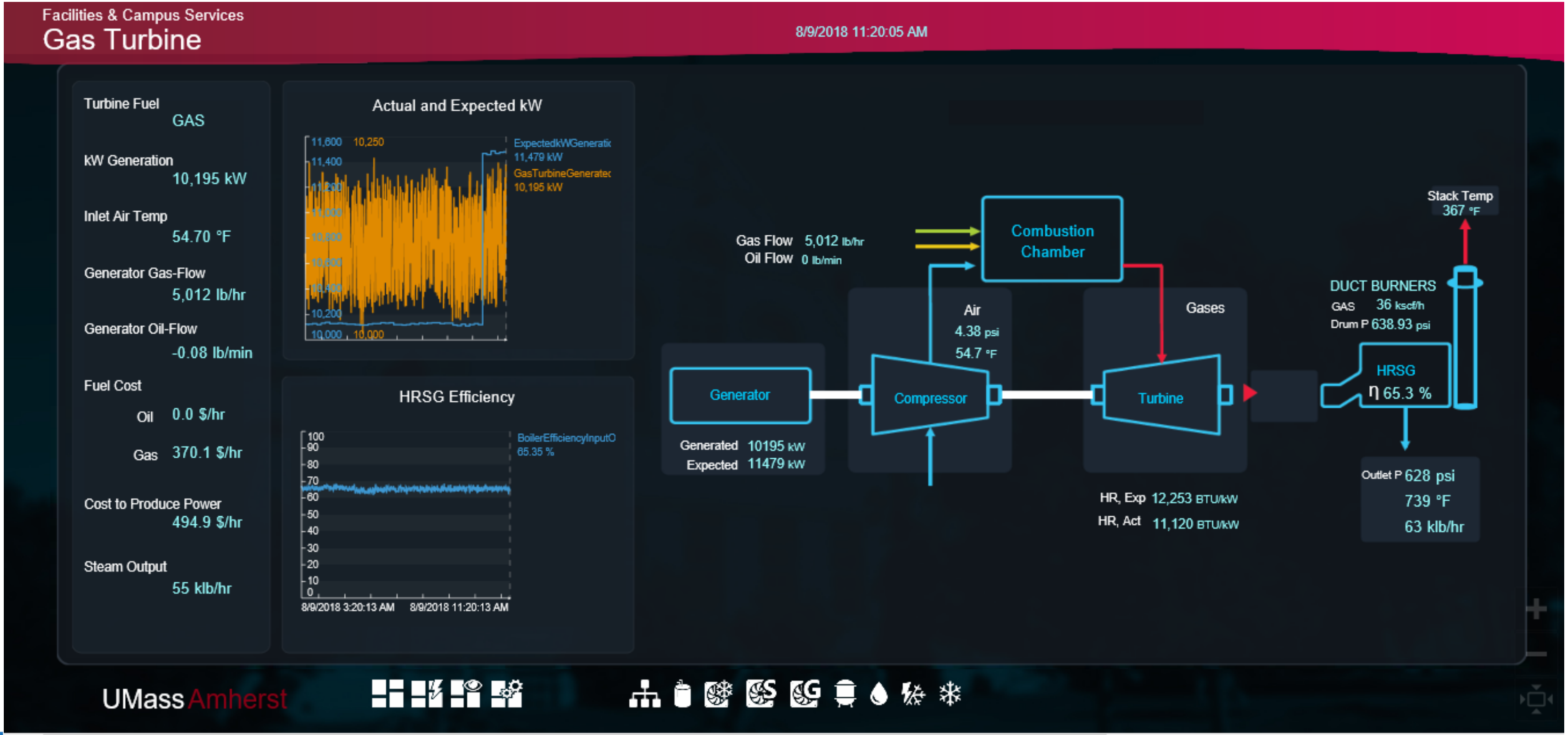
Phase 1 - Dashboard

Management Screen



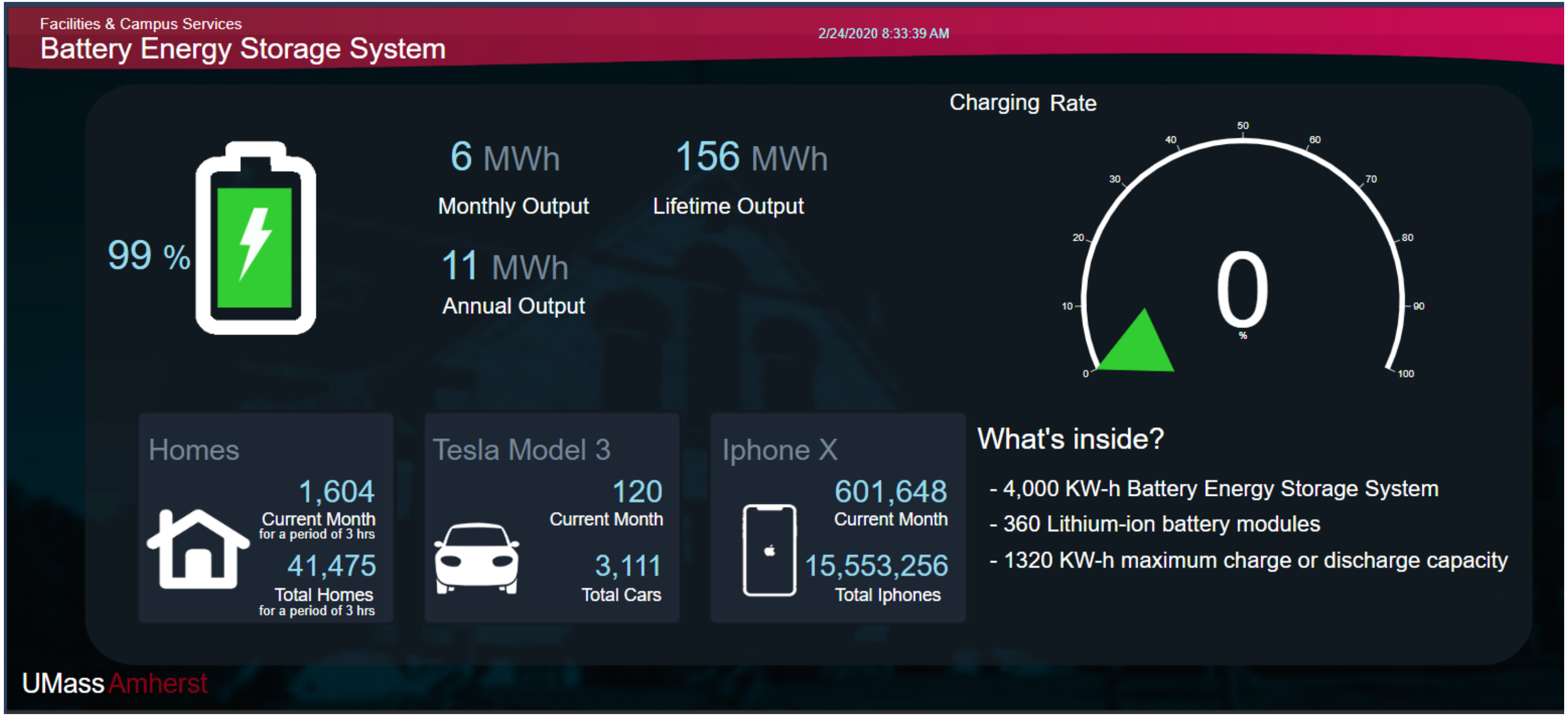
Phase 1 - Dashboard

Gas Turbine



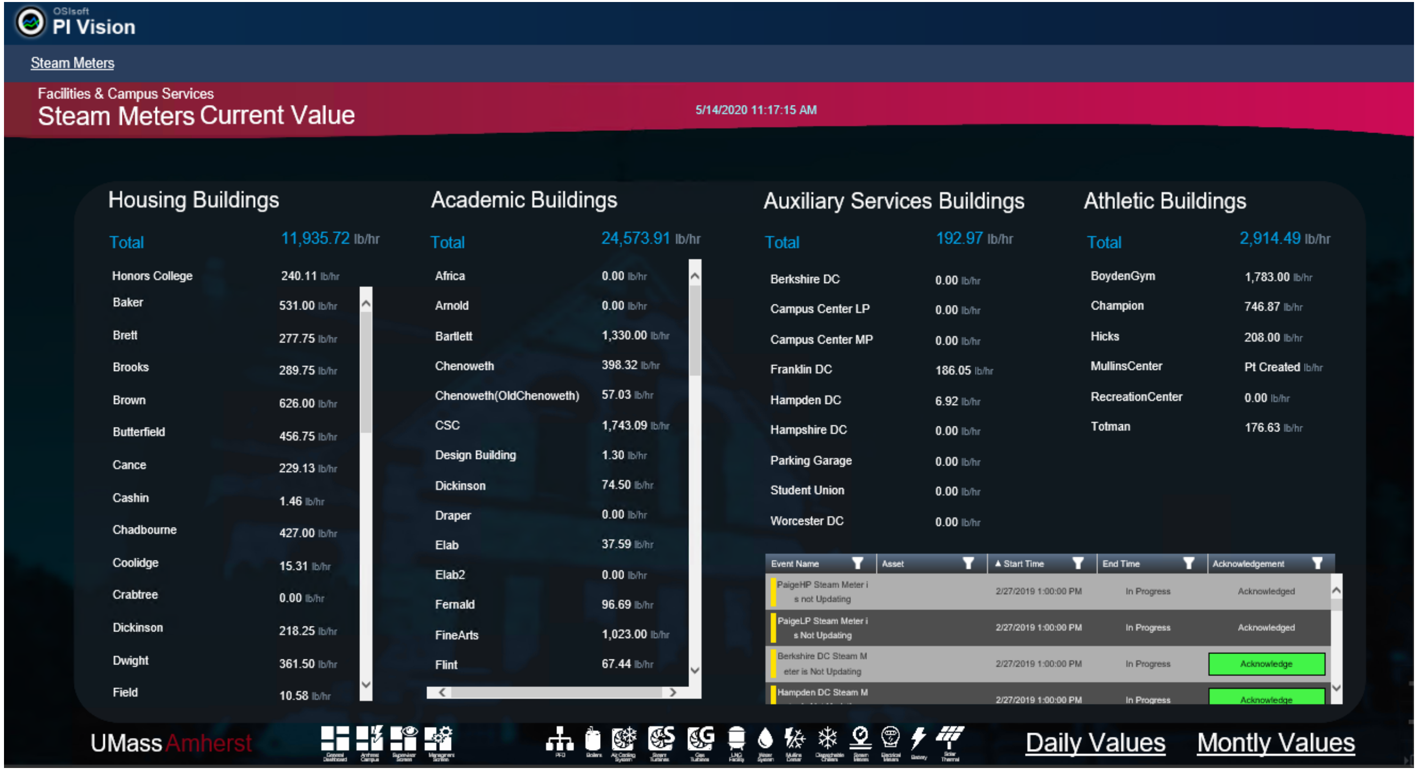
Phase 1 - Dashboards

PI Vision Screen Around the Campus



Phase 1 – Steam Meter Alerts

The solution implemented reduce the time response from 1-2 months to one 1 day and maintenance cost



Steam Meter alert considered the number of events in 24hrs and the temperature outside the plant, to alert the maintenance team of problem.

Phase 2 - Energy Efficiency Assessment

An energy assessment was performed to **find useful information** for the development of an **Advisory System tool** to help operators keep the plant always operating **at maximum possible efficiency**.

The assessment was divided in three main phases:

Thermodynamic Design

Build the simulation

Engineering Design

Tune the simulation

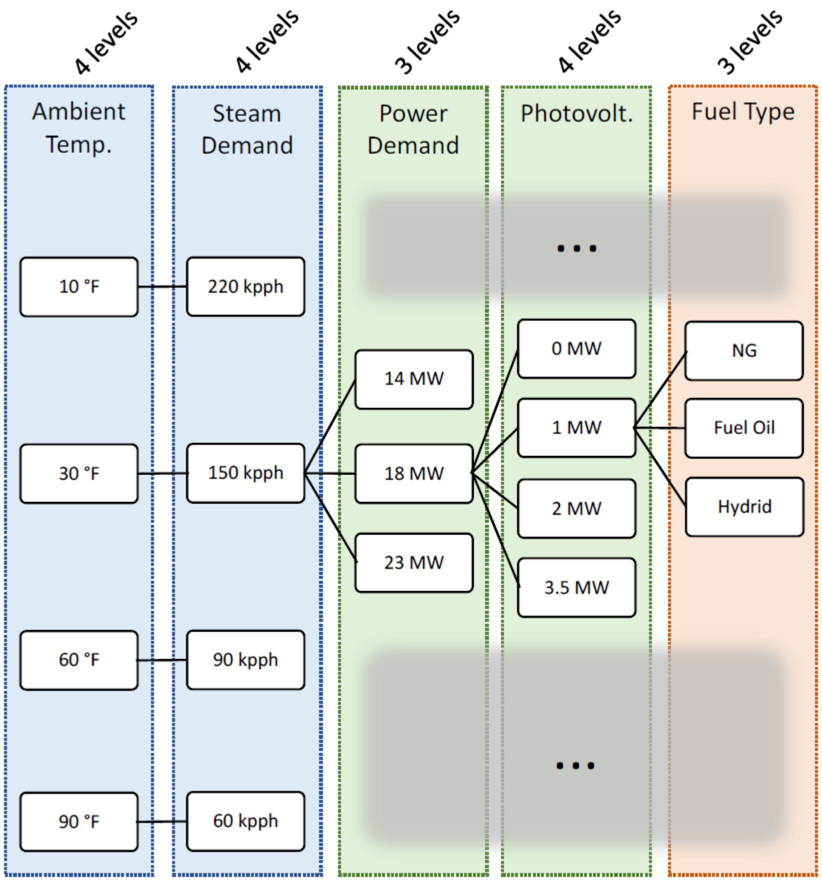
Offline design

Run the scenarios

Phase 2 - Scenario Definitions

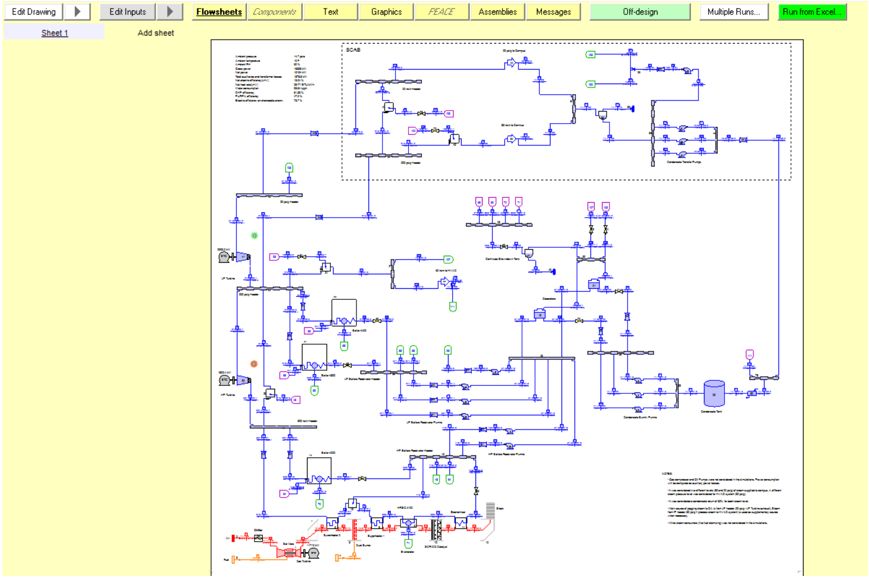
Using the decision tree to chose the best scenario according to the following variables:

- Ambient temperature
- Steam demand
- Power demand
- Photovoltaic capacity
- Fuel Type availability



Phase 2 – Goals Achieved

- Develop custom tools to store **real time price information**
- Compile **representative operating configurations** of the CHP
- Simulate the plant under configurations and store model within the PI system. **About 150 scenarios simulated**.
- An operations advisory system **for operators and engineers**
- Develop visualizations to provide to plant management to monitor **cost savings**



Phase 2 – Scenarios Simulated

ID	Conditions					Optimal Configuration								Results			
	Amb. Temp. [°F]	Steam Demand [kpph]	Power Demand [MW]	Photov. Capacity [MW]	Fuel Type [NG/FO/HY]	GTG Load [%]	Chiller [ON/OFF]	DB Load [%]	STG-001 Inlet Flow [kpph]	STG-002 Inlet Flow [kpph]	BRL-200 Load [%]	BRL-300 Load [%]	BRL-400 Load [%]	CHP Gross Power [MW]	CHP Net Power [MW]	CHP Efficiency [%]	Purchased Power [MW]
134	90	60	23	2	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	10,865
135	90	60	23	1	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	11,865
136	90	60	23	0	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	12,865
137	90	60	18	3.5	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	4,365
138	90	60	18	2	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	5,865
139	90	60	18	1	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	6,865
140	90	60	18	0	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	7,865
141	90	60	14	3.5	HY	99,7	ON	48,6	68	35,5	0	0	0	11,128	10,100	77,13	0,400
142	90	60	14	2	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	1,865
143	90	60	14	1	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	2,865
144	90	60	14	0	HY	100	ON	48,3	68	35,5	0	0	0	11,163	10,135	77,14	3,865

Phase 2 – Scenarios Simulated and PI System Integration

The scenarios are integrated through **SQL Server Table**

ScenariosTable

General | Table | Define Table | Version

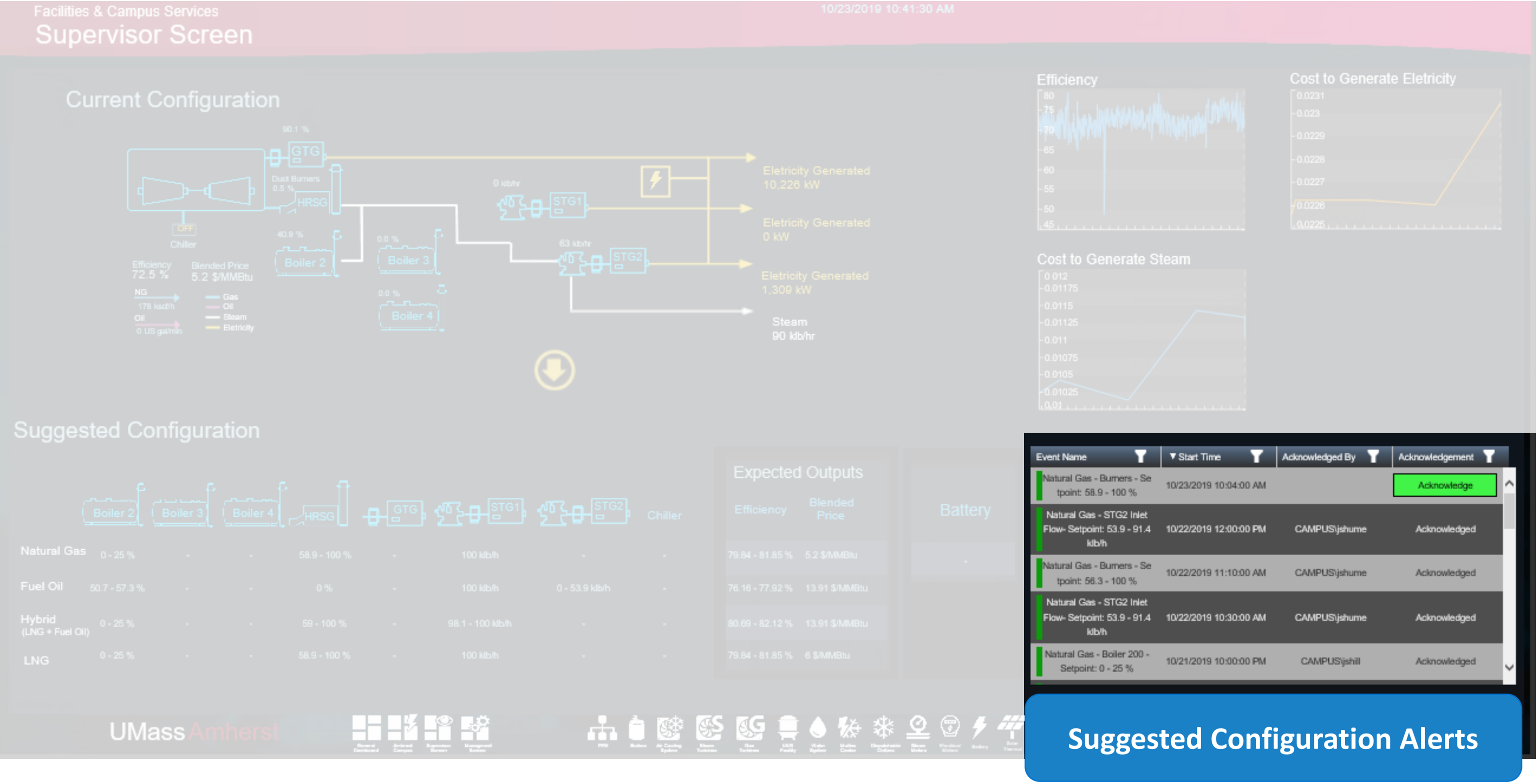
ScenariosTable

Filter

Temperature	Steam	Power	Photov. Capacity	NG Availability	Mode	GT Load	GT Gas Flow
10	220	18	2	High	Natural Gas	100	133.57
10	220	18	2	Low	Fuel Oil	100	0
10	220	18	1	High	Natural Gas	100	133.57
10	220	18	1	Low	Fuel Oil	100	0
10	220	18	0	High	Natural Gas	100	133.57
10	220	18	0	Low	Fuel Oil	100	0
10	220	14	2	High	Natural Gas	69.1	115.13
10	220	14	2	Low	Fuel Oil	100	0
10	220	14	1	High	Natural Gas	77.6	120.63
10	220	14	1	Low	Fuel Oil	100	0
10	220	14	0	High	Natural Gas	86.3	125.76
10	220	14	0	Low	Fuel Oil	100	0
30	150	18	2	High	Natural Gas	100	128.76
30	150	18	2	Low	Fuel Oil	100	0
30	150	18	1	High	Natural Gas	100	128.76
30	150	18	1	Low	Fuel Oil	100	0
30	150	18	0	High	Natural Gas	100	128.76
30	150	18	0	Low	Fuel Oil	100	0
30	150	14	2	High	Natural Gas	78.4	116.26
30	150	14	2	Low	Fuel Oil	100	0
30	150	14	1	High	Natural Gas	87.3	121.2
30	150	14	1	Low	Fuel Oil	100	0

Phase 2 - Dashboards

PI Vision Advisory Screen



Results Obtained And Business Impact

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Results Obtained And Business Impact

ECONOMIC IMPACT

Monitor **fuel usage** and **costs** associated with production

Saving money by:

Make or Buy Energy decision considering **multiple fuels** onsite, and **live market data**

Integrating the **PI System** and the **Energy Assessment Study**

Track M**arket data** in **real time**

- Electricity (LMP Day Ahead + Real Time)
- Natural Gas Day Ahead
- Static Contracted Prices and Volumes

Suggesting the **most efficiently configuration** to run the plant.

Charge or Discharge Battery (Energy Storage System)

- Monitoring the **cost of electricity** and **campus demand** to advise the **best time to dispatch** this resource.

Results Obtained And Business Impact

OPERATIONAL AWARENESS

Intuitive **dashboards** and consolidated data allows operators to have more insight into how their plant is operating.

Energy production and consumption data helps make **operating decisions** and meet **campus demand**.

Management dashboards and automatic reports make the **results easily accessible**.

The created events frames allow the maintenance team to be **alerted when a meter is offline**.

Integration of many different system data in a unique one.

Results Obtained And Business Impact

EDUCATIONAL IMPACT

Removing the CHP data from **behind a firewall** allows the students to gain insight to the operation of their campus and advances the University's curriculum.

Another advance is to allow display the **production results** to the entire campus

Central Heating Plant

Goal: Collect, model, and visualize process and instrument data. Use the data to drive optimization efforts to reduce costs and meet an increasing demand.

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CHALLENGES

- Multiple data locations
- Dozens of plant configurations
- Fluctuations in demand, weather, and fuel prices
- Assisting decision making for cost saving and optimization

SOLUTION

- Use PI Interfaces
- PI Vision to create intuitive dashboards and as advisory system
- Analytics engine to store KPIs, cost information, and configuration models

BENEFITS

- Data is available outside of the control room
- Advisory screens include real time cost and savings information
- Reduce operation cost by making real time decisions

“ ”

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