PI System Transforms NIH Central Utility Plant (CUP) Operations

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Presented by

National Institutes of Health
Department of Human and Health Services

NIH and What We Do

- A federal government agency
- Leading biomedical research center
- Annual research funding ~ $32 billion 2016
- 27 research institutes
- 18,000 employees, 4,000 post-doctors and 1,200 principal investigators
- Houses world-class 240-bed research hospital
- Many state-of-the-art research facilities

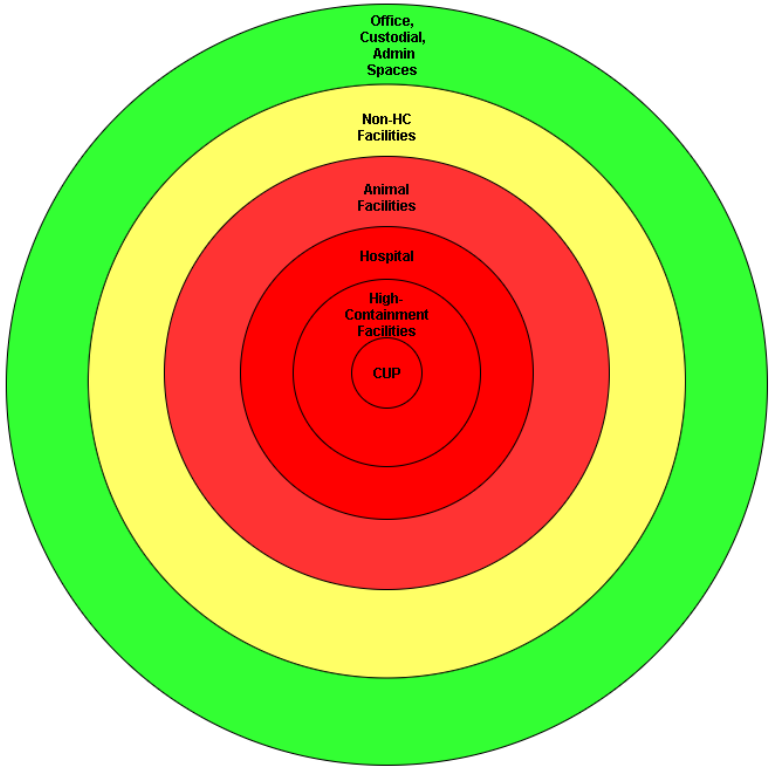
NIH Central Utility Plant (CUP) At a Glance

- One of the largest CUPs under one roof in the USA
- CUP includes a chiller plant, boiler plant, and cogeneration plant.
- Generates chilled water, steam, electricity and compressed air
- Serves 12 million sqft. of space in Bethesda campus.

What Makes Operation of NIH CUP So Special?

- CUP is the core of the NIH facility.
- Reliability is crucial for the mission critical spaces served
  - High containment facilities
  - Highly climate controlled clinical research centers
  - Animal facilities
  - World renowned research hospital

NO CUP = NO FUNCTIONING NIH



Boiler Plant Overview

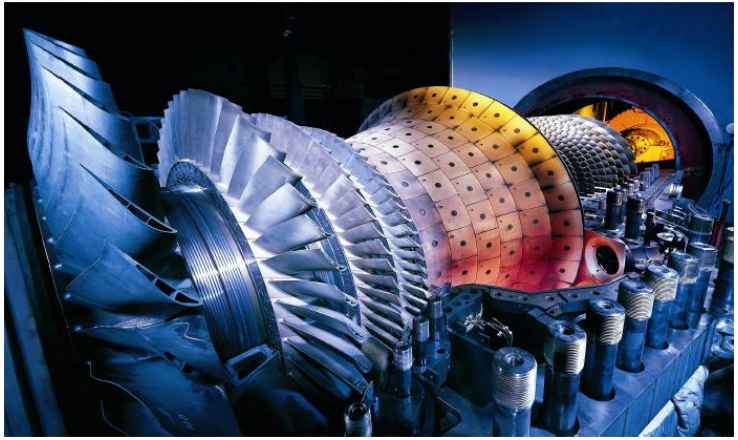
- 5 gas / diesel fired boilers
- Total steam generation capacity: 800 KPPH /980kpph w/Cogen
- 3 Billion cubic feet of natural gas annually
- Nearly 2 billion pounds of steam generation annually
- Steam used for a variety of reasons
  - Space heating and humidity control
  - Domestic hot water
  - Medical equipment sterilization
  - Autoclaves
  - Animal cage and rack washing

Chiller Plant Overview

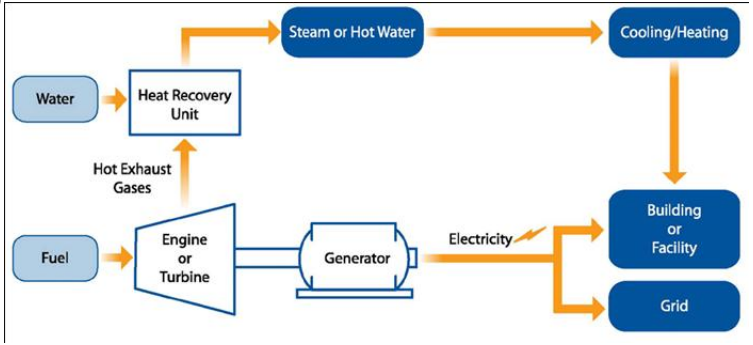
- Twelve 5,000 Ton capacity chillers
- Total cooling capacity 60,000 Ton
- Chiller plant consumes 165 MWH electricity per year
  - Equivalent to 100,000 Maryland Homes
- Currently constructing Thermal Energy Storage (TES) tank and Industrial Water System (IWS) tank to enhance CUP's ability to serve NIH even more reliably



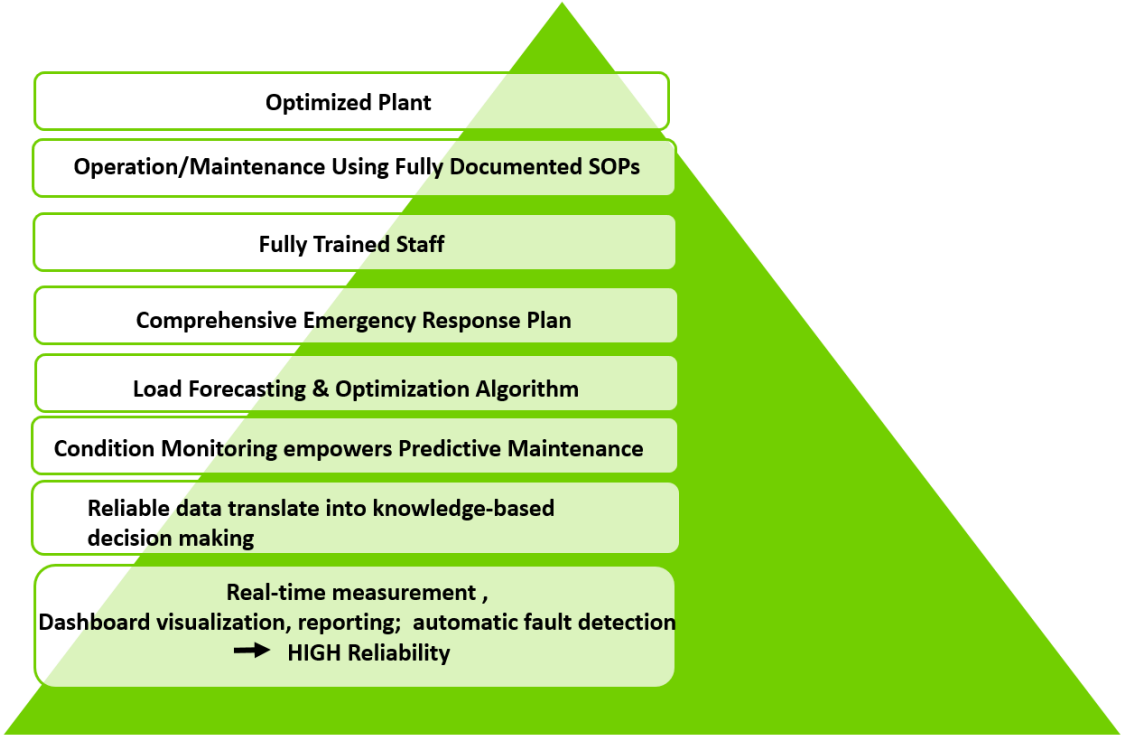
NIH Cogeneration Plant



- 23 MW Siemens SGT-600 Gen 3 (40% of the campus demand)
- Steam generation capacity is 100 KPPH by the heat recovery steam generator (HRSG), and up to an additional 80 KPPH with duct burner
- Thanks for CHP, only 15% input energy goes unused
- 44% fewer emissions than most recent built turbine of its type
- Generates less than half the NOx emissions of other commercial turbines
- CO_2 footprint reduction of 58,000 tons/year
- Energy savings = 5,000 households/year



PI and Operational Paradigm Shift



You can't manage what you can't measure!

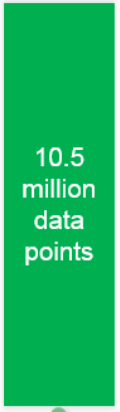
"Measurement is the first step that leads to control and eventually to improvement. If you can't measure something, you can't understand it. If you can't understand it, you can't control it. If you can't control it, you can't improve it."

— H. James Harrington

Data is the foundation to operate the plant safely, reliably, energy efficiently and cost effectively.

CUP from a Data Analytics Perspective

- OSIsoft PI System at the heart of actionable operational intelligence at NIH CUP.
- Goal: leverage OSIsoft PI System and offer intelligent real-time operational recommendations (issue alert, potential reason and solution) and allow for complex systems optimizations (set points, equipment and chiller / TES dispatch, etc.)



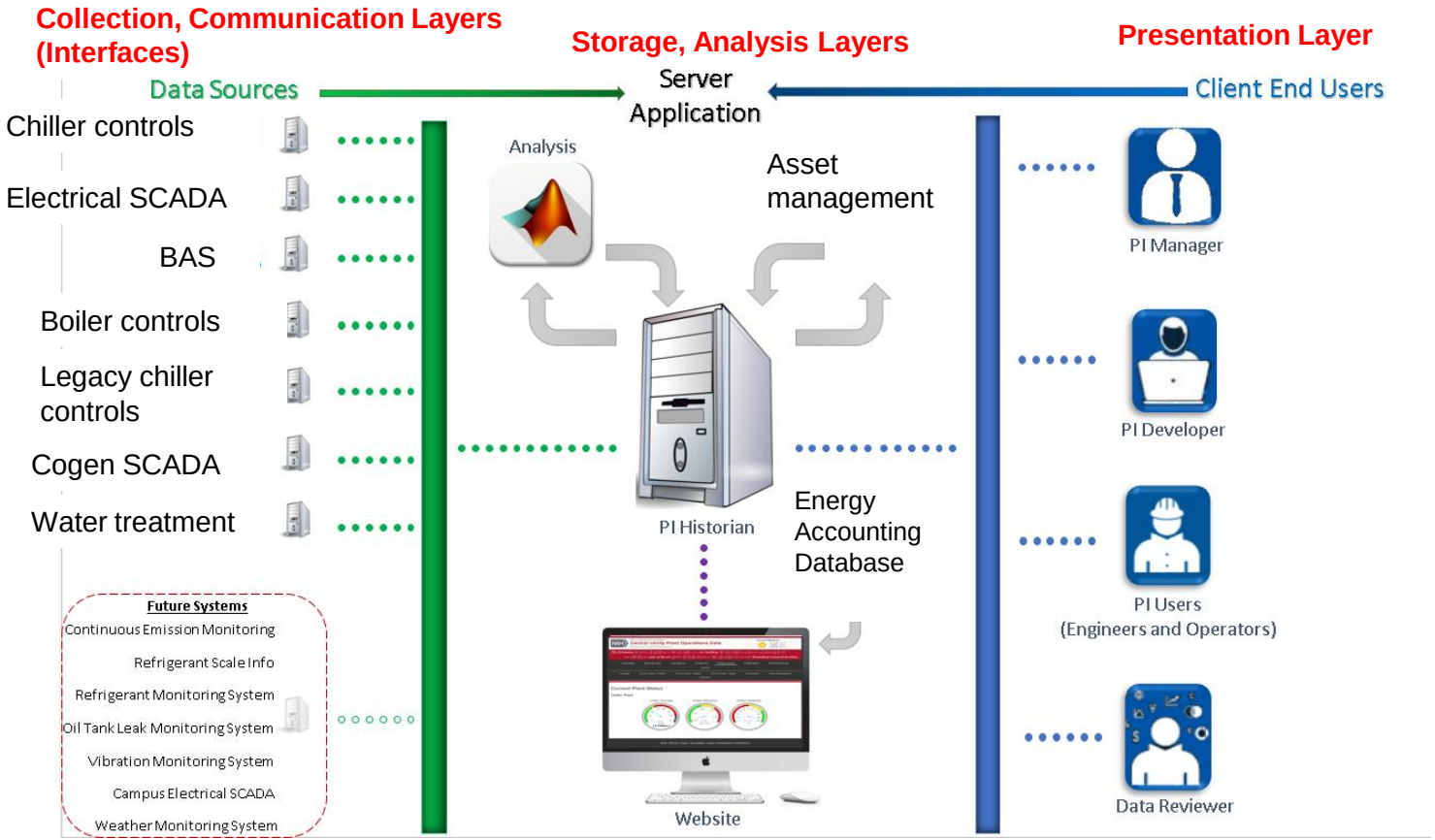
10.5 million data points per day

System	Reads per day
Chiller Plant	4,900,000
Boiler Plant	2,500,000
Water Treatment	115,000
Electrical Monitoring	3,000,000
Campus Load Monitoring	120,000
TOTAL	10,500,000

System	Reads per day
Cogen	1,500,000

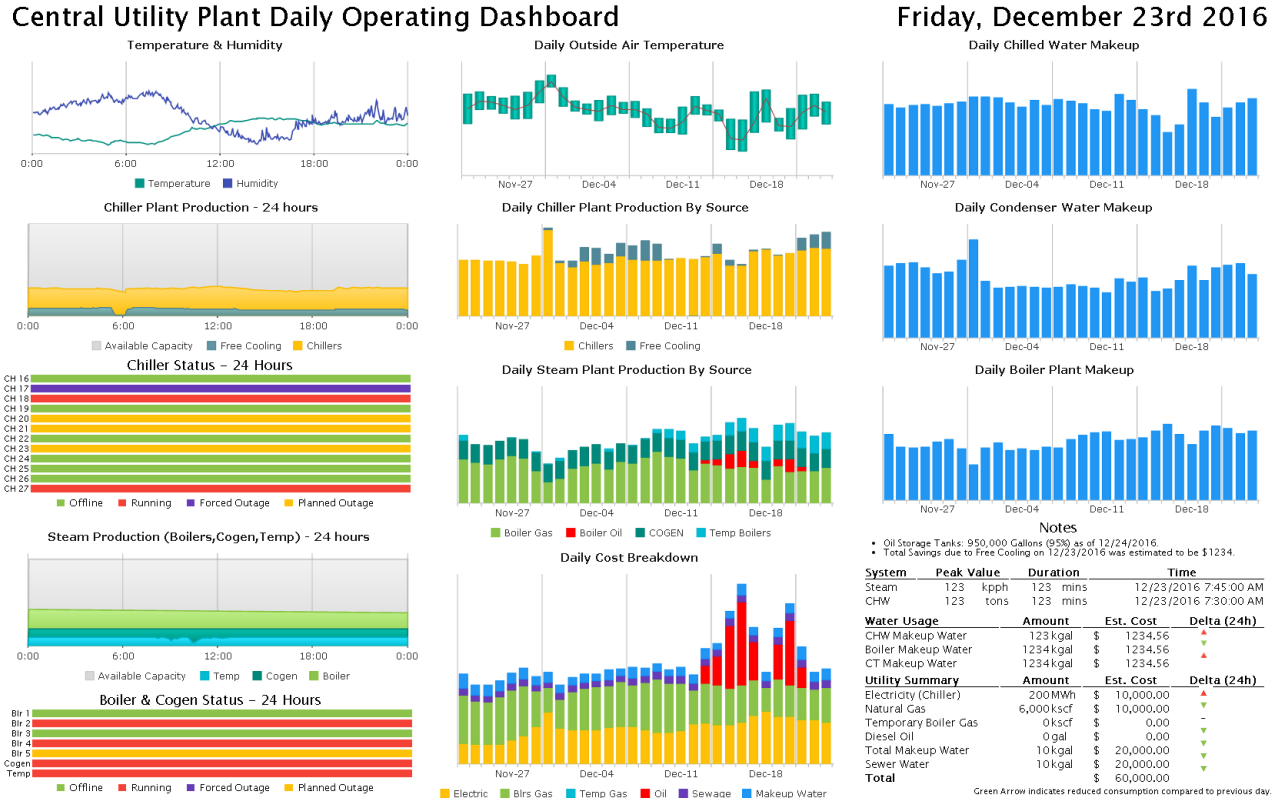
Over 150,000 advanced calculations conducted per day from approximately 1,600 continuously running analyses

Multi-layer Data Platform Architecture



Executive Level Summaries and Reporting

- PI makes high level, executive daily performance data accessible with 1 click



System	Peak Value		Duration		Time
Steam	123	kpph	123	mins	12/23/2016 7:45:00 AM
CHW	123	tons	123	mins	12/23/2016 7:30:00 AM

Water Usage	Amount	Est. Cost	Delta (24h)
CHW Makeup Water	123 kgal	$ 1234.56	▲
Boiler Makeup Water	1234 kgal	$ 1234.56	▼
CT Makeup Water	1234 kgal	$ 1234.56	▲

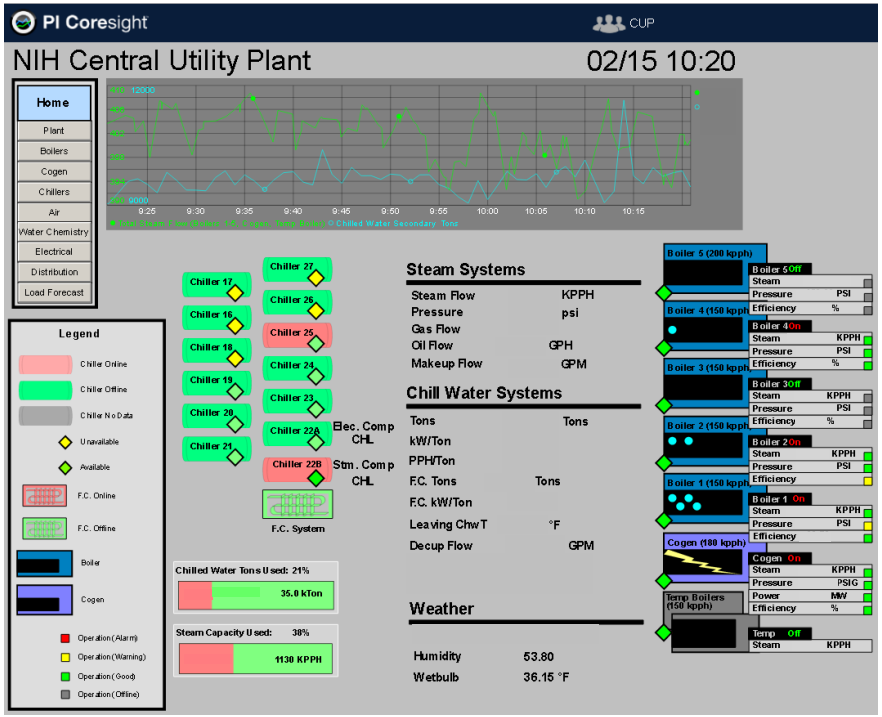
Utility Summary	Amount	Est. Cost	Delta (24h)
Electricity (Chiller)	200 MWh	$ 10,000.00	▲
Natural Gas	6,000 kscf	$ 10,000.00	▼
Temporary Boiler Gas	0 kscf	$ 0.00	-
Diesel Oil	0 gal	$ 0.00	▼
Total Makeup Water	10 kgal	$ 20,000.00	▼
Sewer Water	10 kgal	$ 20,000.00	▼
Total		$ 60,000.00	

(Not the actual data)

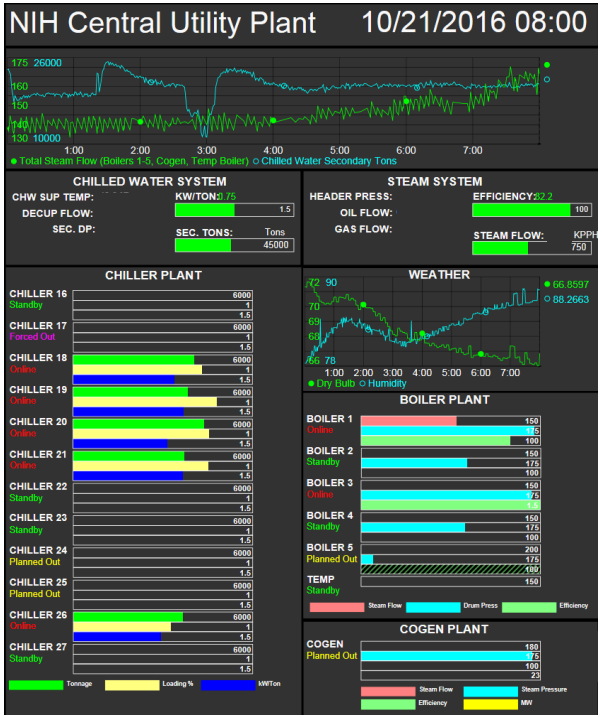
PI Providing Real-time Dashboard Situational Awareness

- When seconds matter, PI Coresight ™ allows for viewing system vitals on the go

Desktop GUI

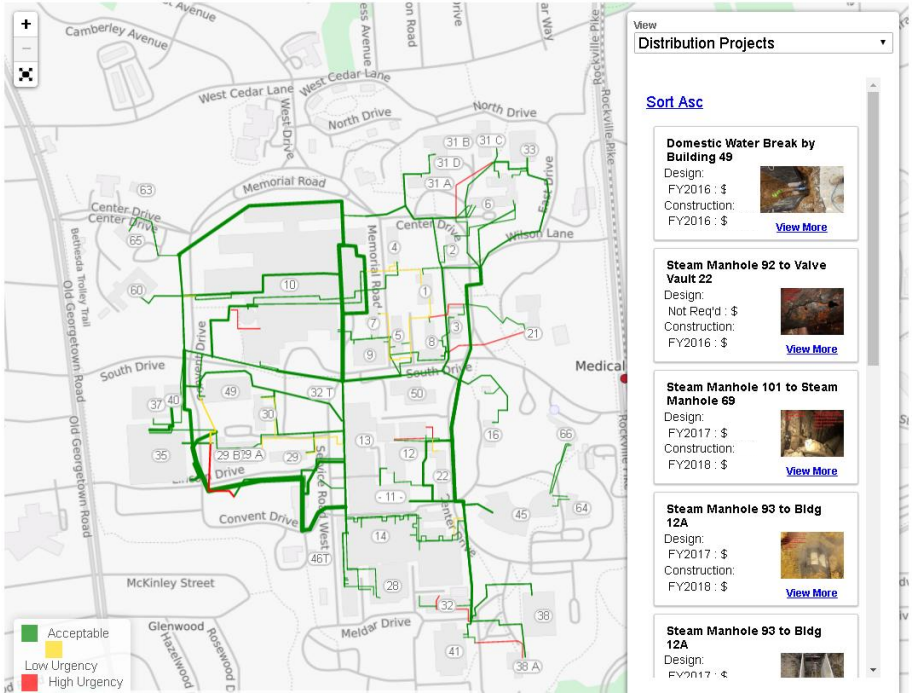


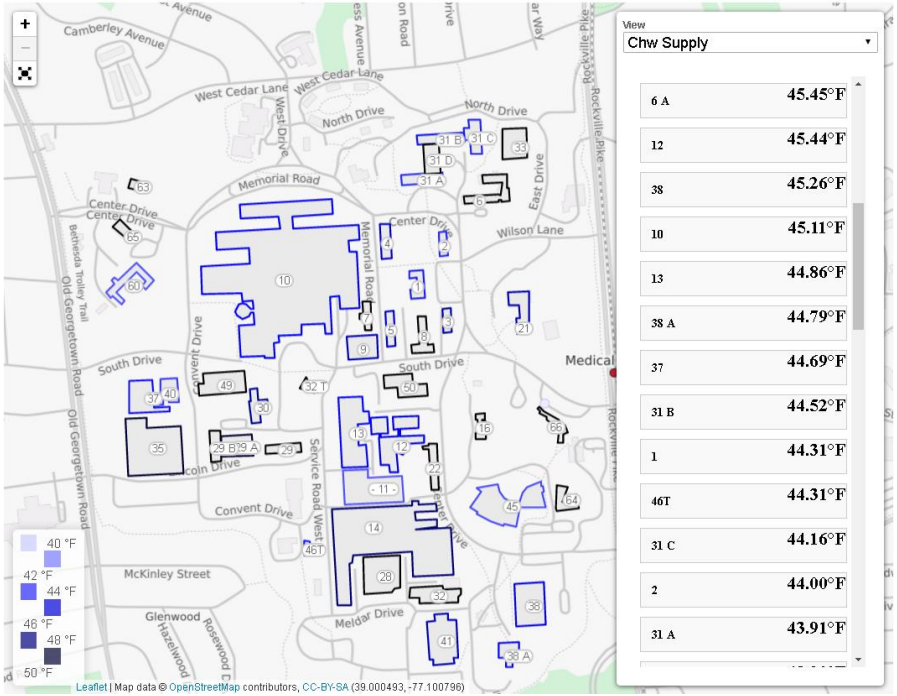
Tablet / Cell Phone GUI



PI and GIS Visualizing Campus BAS Data

Integrate PI with open-source GIS & lead to real-time monitoring of BAS and utility distribution





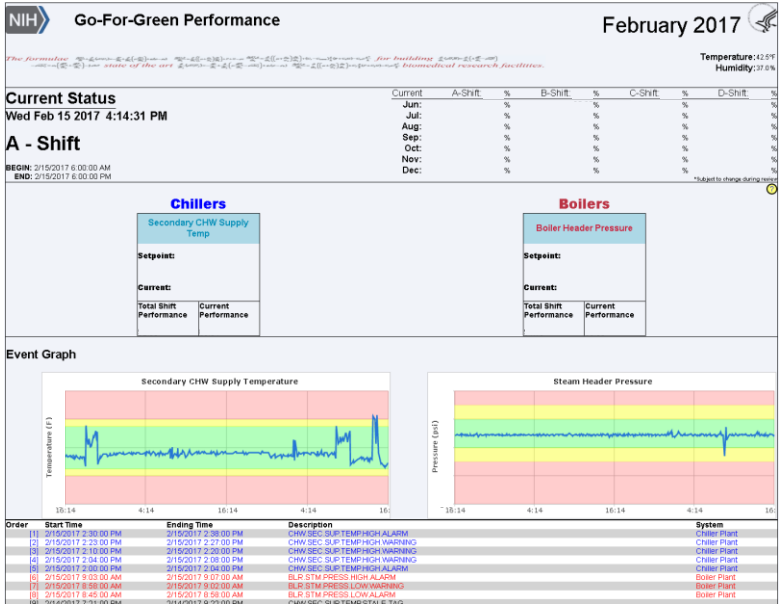
PI Providing Actionable Operational Intelligence

PI provides operators **actionable** intelligence, real-time RCA, and helps review operators performance

Operation 96 Hour Event Log

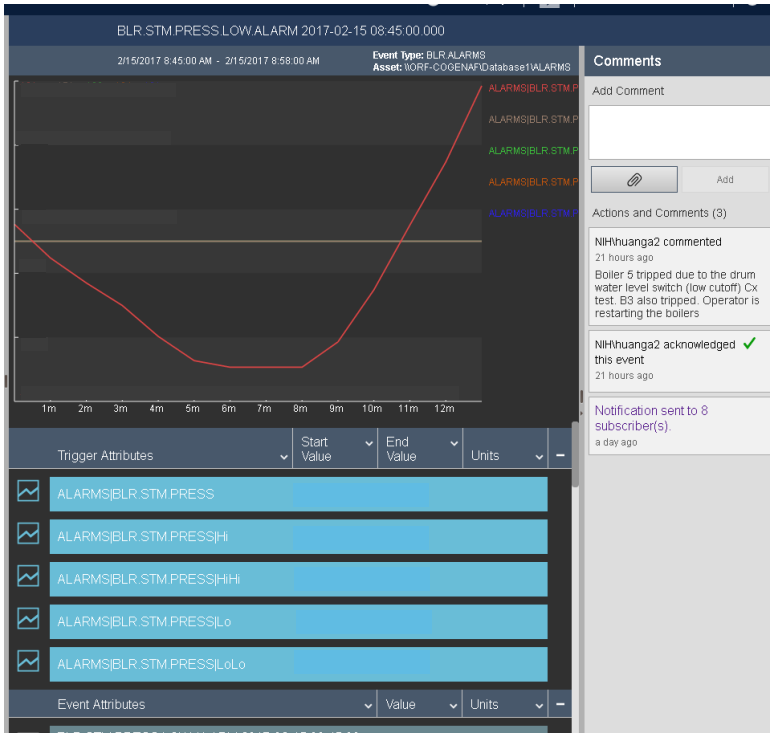
Mon Feb 27 2017 12:49:14 PM

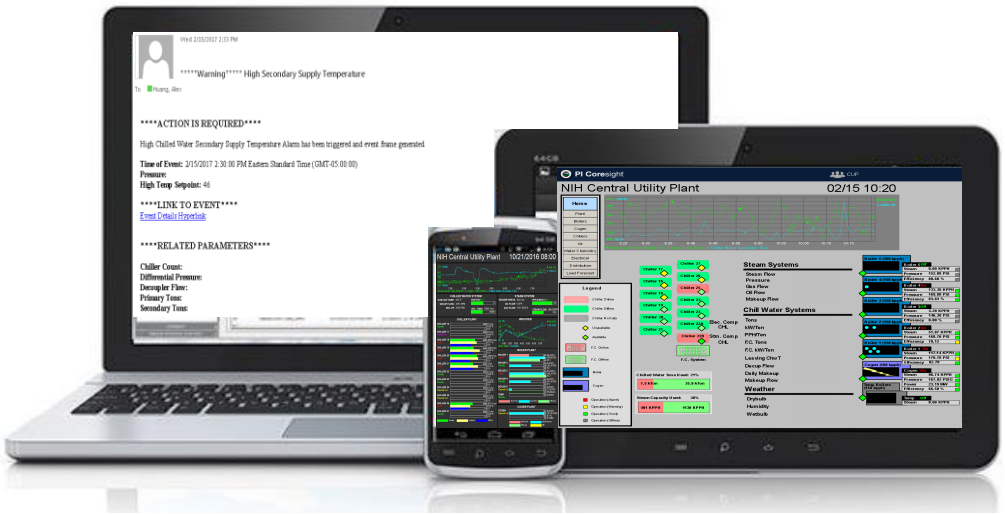
Start Time	Duration	System	Description	Recommendation	Current Reading	Log
2/24/2017 102:35:21 PM	Active Event	CLT20	Flexpro Concentration Too High (>130)	Check Flexpro Pumps	Concentration:	Root Cause Log
2/24/2017 102:40:00 PM	Active Event	BLR02	Excess Air Too High (>40)	Check FD and ID Fans. Use Manual mode if needed.	Excess Air:	Root Cause Log
2/24/2017 1:14:49 PM	5 hours	BLR04	Excess Air Too High (>40)	Check FD and ID Fans. Use Manual mode if needed.	Excess Air:	Root Cause Log
2/24/2017 1:16:47 PM	14 minutes	CHL24	Chiller Loaded Low (<65%)	Chiller Loaded Low. Look into turning off a Chiller.	Load:	Root Cause Log
2/24/2017 2:10:46 PM	15 minutes	CHL24	Chiller Loaded Low (<65%)	Chiller Loaded Low. Look into turning off a Chiller.	Load:	Root Cause Log
2/24/2017 2:55:41 PM	14 minutes	CLT19	Conductivity High (>1650 and <1700)	Check Blowdown Valve	Conductivity:	Root Cause Log
2/24/2017 3:10:06 PM	33 minutes	CLT19	Conductivity High (>1650 and <1700)	Check Blowdown Valve	Conductivity:	Root Cause Log
2/24/2017 3:43:56 PM	8 hours	CLT19	Conductivity High (>1650 and <1700)	Check Blowdown Valve	Conductivity:	Root Cause Log
2/24/2017 4:35:56 PM	1 hour	CLT22	Flexpro Concentration Too High (>130)	Check Flexpro Pumps	Concentration:	Root Cause Log
2/24/2017 5:49:11 PM	7 hours	CHL24	Chiller Loaded Low (<65%)	Chiller Loaded Low. Look into turning off a Chiller.	Load:	Root Cause Log
2/24/2017 6:45:31 PM	1 hour	CLT22	Flexpro Concentration Too High (>130)	Check Flexpro Pumps	Concentration:	Root Cause Log
2/24/2017 8:47:26 PM	3 hours	CLT20	Flexpro Concentration High (>120 and <130)	Check Flexpro Pumps	Concentration:	Root Cause Log



PI Assisting in Alarm Notification and Mobility

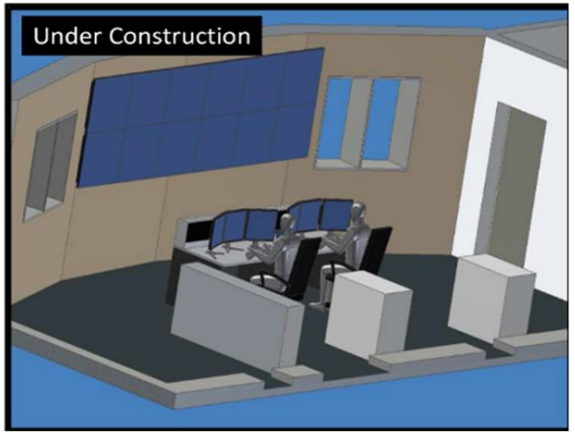
PI Notifications has allowed for automatic alerting via emails, and SMS text messages





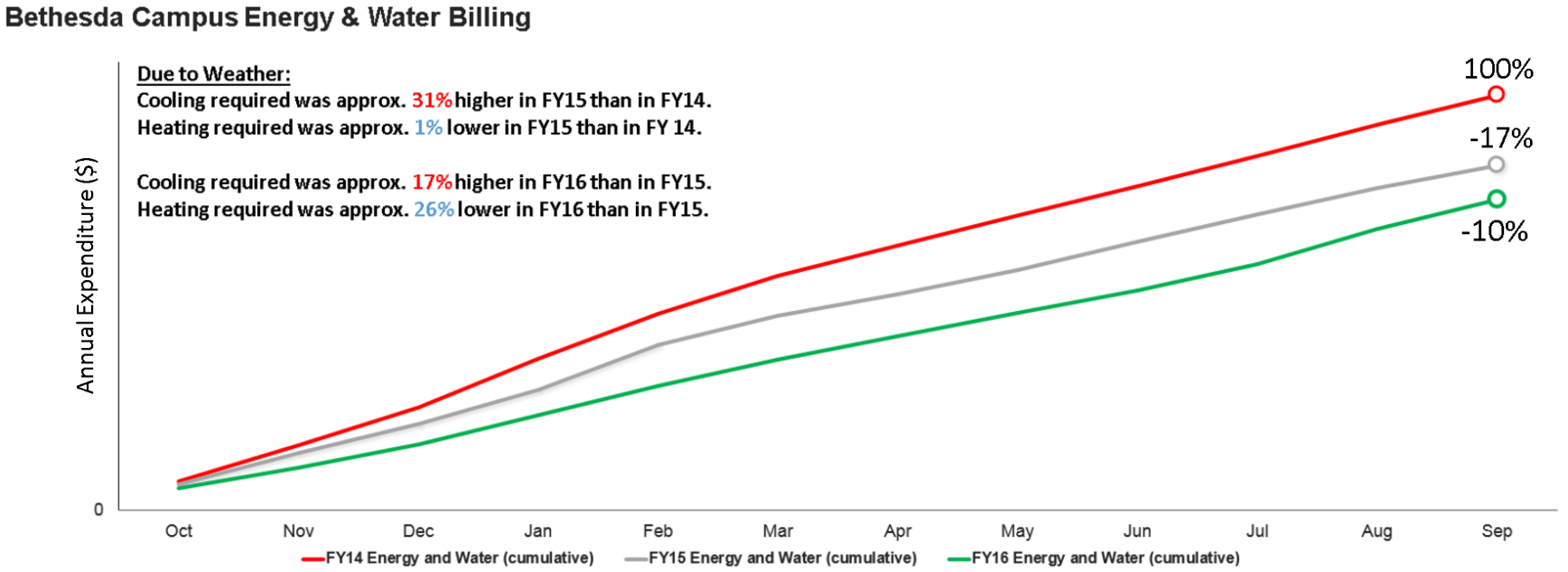
PI Powering the CUP Control Room

- PI Data and Displays will be front and center at the new CUP control room.
- Real-time, actionable data to drive operations from reactive to proactive.



Tangible Results – Financial

Millions of dollars saved despite increased utility demand!



Tangible Results – Reliability Improvement

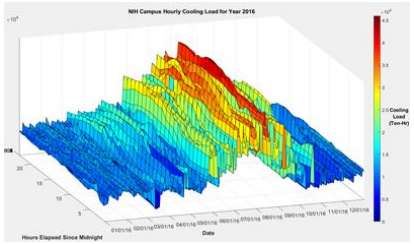
Peak Chiller Load Timeline

2012	2013	2014	2015	2016 (weekend/holiday)	2016 (weekday)
June 29 (1:00pm ET)	July 19 (6:00pm ET)	July 2 (12:06pm ET)	June 23 (2:41pm ET)	August 13 (5:00pm ET)	July 25 (3:00pm ET)
Peak Temperature: 88°F	Peak Temperature: 90°F	Peak Temperature: 90°F	Peak Temperature: 94°F	Peak Temperature: 96°F	Peak Temperature: 97°F
Wet Bulb 72°F	Wet Bulb 78°F	Wet Bulb 76°F	Wet Bulb 77°F	Wet Bulb 84°F	Wet Bulb 84°F
Number of Chillers Running: 12	Number of Chillers Running: 11	Number of Chillers Running: 10	Number of Chillers Running: 9	Number of Chillers Running: 9	Number of Chillers Running: 9
Chilled Water Tonnage at Peak Temperature 59,350 tons	Chilled Water Tonnage at Peak Temperature 51,327 tons	Chilled Water Tonnage at Peak Temperature 47,263 tons	Chilled Water Tonnage at Peak Temperature 44,900 tons	Chilled Water Tonnage at Peak Temperature 44,300 tons	Chilled Water Tonnage at Peak Temperature: 43,500 tons

Added 440,000 ft² to Campus

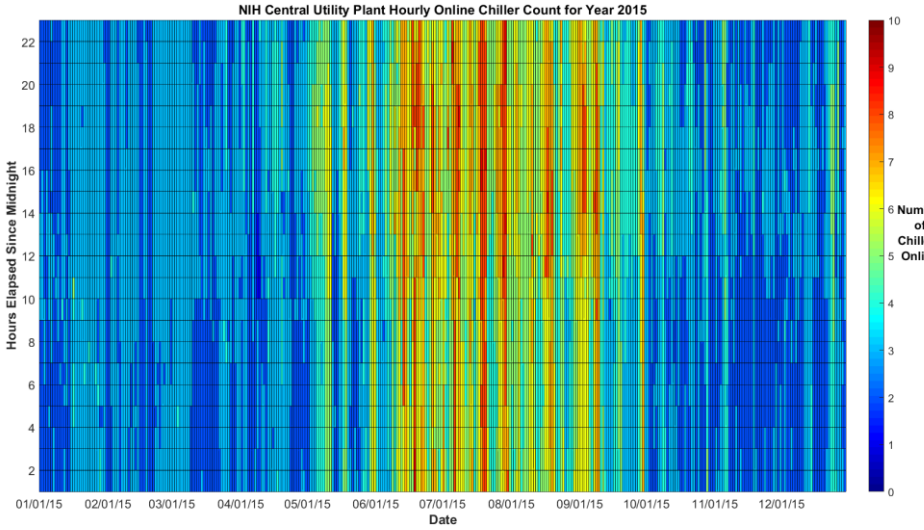
Lower cooling load due to 1) chiller optimization/repairs/ calibration and 2) secondary loop optimization.

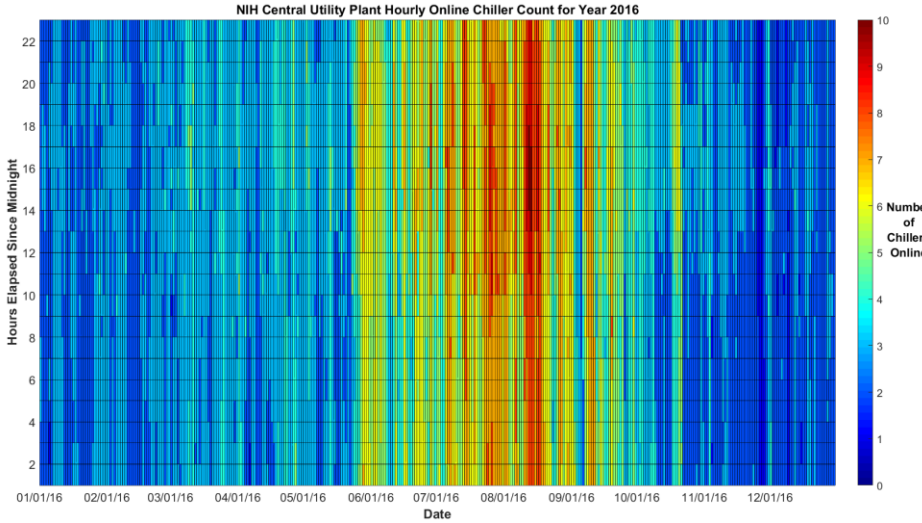
Tangible Results – Reliability Improvements



- 2-D waterfall mesh representing day of the year and hour in the day,
- Colors correspond to campus cooling load /# of chillers for that hour.
- 2016: More chiller load, spread over the course of the year

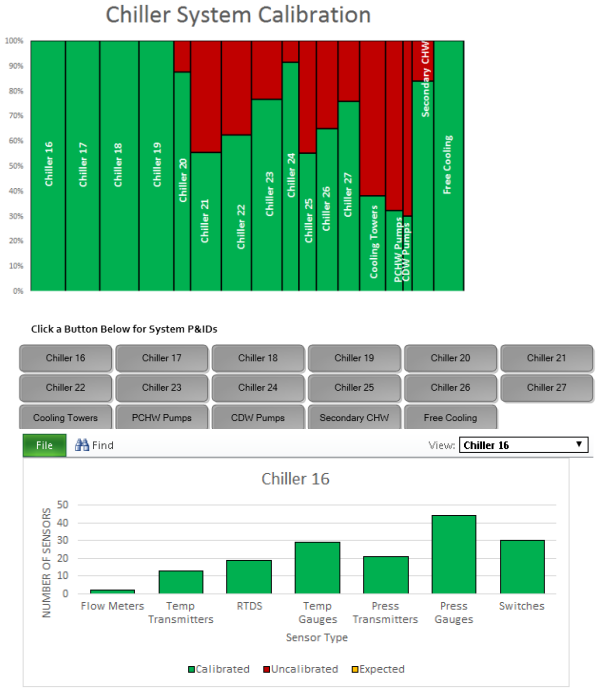
More chillers were available on average during 2016 vs 2015, plant overall efficiency improved (number of online chillers reduced) during 2016 vs 2015 despite the increased load during 2016





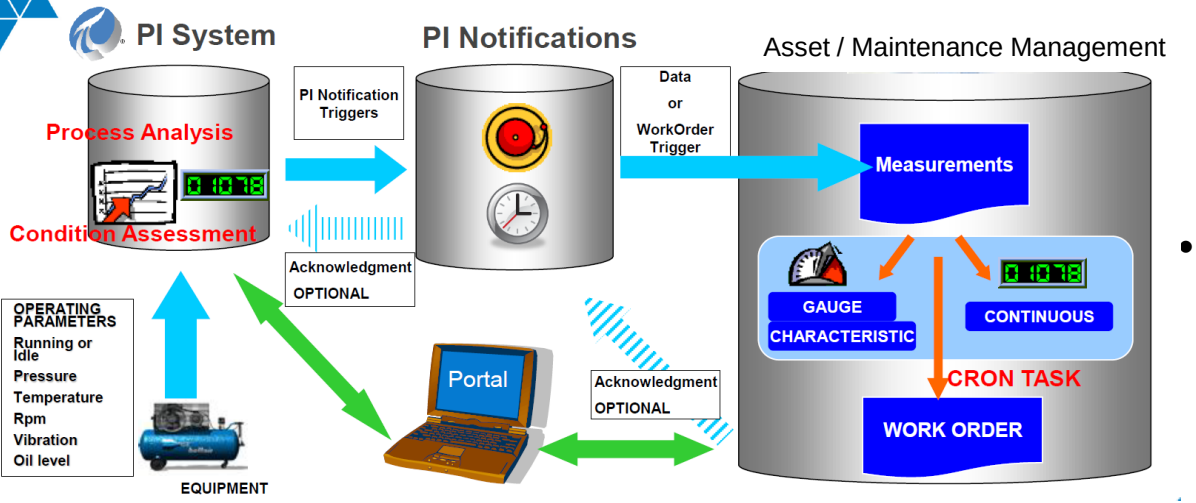
PI Assisting in Data Quality and Calibration Program

- To avoid GIGO, Calibration and online cross platform validation improve the data quality
- PI allows for visual reporting and status checks on calibration program
- Strides are being made on error propagation and more rigorous metrological standards



Using PI System to Increase System Reliability

Data Flow Between PI & Maintenance Software



Courtesy of OSIsoft

NIH CUP has begun integrating Maintenance / Asset Management with PI AF System to augment data analytics and reliability.

- Integration process with PI System rarely attempted before at such a large scale.

Summary Slide

COMPANY and GOAL

1) NIH operations depend on reliable utility provisions.
2) Central Plant of this scale relies on the leveraging of big data of to best serve NIH campus optimally and reliably.

CHALLENGE

Utilizing millions of data points daily in an intelligent manner such as to ensure the CUP's mission of serving NIH facilities.

- **Data must be ensured to be of quality in order to be actionable.**
- **Must adhere to strict reliability standards due to unique nature of NIH utility needs.**

SOLUTION

Leverage PI system features to collect, analyze, validate, and deliver data to a broad base of data consumers, all vital to the CUP mission.

- **PI data historian crucial to management of over 10,000,000 data points captured daily.**
- **PI AF system serves as data hub.**
- **PI System Explorer and Coresight vital for organization and visualization of the data across multiple systems.**

RESULTS

PI's role in data management has led to increased reliability in conjunction with systems optimization and monetary savings, with improvements in all facets expected to continue.

- **Reliability improvement of over 50% in terms of equipment failure and reliability since FY13**
- **Consistent 10~17% annual utility saving per year since FY13**
- **Integration with data-driven optimization technology.**

Contact Information

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Questions

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谢谢

Danke

Gracias

Merci

Thank You

ありがとう

Спасибо

Obrigado