
CampusEnergy2016
The Changing Landscape
Conference & Trade Show
Austin, Texas | February 8 – 12, 2016
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

Welcome To IDEA

Laxmi Rao
Director of International Programs, IDEA

Welcome To Workshop 2:
Intelligent Energy and Water Management for a Smart, Resilient & Sustainable Campus

Panel Discussion

Data for a Smart, Resilient & Sustainable Campus

Panel Discussion

Abbe Bjorklund – Dartmouth College
Jaon Kowal – Emory University
Mark Petty – Vanderbilt University
Juan Ontiveros – University of Texas Austin
John Vucci – University of Maryland
Les Williams – Texas A&M University


Dartmouth College

Dartmouth College Campus Overview

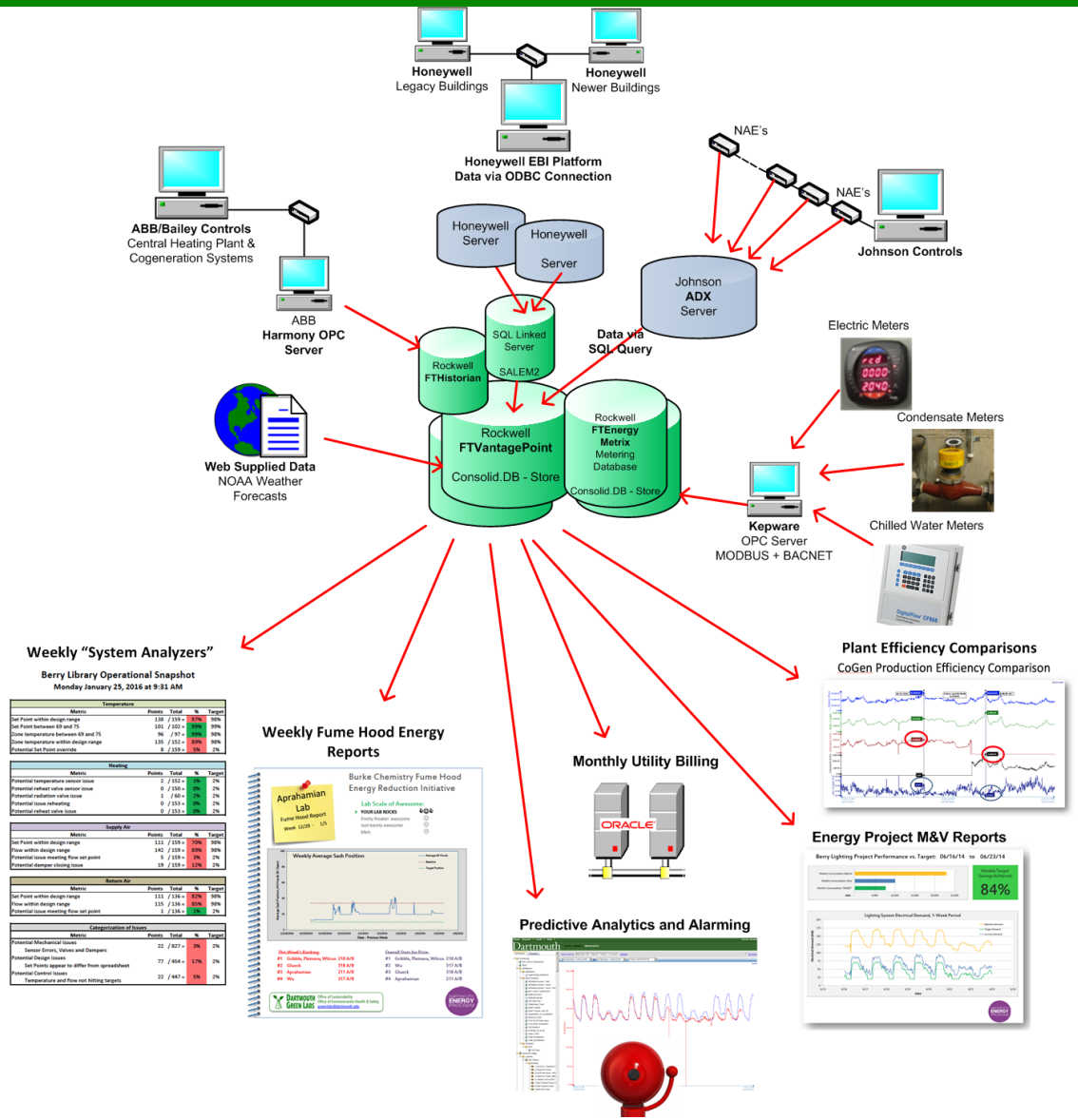
- **6,200 Students, 4,400 Faculty/ Staff**
- **5 Million Sq Ft, 120 Buildings**
- **4 HP boilers,310,000 #/HR capacity**
- **8 MW Capacity Steam Turbines**
- **Low Pressure Steam Distribution**
- **8,000 Tons Chiller Capacity**
- **12 MW Peak Electric Demand, 5 MW from Cogeneration**
- **$12 Million/yr Energy Spend**

1769

Dartmouth

Campus Energy Management System

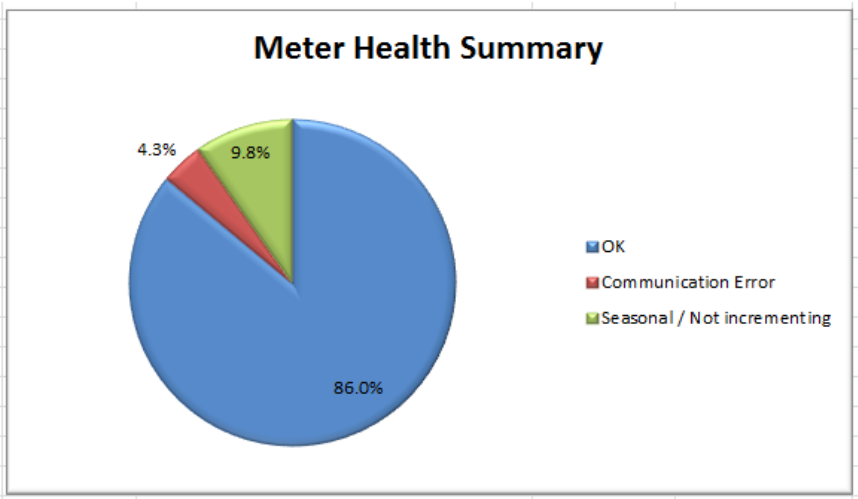
- Metering
- Data Integration
- Fault Detection
- Metrics
- Data Sharing
- Trending
- Modeling
- Dashboards



Excel Add-In + Analytics

“SmartChecker” - Meter Health Checks

- 350 Revenue meters
- Monthly Utility Billing
- Ongoing system changes and additions
- In-house tools to assess meter health and data integrity
- Able to reconstruct usage based on history and partial data
- Ready to investigate & fix

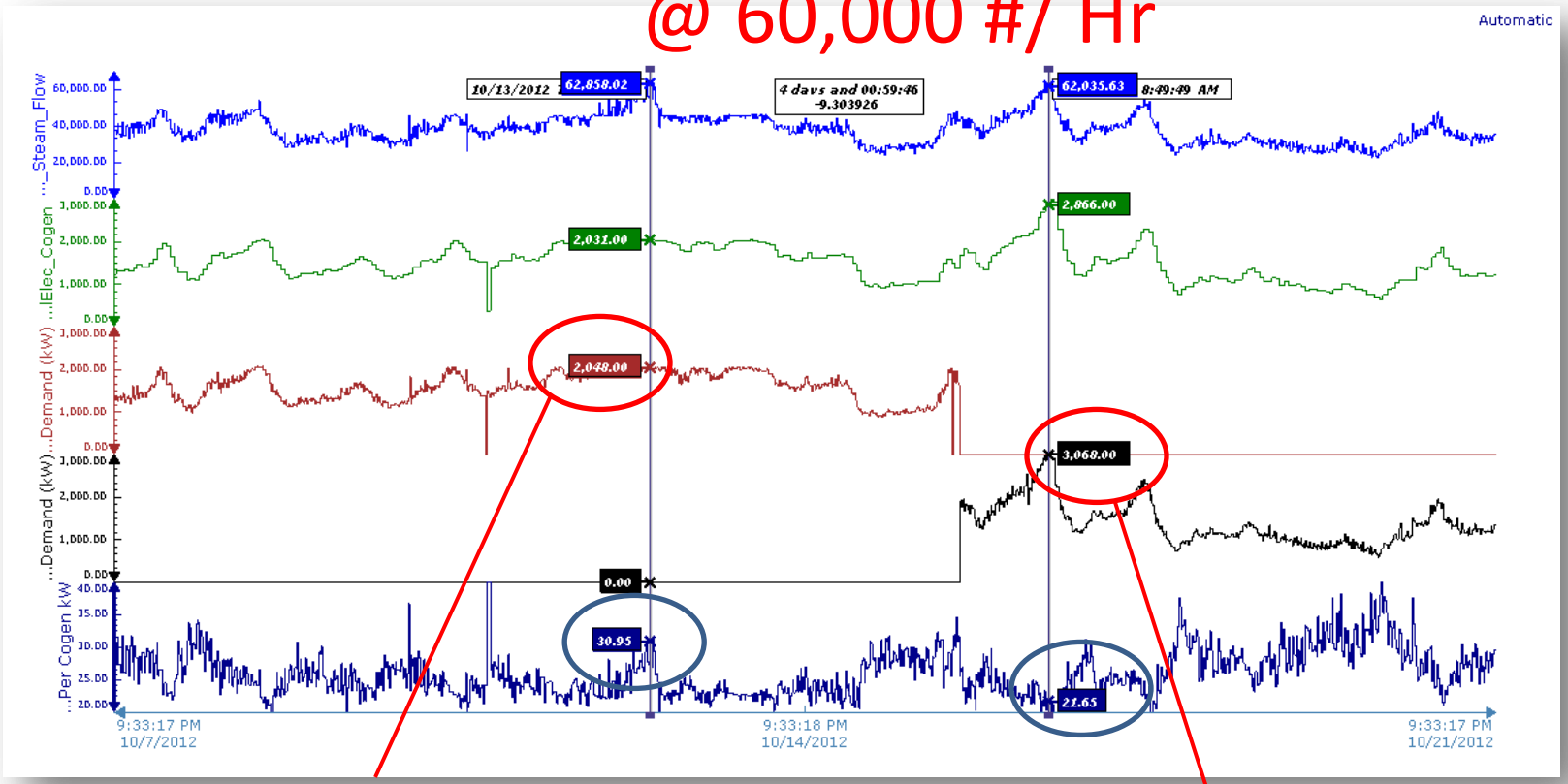


Meter	Meter Name	Current Status	DB Status
C0434	2 North Park Main CHW C0434	Comm Error	In Service
E1462A	Black Arts Center Electric E1452A	Comm Error	In Service
E1462B	Black Arts Center Electric E1452B	Comm Error	In Service
E1462J	Black Arts Center Electric E1462J	No Increase	In Service
S0102-S	Fairchild Tower AHU Condensate S0102-S	No Increase	In Service
E0021D	Hood Cooling Auxiliaries E0021D	Comm Error	In Service
E1458K	Kemeny DPKBA Electric E1458K	No Increase	In Service
E1458L	Kemeny DPKBB Electric E1458L	No Increase	In Service
E0022B	Hopkins Center Main Electric E0022B	OK	Work Order
S0072	Ripley Hall Main Condensate S0072	OK	Work Order
E1459A	78 LSC Main Electric E1459A	No Increase	Work Order
S0054	Alumni Gym Main Condensate S0054	No Increase	Work Order
C0141D	Burke Chemistry AHU4 CHW C0141D	Comm Error	Work Order
S0027A	McKenzie Hall Condensate S0027A	No Increase	Work Order
E1463A	Science Ctr CHW Plant Chiller 1 E1463A	Comm Error	Work Order

Trend – Operational Comparisons

CoGen Production Efficiency Comparison

@ 60,000 #/ Hr

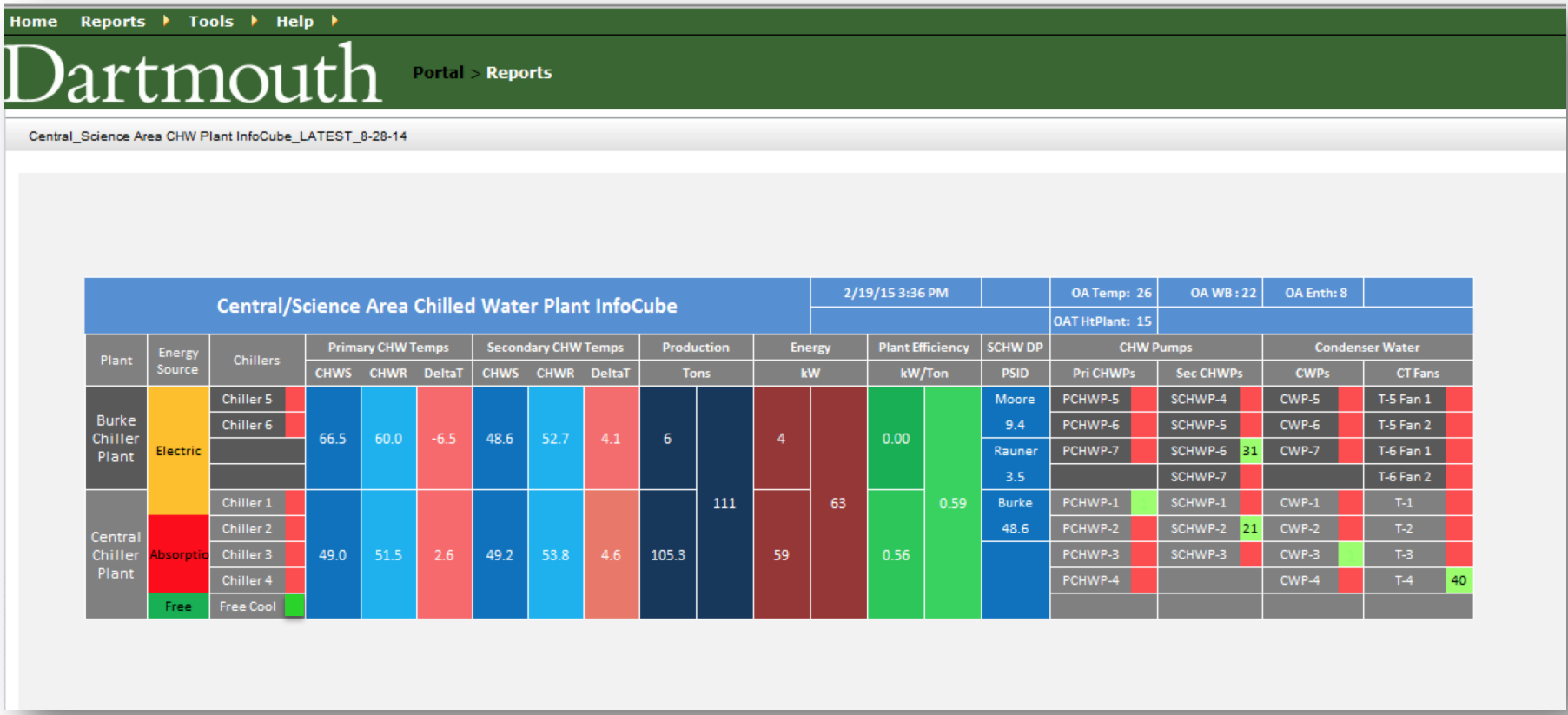


2 mW from TG 1 or 3 mW from TG 3

> $100/Hr. Operating Difference!

Operational View

Info Cube – Contextualized Info in a Compact Space




Emory University

Emory Overview

- 14,724 students
- 29,338 employees
- Approximately 9 million square feet; 130 buildings
- Central Steam Plant; 500,000 pph capacity
- Three Central Chiller Plants; 20,300 tons capacity
- Utility budget of approx. $35M

Emory's Approach to Data Use

Currently:

- Building data
  - Approximately 90% of buildings are directly metered by utility or sub-metered by Emory
  - Data used for monthly billing and reporting
  - Real-time use of meter data has not proved beneficial; moving away from lobby monitors
  - BAS data points valuable for monitoring performance and identifying issues
- Central Plants
  - Separate control systems
  - Monitored real-time

Looking Forward:

- Pursuing a front end overlay that will integrate building and plant data
- Centralized control room approach

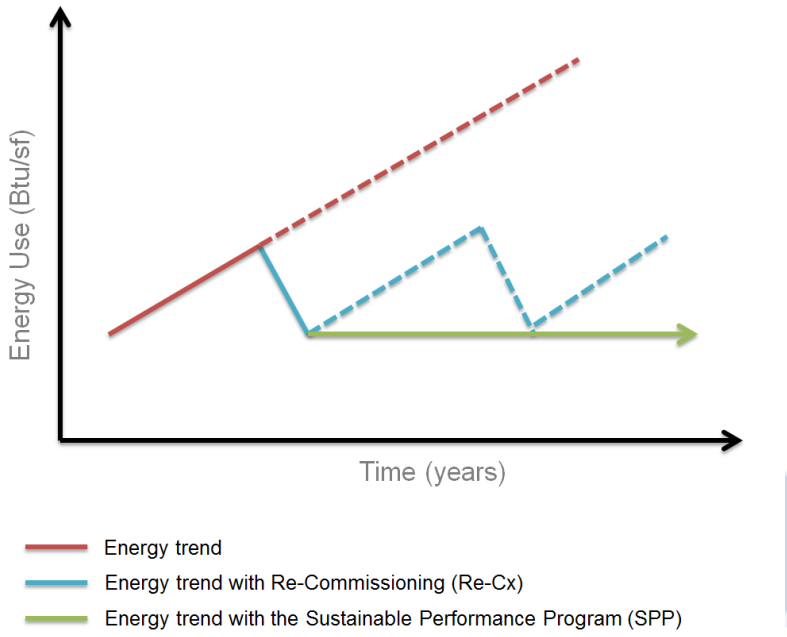
Sustainable Performance Program

Emory University's On-Going Commissioning program, focusing on the building mechanical systems.

Goals:

- Avoid performance degradation over the life-cycle
- Strive to improve annual consumption performance through pro-active operation, monitoring and optimization.
- Maintain the Current Functional Requirements throughout the life of the facility.
- Ensure systems will effectively and optimally serve re-purposed spaces.

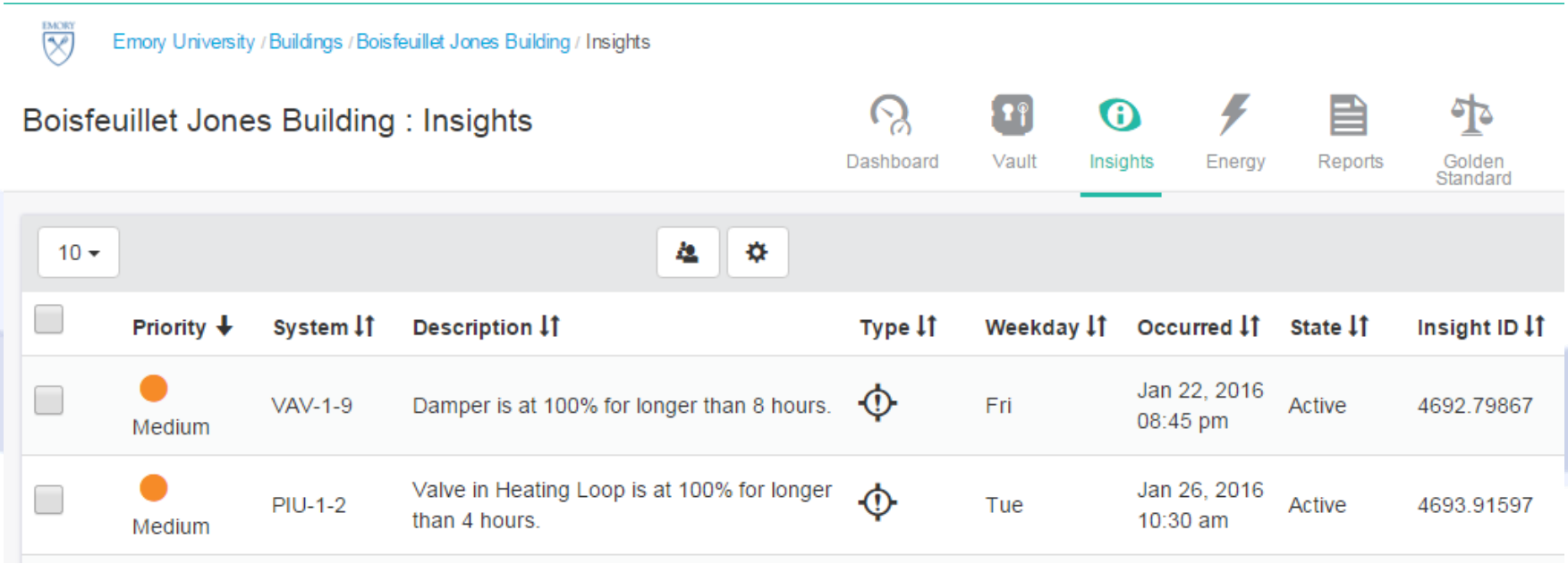
Optimize the load side, then optimize the plant to the load



Automated Fault Detection

A key strategy to obtain our SPP goals is utilization of Automatic Fault Detection and Diagnostics (AFDD); AFDD at Emory is accomplished by two strategies: Within the BAS, and with a 3rd party software platform.

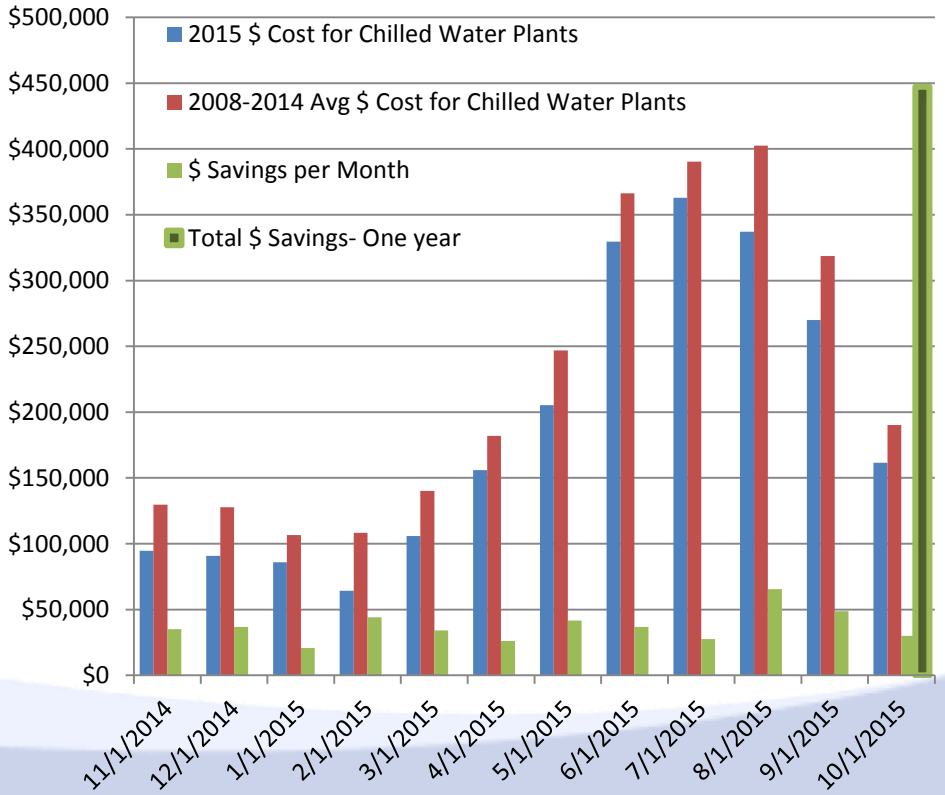
- Insights are created based on trended operation and/or observed history.
- Built to look for scenarios of inefficient operation that lead to an increase in energy use.
- Built to find issues that mask themselves and don't create occupant discomfort.
- Our signal to review operations and trend data collected.



Priority	System	Description	Type	Weekday	Occurred	State	Insight ID
Medium	VAV-1-9	Damper is at 100% for longer than 8 hours.		Fri	Jan 22, 2016 08:45 pm	Active	4692.79867
Medium	PIU-1-2	Valve in Heating Loop is at 100% for longer than 4 hours.		Tue	Jan 26, 2016 10:30 am	Active	4693.91597

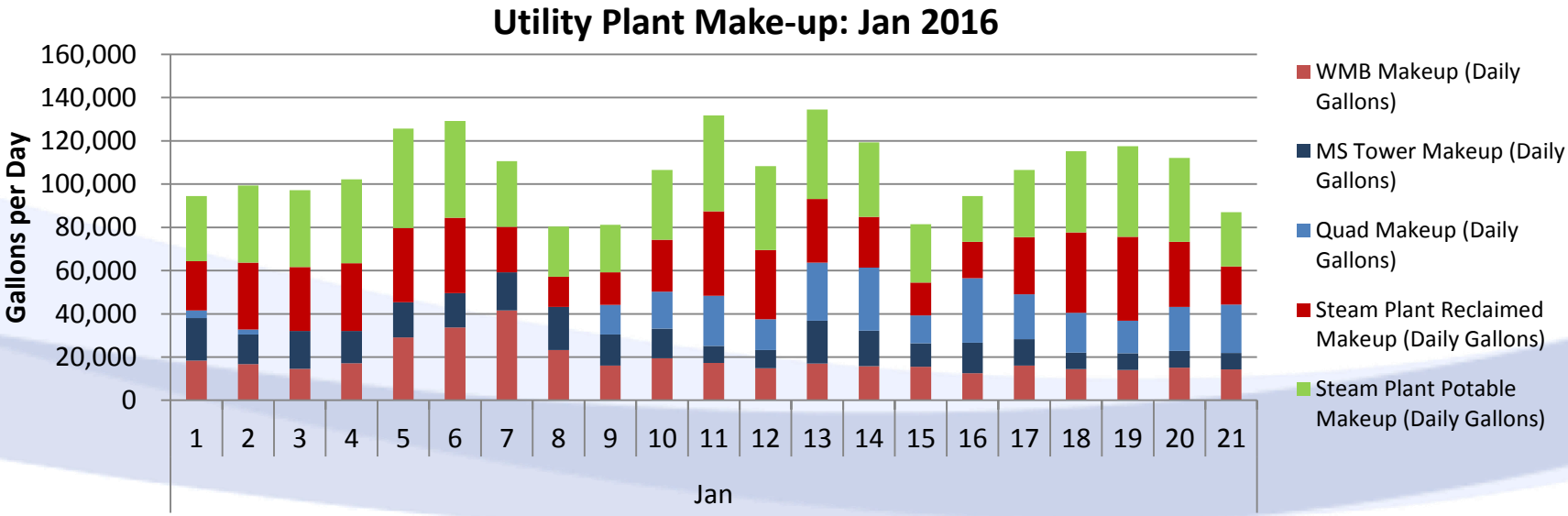
Chiller Plant Optimization

- Smart automation logic used to manage and balance both the load from buildings and capacity for production from the plant.
- Custom designed for each chiller, total plant, and building loop- based on optimizing flow and electrical efficiency “sweet spots” -enabling chillers to produce at or below kWh/ton design.
- Minimize wasted production energy, and smartly sequence the staging of chillers to maintain balanced load and production.



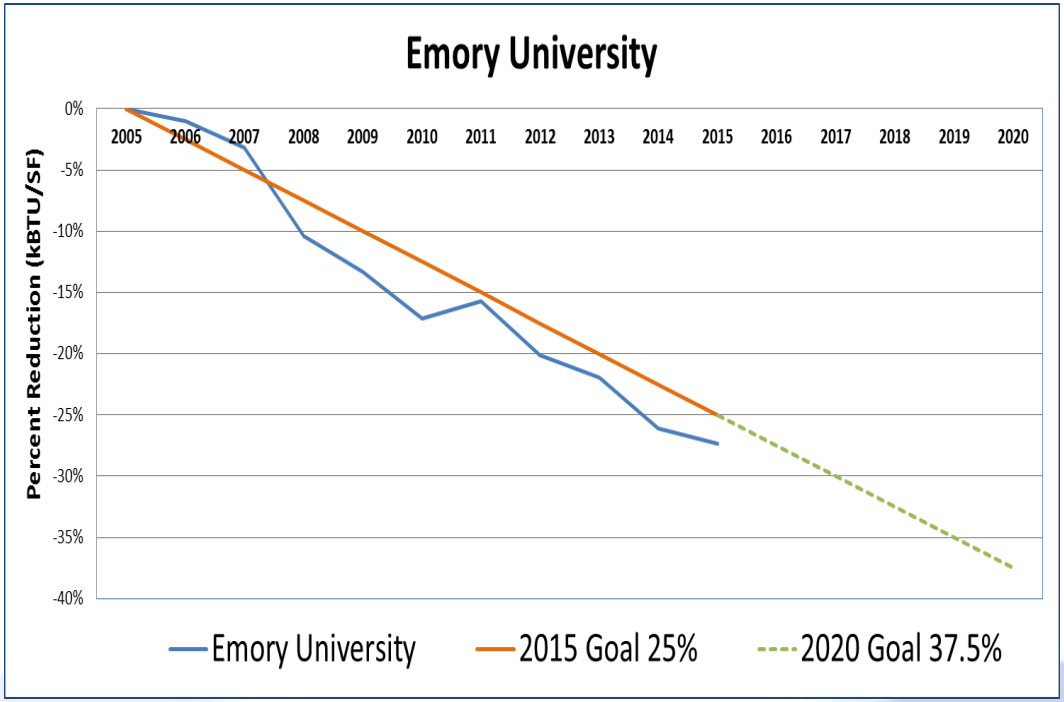
Water Metering

- Stormwater and greywater reuse systems not metered but designed to displace 700,000 and 826,000 gallons annually
  - Metered data would help us to understand operational reliability, measure performance and calculate payback as well as make decisions on investing in similar technologies in the future
- Metered reclaimed water used at utility plants helps provide operational data that was not previously trended



Invoicing/Benchmarking

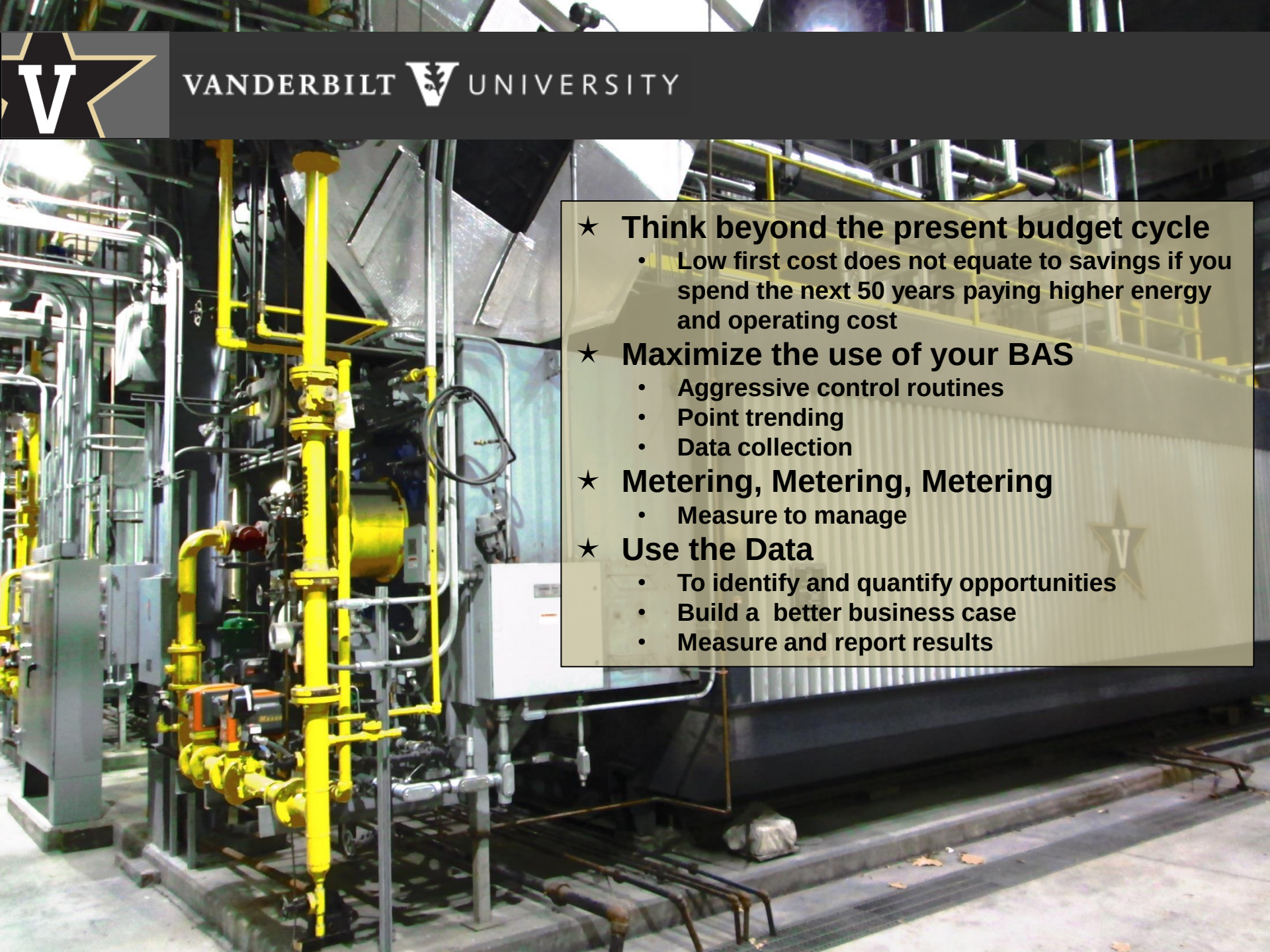
- Monthly Invoicing
  - Identifies abnormalities in consumption; initiates corrective action; and requires appropriate adjustments to billing data
- Benchmarking
  - Allows comparison among similar building types
  - Track reductions in overall use as well as per square foot
  - Includes weather normalization to reflect more accurate changes

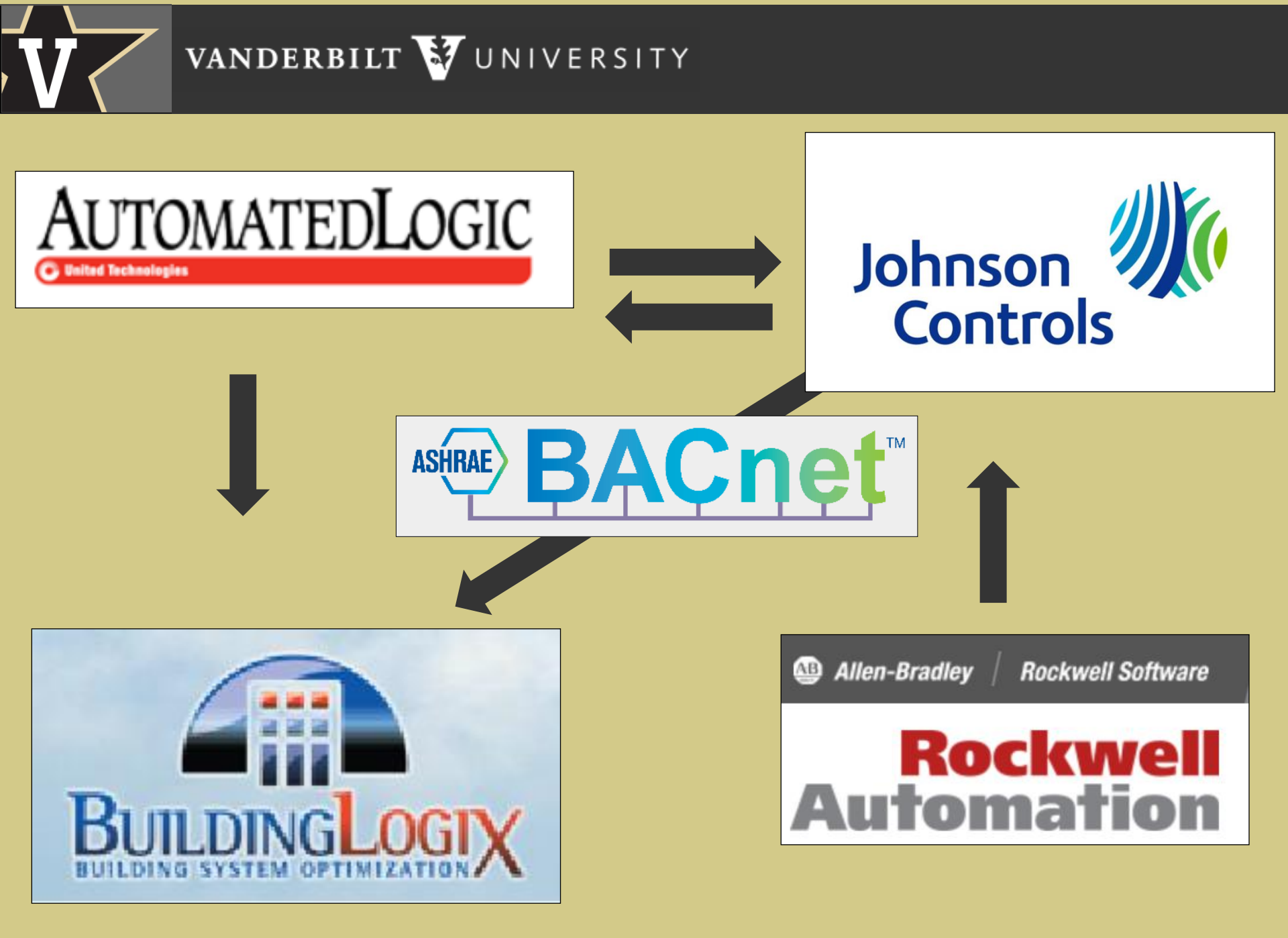


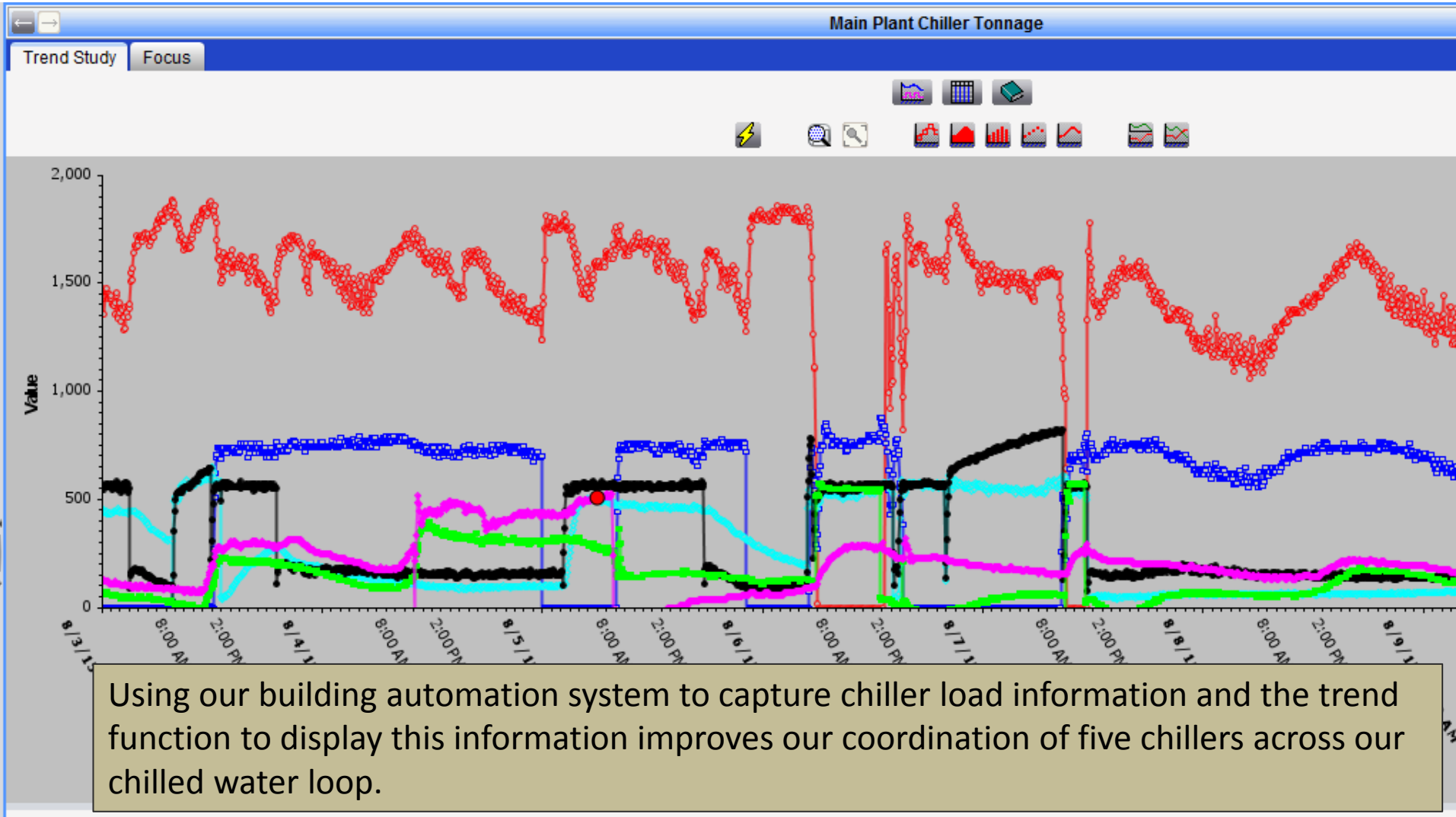

Vanderbilt University

VANDERBILT UNIVERSITY

- Vanderbilt University located 1 mile from downtown Nashville, TN. Founded with a $1,000,000 gift from Commodore Cornelius Vanderbilt in 1873
- Vanderbilt is a private research university and medical center with just over 12,000 under graduate and graduate students, a faculty and staff of 24,176. Vanderbilt is the second largest private employer in the state of Tennessee.
- 330 acres, 392 buildings, with 6.9 million sq. ft. University, 10.9 million Medical Center, and another 2.2 million leased.
- We serve 153 buildings with some combination of central plant utilities including electricity, steam, and chilled water.
- FY2015 from our Co-Generation facility we;
  - Purchased 340,410 MWH of electricity
  - Co-generated 26,240 MWH of electricity
  - Generated 1.5 billion lbs. of steam
  - purchased 1.8 million dekatherm of natural gas


VANDERBILT UNIVERSITY
★ Think beyond the present budget cycle
• Low first cost does not equate to savings if you spend the next 50 years paying higher energy and operating cost
★ Maximize the use of your BAS
• Aggressive control routines
• Point trending
• Data collection
★ Metering, Metering, Metering
• Measure to manage
★ Use the Data
• To identify and quantify opportunities
• Build a better business case
• Measure and report results


VANDERBILT UNIVERSITY
AUTOMATEDLOGIC
United Technologies
Johnson Controls
ASHRAE BACnet™
BUILDINGLOGIX
BUILDING SYSTEM OPTIMIZATION
Allen-Bradley | Rockwell Software
Rockwell Automation



Using our building automation system to capture chiller load information and the trend function to display this information improves our coordination of five chillers across our chilled water loop.

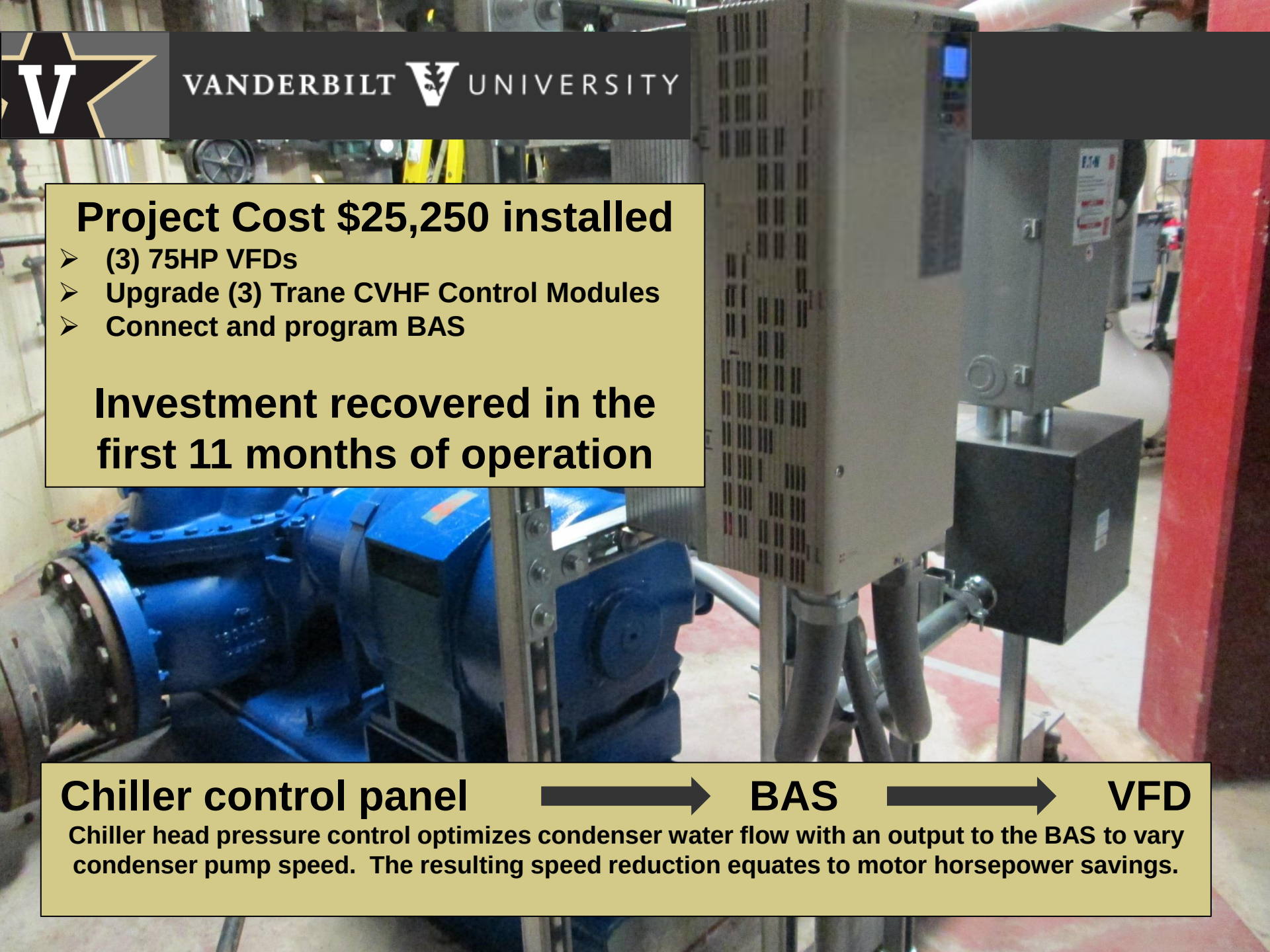
Show	Marker	Name	Reference
☑		Chiller 1 Tonnage.Trend - Present Value	metasysprod:29-POWERHOUSE2/Programming.Chi
☑		Chiller 2 Tonnage.Trend - Present Value	metasysprod:29-POWERHOUSE2/Programming.Chi
☑		Chiller 4 Tons.Trend - Present Value	metasysprod:6-BARNARD/BTU Calculations.Chilled
☑		Chiller 5 Tons.Trend - Present Value	metasysprod:6-BARNARD/BTU Calculations.Chilled
☑		Vaugh Carrier Chiller Tons.Trend - Present Value	metasysprod:8B-VAUGHN/BTU Calculations.Chilled
☑		Vaugh Trane Chiller Tons.Trend - Present Value	metasysprod:8B-VAUGHN/BTU Calculations.Chilled

VANDERBILT UNIVERSITY

Replaced (2) 900 ton absorption chillers with (1) 1800 ton turbine

5,326,779 Ton-hours
since the June startup

$639,213
in steam savings



VANDERBILT UNIVERSITY

Project Cost $25,250 installed

- (3) 75HP VFDs
- Upgrade (3) Trane CVHF Control Modules
- Connect and program BAS

Investment recovered in the first 11 months of operation

Chiller control panel → BAS → VFD

Chiller head pressure control optimizes condenser water flow with an output to the BAS to vary condenser pump speed. The resulting speed reduction equates to motor horsepower savings.

Peabody Chiller Summary

Peabody Campus Chiller Summary | Mayborn Chiller Plant | Peabody Maintenance Chiller Plant | Peabody Cooling Tower Summary | Secondary Loop | Loop Study

OAT 43.9 deg F
OAH 78.0 %RH

Mayborn Chiller 1

Chiller 1 Enable Off
Chiller 1 Setpoint 42.0 deg F
Chiller 1 Tons 0.0 tons

Chilled Water Supply Temperature 59.1 deg F
Condenser Return Temperature 60.5 deg F

Mayborn Chiller 2

Chiller 2 Enable Off
Chiller 2 Setpoint 42.0 deg F
Chiller 2 Tons 0.0 tons

Chilled Water Supply Temperature 62.0 deg F
Condenser Return Temperature 60.2 deg F

Mayborn Chiller 3

Chiller 3 Enable Off
Chiller 3 Setpoint 42.0
Chiller 3 Current 0.0
Chiller 3 Hours 74,328.0
Chiller 3 Tons 0.0 tons

Chilled Water Supply Temperature 48.0 deg F
Chilled Water Return Temperature 47.1 deg F
Condenser Supply Temperature 63.0 deg F
Condenser Return Temperature 63.6 deg F

Graphic are a powerful tool within the building automation system. This we use to monitor and coordinate our Peabody Chiller Plant.

Peabody Maintenance Chiller 4

Chiller 4 Command On
Chiller 4 Setpoint 42.0 deg F
Chiller 4 Percent FLA 35.0 %
Chiller 4 Hours 39,768 hours
Chiller 4 Tons 226.0 tons

Condenser Supply Temperature 63.5 deg F
Condenser Return Temperature 65.8 deg F

Peabody Maintenance Chiller 5

Chiller 5 Command Off
Chiller 5 Setpoint 42.0 deg F
Chiller 5 Percent FLA 0.0 %
Chiller 5 Hours 39,812 hours
Chiller 5 Tons 0.0 tons

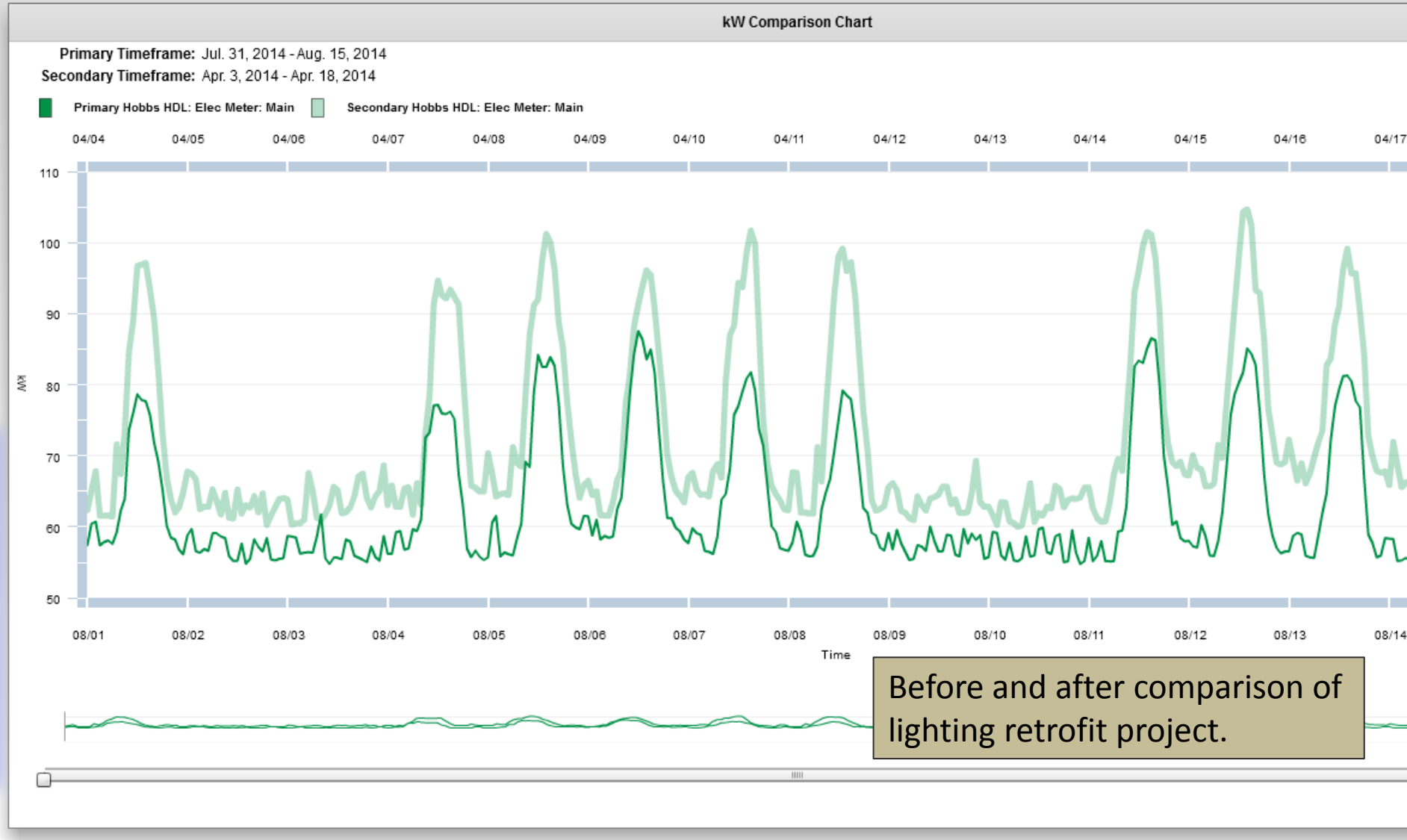
Condenser Supply Temperature 62.7 deg F
Condenser Return Temperature 66.7 deg F

Note the use of a plate and frame heat exchanger, this allows us to shut down chillers in the winter.

Mayborn Plate and Frame Heat Exchanger

Plate and Frame Enable Enable
Tower Speed Command 100.0 %
Secondary Water Supply 43.8 deg F
Secondary Water Return 46.1 deg F
Tonnage 69.56 tons

Chilled Water Supply Temperature 42.5 deg F
Chilled Water Return Temperature 43.9 deg F
Condenser Supply Temperature 42.6 deg F
Condenser Return Temperature 42.7 deg F



Before and after comparison of lighting retrofit project.

- **Think beyond the present budget cycle**
  - Low first cost does not equate to savings if you spend the next 50 years paying higher energy and operating cost
- **Maximize the use of your BAS**
  - Aggressive control routines
  - Point Trending
  - Data collection
- **Metering, Metering, Metering**
  - Measure to manage
- **Use the Data**
  - To identify and quantify opportunities
  - Build a business case
  - Measure & report results


University of Texas
Austin

The University of Texas at Austin

JUAN M. ONTIVEROS, P.E.

ASSOCIATE VICE PRESIDENT OF UTILITIES, ENERGY AND FACILITIES MANAGEMENT

Background

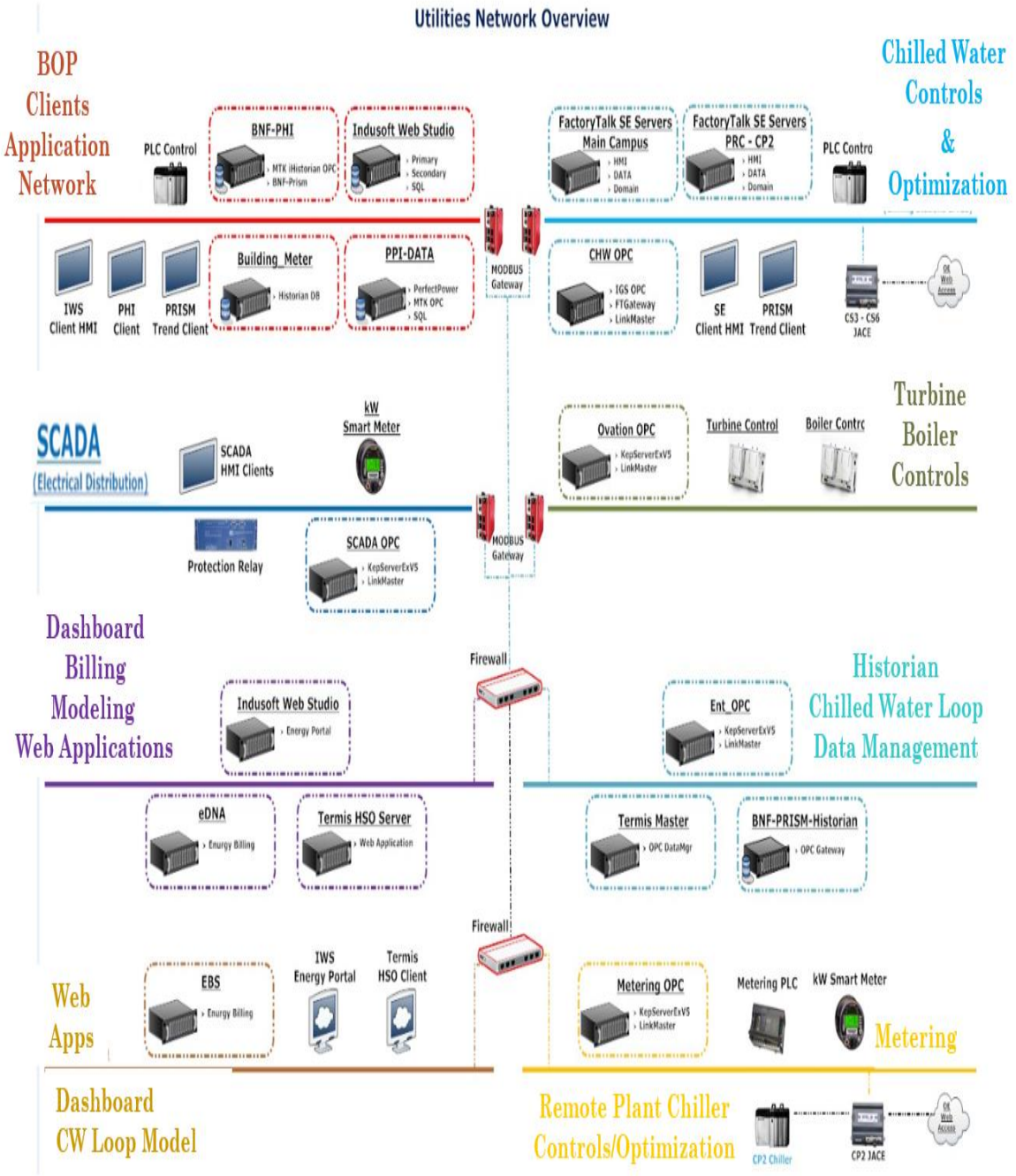
- 51,000 students, 24,000 faculty and staff
- 17 million square feet served
- 350-acres and 160-plus-buildings
- 60 MW peak load – 350 million Kwh
- 33,000 peak tons of CHW – 157 million ton-hours
- 220,000 pph peak steam - 775 million pounds
- Nine miles of tunnels
- All electricity distributed underground
- 87% annual efficiency
- 4 campus wide outages in 54 years

Performance Features

- Ability to 100% Island all Power at will
- Net Zero Power to ERCOT Grid since 1929 plus
  - Real-Time Load Balancing for Steam and Chilled Water
- Redundant Power (134 MW – 60 MW Peak)
  - Multiple Generators
  - 4 – 50 MVA XFMR'S in a ring at the Substation (25 MW Grid Stand-By Agreement)
  - Underground grid distribution is a looped bus system
- Redundant Chilled Water (45,000 tons – 30,000 tons Peak)
- 2 Independent High Pressure Gas Mains to Plants
- Load-Shed built in for excess Steam & Electricity

Performance Features

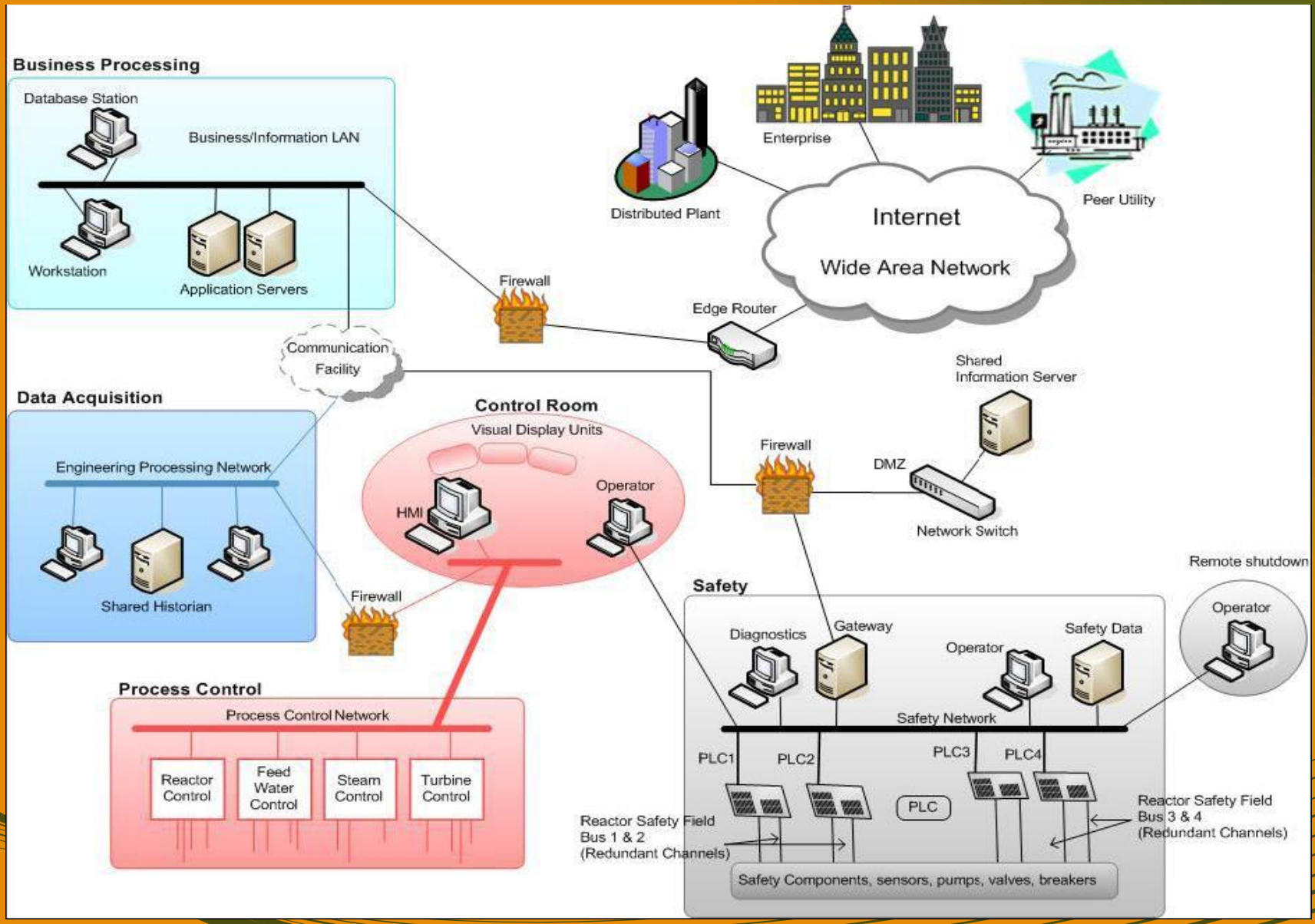
- Thermal Storage (4 MG soon to be 6 MG more)
  - Back-up and Load Shifting
- Real Time Energy Modeling
  - Chilled Water Distribution &Overall Energy Balance
- Optimization
  - Chilled Water System (.64 kW/Ton Annual Average)
  - Heat Rate (8,791 Btu/kW Annual Average)
- Plant Condition Monitoring (Plant Health Index)
- Meter 95% of all Campus Facilities (20 million GSF)
  - 1,000 meters
    - electricity, steam, chilled water and domestic water



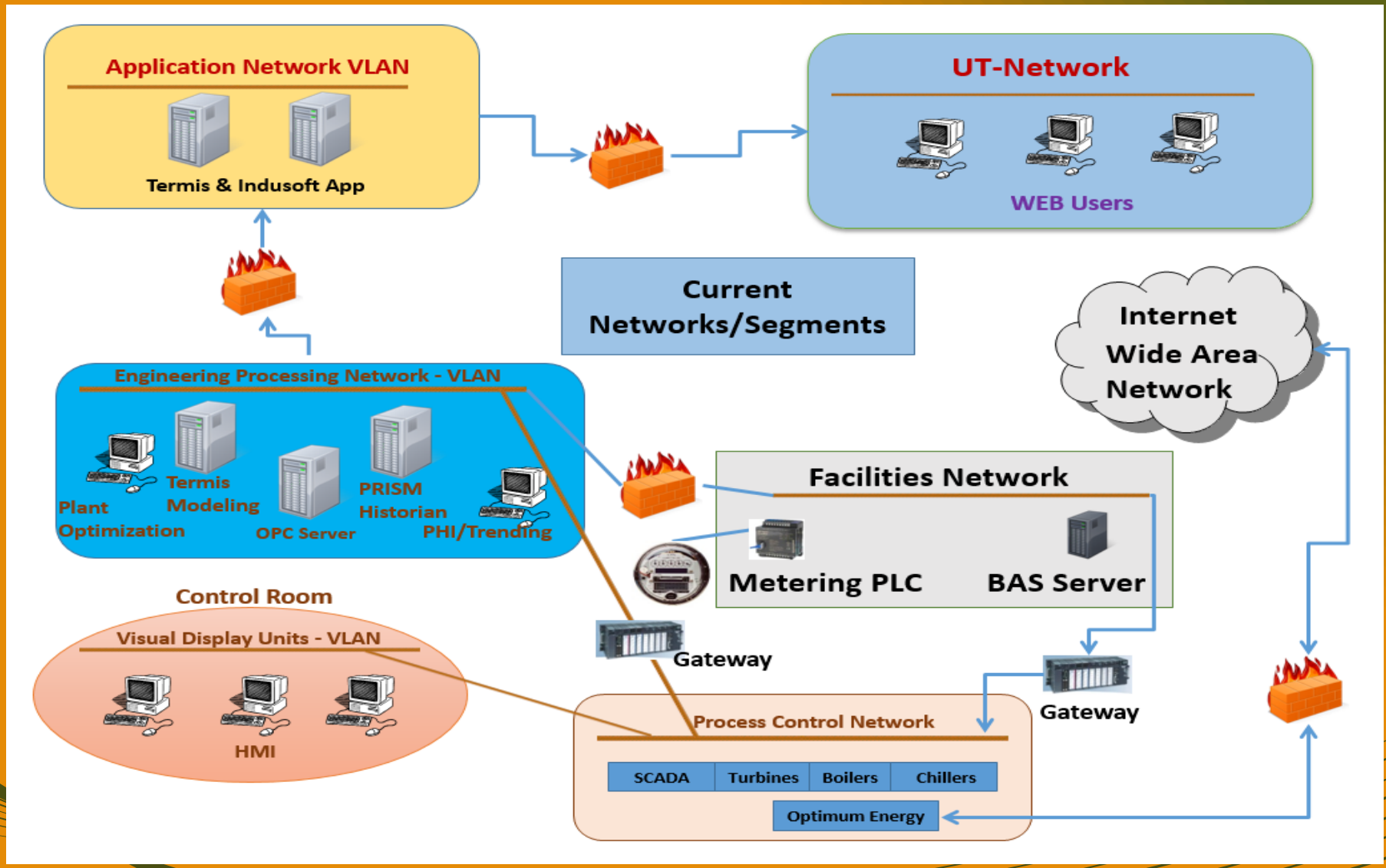
Network Needed for Connecting The Microgrid

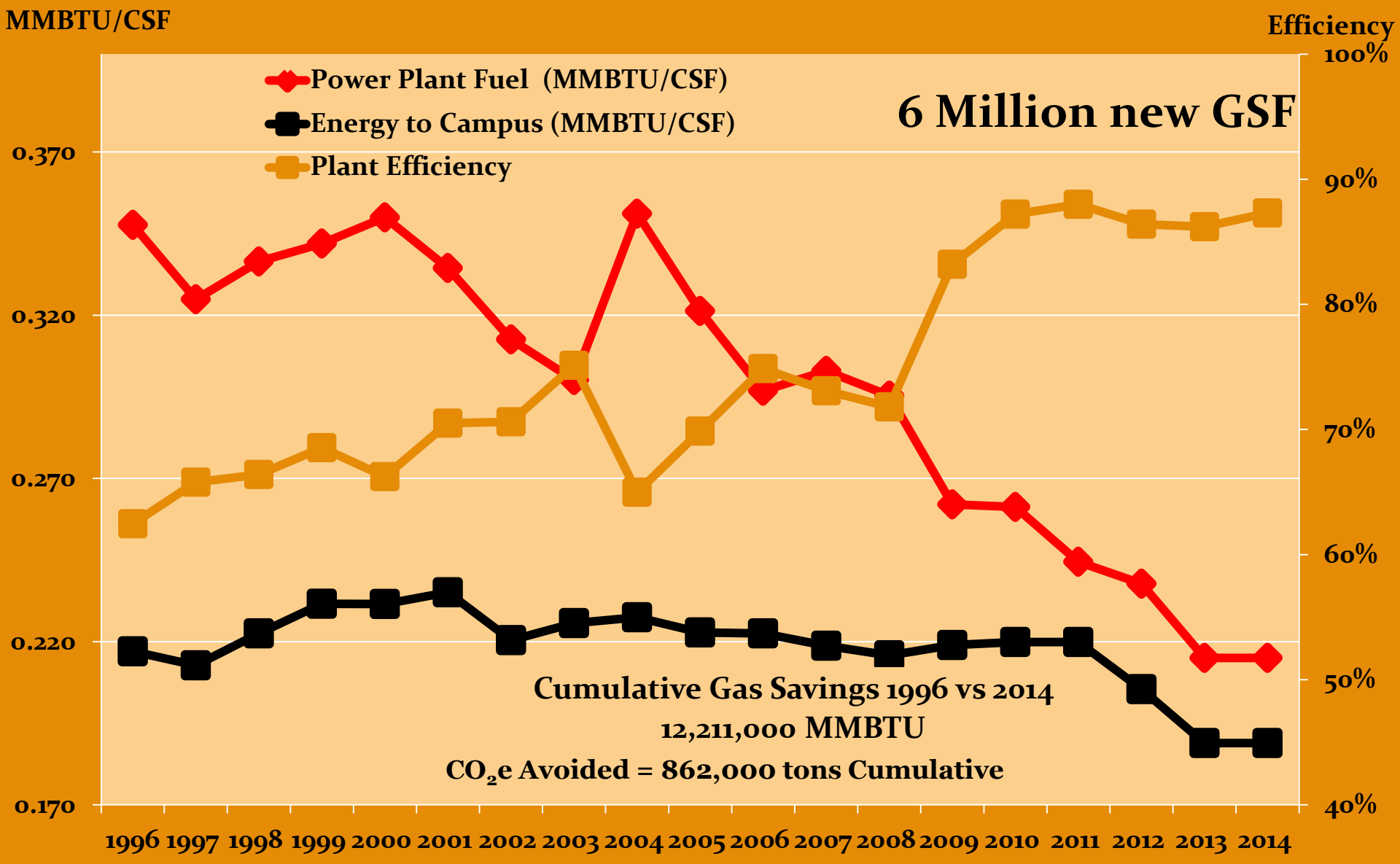
- Power Plant Equipment
- Power Augmentation/IAC
- Chilling Stations
- Thermal Energy Storage
- Steam Plant
- Auxiliary Equipment
- Energy Distribution
  - 1,000 Campus Energy Meters
  - Electrical Distribution Controls
- Billing for Energy
- Migrogrid Management
  - Load Shedding/Shifting
  - Backup Power/Plant Equipment
- Plant Health Monitoring
- Optimization Systems
- Real Time Thermal Modeling

Nuclear Power Plant Network Model



Energy Portal - Networking




MMBTU/CSF
Efficiency
Power Plant Fuel (MMBTU/CSF)
Energy to Campus (MMBTU/CSF)
Plant Efficiency
6 Million new GSF
0.370
0.320
0.270
0.220
0.170
100%
90%
80%
70%
60%
50%
40%
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Cumulative Gas Savings 1996 vs 2014
12,211,000 MMBTU
CO_2e Avoided = 862,000 tons Cumulative


University of Maryland

CampusEnergy2016 | The Changing Landscape

February 8-12, 2016 | JW Marriott Austin Hotel | Austin, TX

Workshop: Intelligent Data for a Smart, Resilient & Sustainable Campus

Strategies, Models & Tools

Tuesday February 9, 2016

ASHRAE Guideline 22-2008

ASHRAE STANDARD

Instrumentation for Monitoring Central Chilled-Water Plant Efficiency

Approved by the ASHRAE Standards Committee on January 19, 2008, and by the ASHRAE Board of Directors on January 23, 2008.

ASHRAE Guidelines are updated on a five-year cycle; the date following the Guideline is the year of approval. The latest edition of an ASHRAE Guideline may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in US and Canada).

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Accompanying CD includes electronic-format files for Guideline 22.

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

General Statistics about the University of Maryland, College Park Campus

Maryland Flagship institution for higher learning and research located on 1,300 Acres in College park, Maryland

Student population in excess of 35,000

Faculty and staff of approximately 10,000

Over 300 buildings of significance totaling 15 million square feet

Annual operating budget in excess of $1.6 Billion

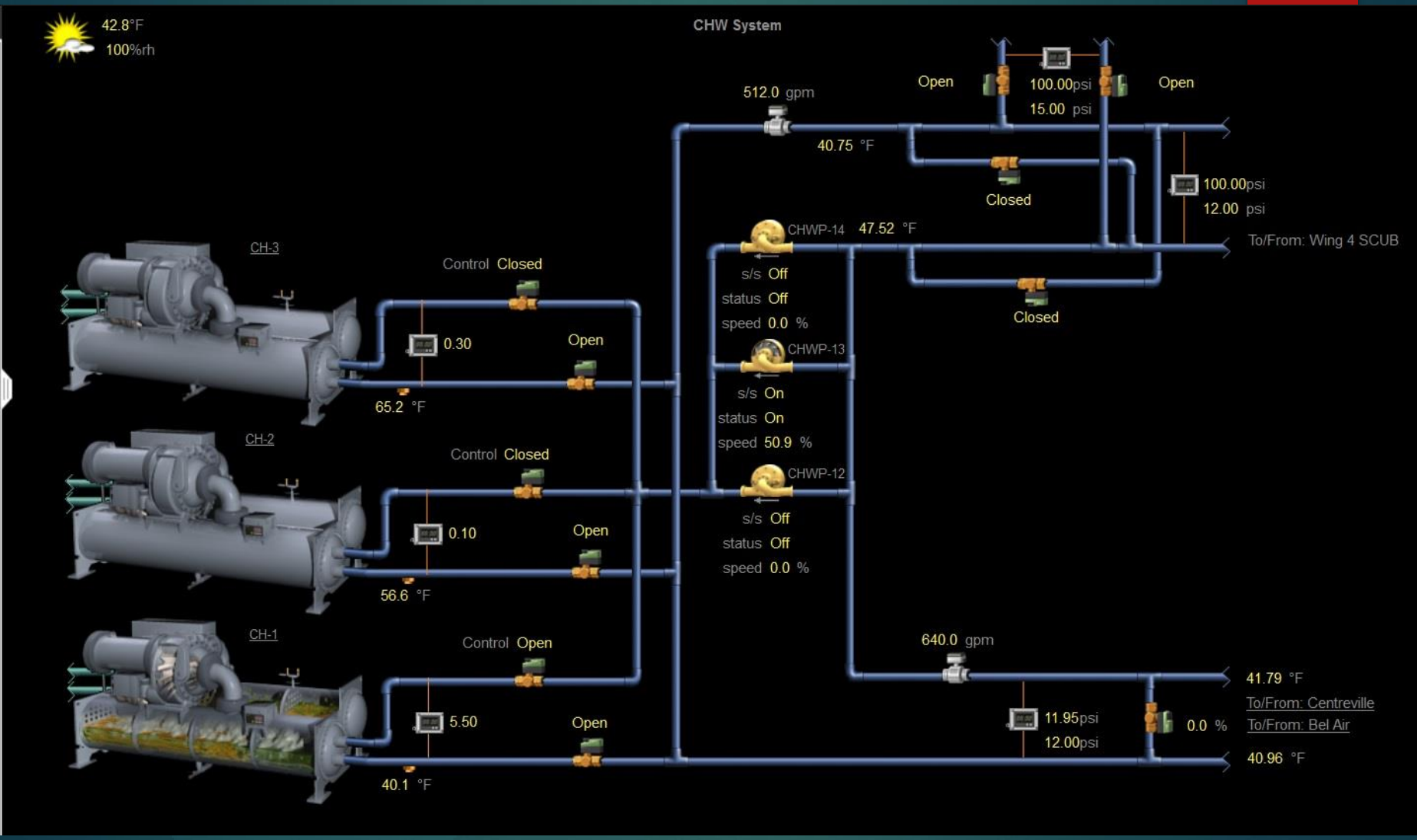
- Facilities Management Annual Budgets
  - $144 Million capital budget
  - $48 Million operating budget (FY-10)
  - $43 Million energy budget

University Infrastructure Information

- Electric – Peak Demand: 42 MW
- Steam – Peak Demand: Approximately 230,000 Lbs./HR
- Central Heating Plant;
  - Cogeneration: Qty. 2 - 11 MW Model Series GE10/1 dual fuel (NG & diesel) Generators. 1 - 5 MW Back Pressure Turbine Generator 27 Total MW capacity @ ISO conditions. Plant output nominally 20 MW summer Peak operation
  - Deltak duct fired HSRG's: Qty. 2 each @ 40K Lbs./Hr. unfired / 140K Lbs./Hr. duct-fired
  - Stand By Boilers: 1976 Union iron Works Boiler #1 – 100K Lbs./Hr. 1966 Union Iron Works Boiler 2 – 80K Lbs./Hr.
- CAMPUS Chillers
  - Multiple Satellite Central Plants: Present Firm Capacity 36,168 + 4,150 under design by 2018)
  - Estimated total 2018 with discrete systems: 42,300 Tons

University Infrastructure Utility Cost Information as of FY-16

- Electric Peak Demand: 42 MW
- Electric F&U: $16M / All-in cost $72/MWh
- Steam Peak Demand: 248 KLbs./Hr.
- Steam Utility Cost: $10M
- Water Costs: $7.37/1,000 gal
- Sanitary Cost: $10.80/1,000 gal
- Annual water & Sewer Cost: $7.5M
- Note; Approximately 50% of campus CT makeup water is sub metered by Public Utility. Agreements with Public Utility credit 73% of makeup water sewer charge and attribute 27% of makeup water to sanitary sewer blowdown


42.8°F
100%rh
CHW System
512.0 gpm
Open
100.00psi
15.00 psi
Open
40.75 °F
Closed
100.00psi
12.00 psi
To/From: Wing 4 SCUB
CHWP-14
47.52 °F
s/s Off
status Off
speed 0.0 %
Closed
CHWP-13
s/s On
status On
speed 50.9 %
CHWP-12
s/s Off
status Off
speed 0.0 %
CH-3
Control Closed
0.30
Open
65.2 °F
CH-2
Control Closed
0.10
Open
56.6 °F
CH-1
Control Open
5.50
Open
40.1 °F
640.0 gpm
41.79 °F
To/From: Centreville
To/From: Bel Air
11.95psi
12.00psi
0.0 %
40.96 °F

B224 Wing 4 Chiller Plant - Instantaneous KW

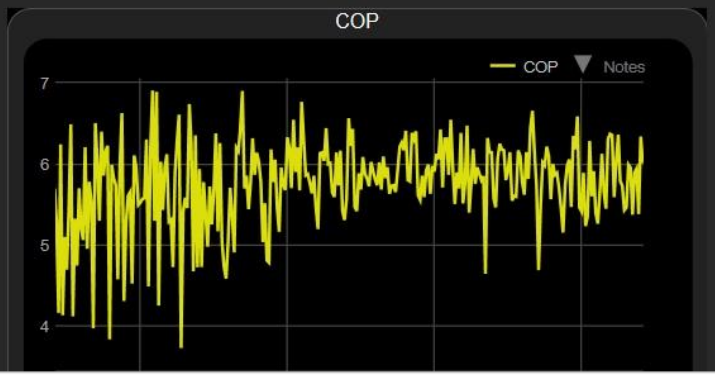
48.0 KW CH-1 SCUB 4	0.0 KW CHWP1	0.0 KW CWP1	3.3 KW CT Fan 1a
2.0 KW CH-2 SCUB 4	17.5 KW CHWP2	26.1 KW CWP2	3.5 KW CT Fan 1b
2.0 KW CH-3 SCUB 4	0.0 KW CHWP3	0.0 KW CWP2	0.0 KW CT Fan 2

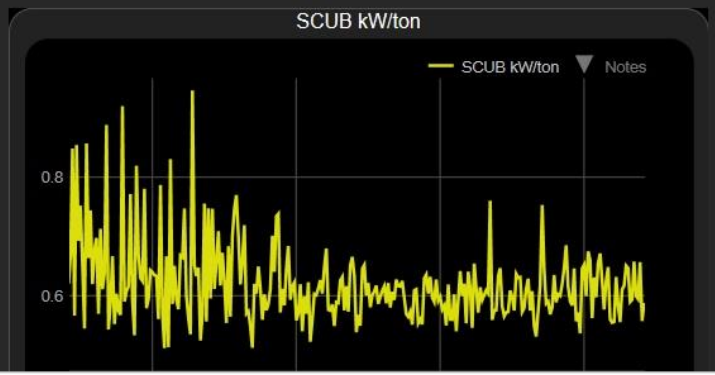
SCUB EFFICENCY

Instantaneous COP	05.70
Instantaneous KW Per Ton	00.61
15-Minute COP	05.15
15-Minute KW Per Ton	00.68

SCUB & Distribution Data

B224 W4 SCUB ECHWT	41.8 °F	41.0 °F		B224 W4 SCUB LCHWT
B224 W4 SCUB ECWT	51.5 °F	53.6 °F		B224 W4 SCUB LCWT
B415 PSC Loop CHWST	41.1 °F	41.9 °F		B224 W134 Loop CHWRT
Current SCUB Production	166 Tons	41	Tons	15-Min.SCUB Production
Total SCUB Current KW	102 Kw	28	Kwh	15-Min. Total SCUB KWH

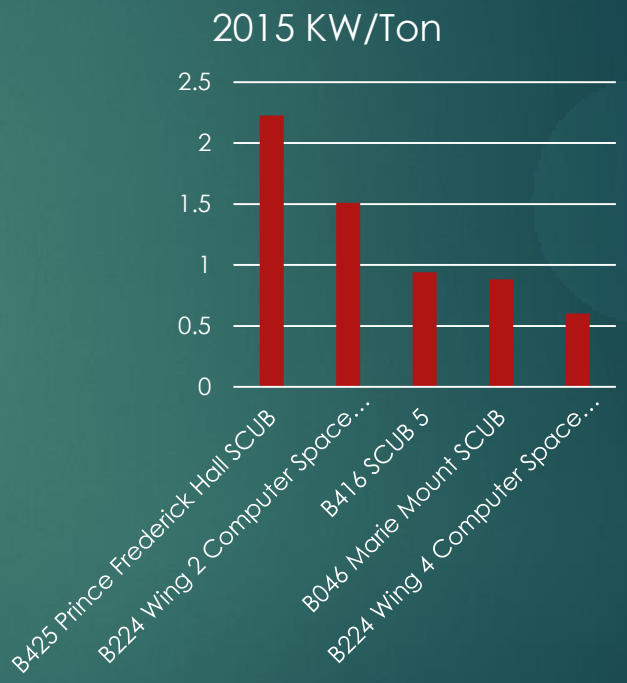




Measurement & Verification

What plants are the most efficient?

- B425 Prince Frederick Hall
- B224 Wing 2 Computer Space Science SCUB
- B416 SCUB 5
- B046 Marie Mount SCUB
- B224 Wing 4 Computer Space Science SCUB



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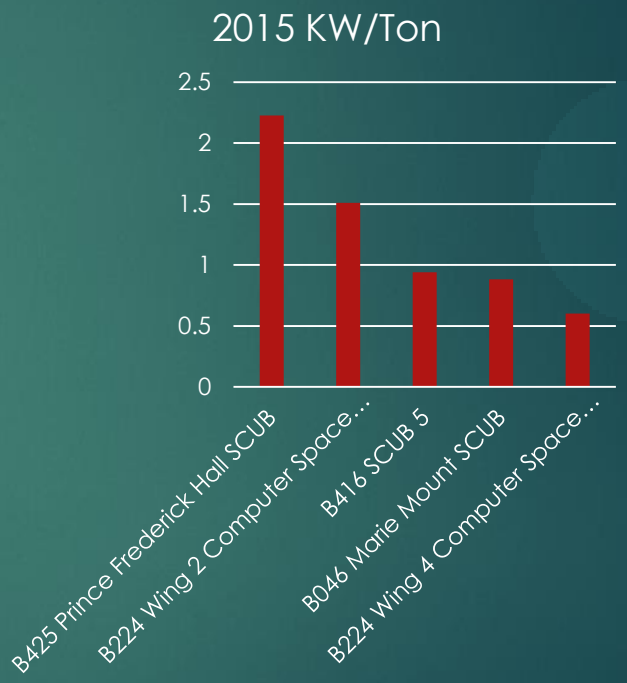



Texas A&M University

Texas A&M University

Les Williams, CEM

CampusEnergy2016: The Changing Landscape
February 8-12, 2016

UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

INTRODUCTION

Texas A&M University System Overview

Campus Size

- 58,000 students
- Over 24 million gross square feet served
- Increasing to 28 million GSF within three years

Thermal systems divided between east/west campus

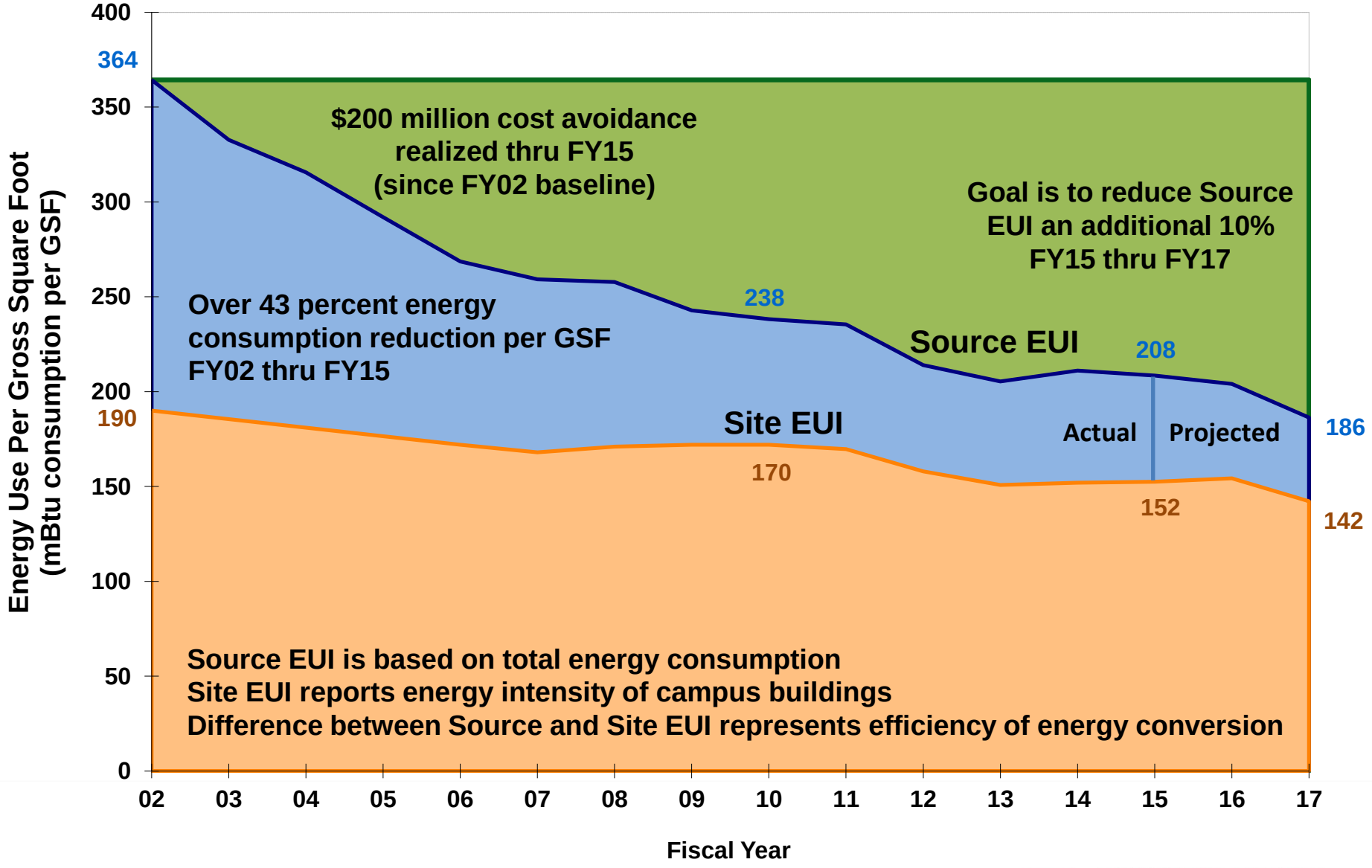
Four utility plants - CUP, SUP1, SUP2, SUP3

Capacities

- 50 MW power generation
  - 34 MW gas turbine
  - 16 MW with two steam turbines
- 60,000 ton of cooling (both electric & steam)
- 440,000 pph steam
- 450 million Btu/hr heating hot water

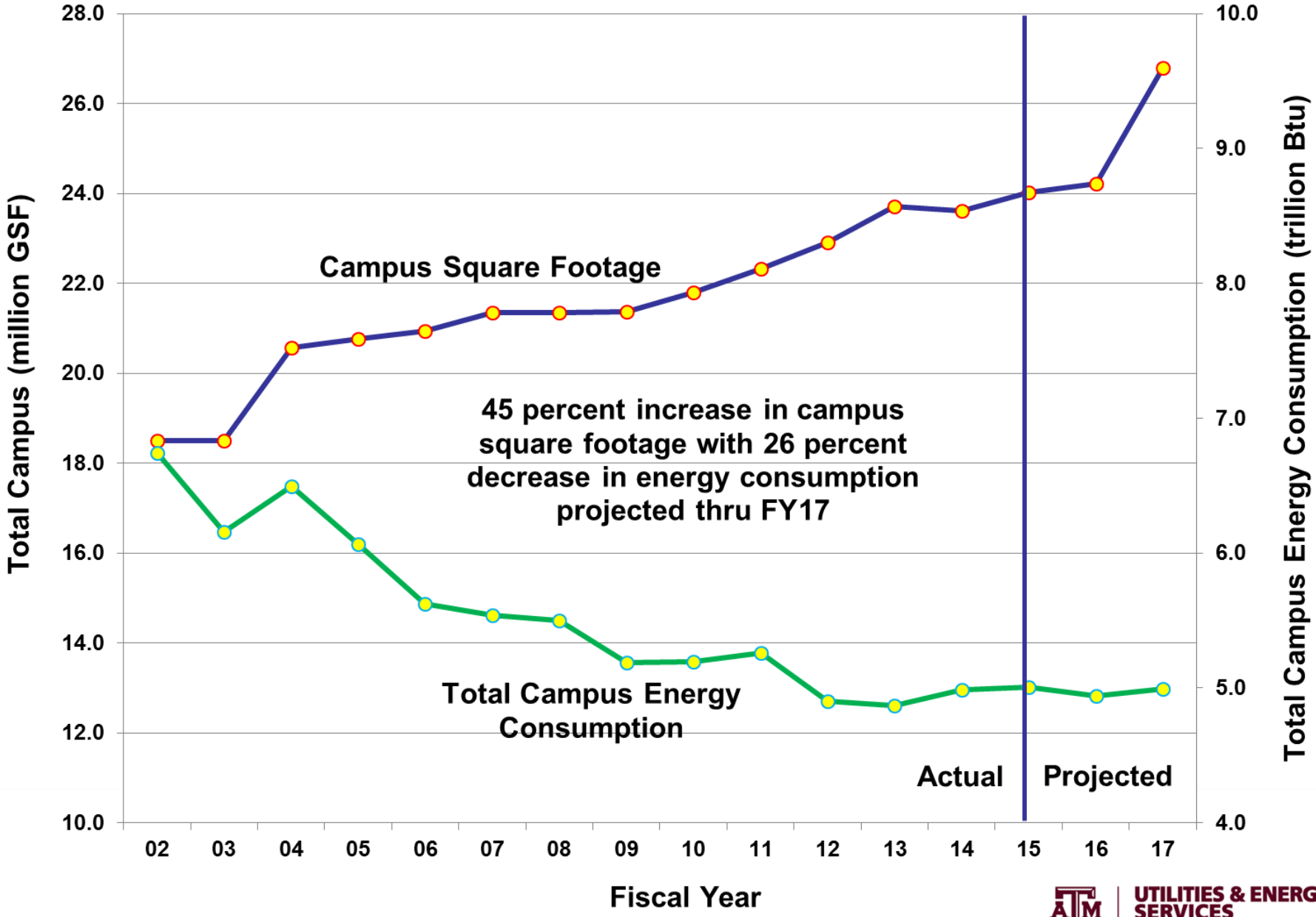
Energy Use Intensity (Energy Consumption per GSF)

Texas A&M University, College Station, Texas



Campus Size vs Energy Consumption

Texas A&M University, College Station, Texas



DATA COLLECTION

Texas A&M University System Overview

Plant Systems

- Emerson Ovation System – 57,000 points

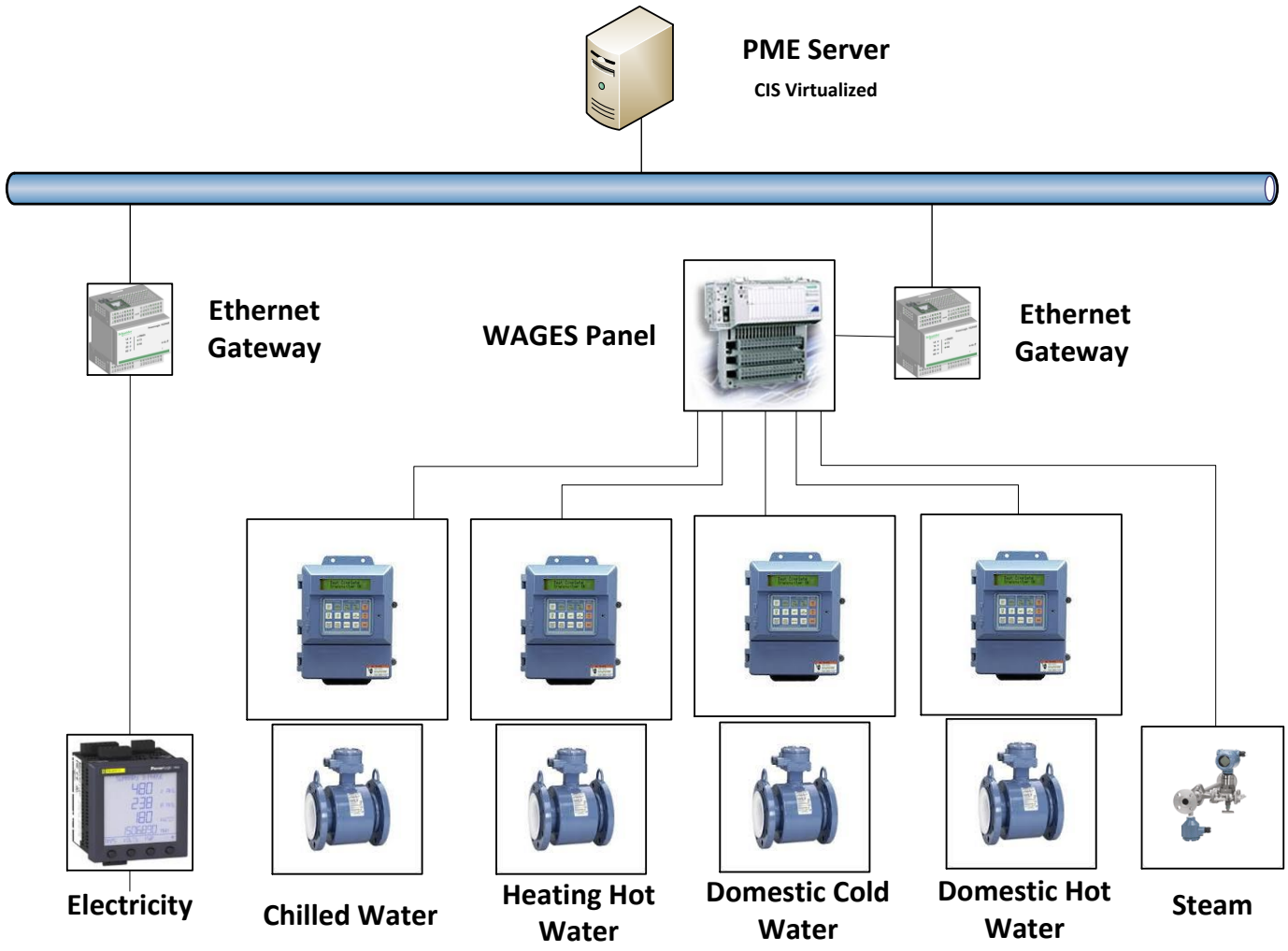
Building Control Systems

- Siemens – 400,000 + points
- Johnson Controls – 57,000 points

Metering System

- Schneider WAGES
- Mag Meters – 1,500
- Electric meters – 2,300

TYPICAL METERING INSTALLATION



THERMAL SYSTEM REPORTING

UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

Main Campus Chilled Water Loop Supply Temperature Performance

Plant Loop: CUP EAST Date: 1/28/2016

TIME	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	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
OAT	42	37	36	36	36	34	33	35	43	48	54	60	63	66	68	69	68	65	59	55	53	53	54	55
SET POINT	45.8	46.0	46.0	46.0	46.0	46.0	46.0	46.0	45.7	45.2	44.6	44.0	43.7	43.4	43.2	43.1	43.2	43.5	44.1	44.5	44.7	44.7	44.6	44.5
SUPPLY (°F)	45.2	45.2	45.2	45.3	45.2	45.2	45.4	45.6	45.8	45.5	44.9	44.3	44.0	43.7	43.5	43.4	43.5	43.8	44.3	44.7	44.8	44.7	44.6	44.5

Not Scheduled

0434	LUEDECKE BUILDING (CYCLOTRO	63.6	64.1	64.5	64.9	65.2	65.7	66.1	66.4	66.8	67.1	67.4	67.7	68.0	68.3	55.0	44.0	43.7	43.5	43.5	43.6	44.1	44.7	44.9	44.8
0477	ANTHROPOLOGY BUILDING	43.9	44.2	44.3	44.1	44.3	44.2	44.1	44.0	44.0	44.1	44.2	44.1	44.1	44.0	44.0	43.9	43.8	43.8	43.9	44.0	44.1	44.1	44.1	44.1
0740	MCNEW LABORATORY	45.4	45.4	45.4	45.5	45.5	45.5	45.5	45.5	45.6	45.9	46.0	45.9	45.3	44.7	44.3	44.0	43.8	43.7	43.7	43.9	44.2	44.6	44.3	44.2

Scheduled

0499	GRAPHIC SERVICES	45.1	45.1	45.2	45.1	45.2	45.2	45.2	45.3	45.6	45.6	45.5	44.9	44.3	44.0	43.6	43.4	43.3	43.5	43.7	44.2	44.6	44.7	44.6	44.6
0436	REED-MCDONALD BUILDING	45.2	45.1	45.2	45.2	45.3	45.2	45.2	45.3	45.6	45.7	45.5	44.9	44.4	44.0	43.7	43.4	43.4	43.5	43.7	44.3	44.7	44.8	44.7	44.7
0490	HALBOUTY GEOSCIENCES BUILDI	45.4	45.4	45.5	45.5	45.5	45.5	45.5	45.5	45.7	45.9	45.9	45.6	45.0	44.5	44.2	43.9	43.7	43.7	43.9	44.2	44.8	45.1	45.0	45.0
0524	BLOCKER BUILDING	45.2	45.3	45.4	45.4	45.4	45.4	45.4	45.3	45.6	45.6	45.8	45.2	44.7	44.2	43.8	43.6	43.4	43.5	43.6	44.1	44.6	44.9	44.8	44.8
0513	DOHERTY BUILDING	45.1	45.1	45.1	45.2	45.2	45.2	45.2	45.2	45.3	45.5	45.7	45.7	45.1	44.6	44.1	43.8	43.5	43.4	43.4	43.6	44.1	44.6	44.8	44.7
0391	JAMES J. CAIN '51 BUILDING	44.8	44.8	44.8	44.8	44.9	44.8	44.8	44.9	45.2	45.2	45.1	44.5	44.0	43.6	43.3	43.1	43.0	43.2	43.4	43.9	44.4	44.4	44.3	44.3
0492	CIVIL ENGINEERING BUILDING	45.4	45.5	45.5	45.5	45.5	45.5	45.5	45.6	45.9	46.0	45.9	45.4	44.8	44.4	44.1	43.9	43.8	43.8	43.9	44.2	44.6	44.4	44.3	44.3
0270	EMERGING TECHNOLOGY BUILDIN	47.4	47.4	47.5	47.6	47.6	47.6	47.6	47.6	47.5	47.2	47.0	46.7	46.4	46.3	46.0	45.8	45.6	45.5	45.4	45.4	45.5	45.7	45.9	46.1
0385	CE/TTI OFFICE & LAB BUILDIN	46.5	46.4	46.4	46.4	46.4	46.4	45.8	45.7	45.9	46.1	46.1	45.5	45.0	44.5	44.2	43.9	43.8	43.8	44.0	44.7	45.2	45.7	45.8	45.9
0682	WISENBAKER ENGINEERING RESE	45.7	45.7	45.7	45.8	45.8	45.8	45.8	45.8	46.0	46.2	46.3	45.9	45.3	44.8	44.4	44.1	44.0	43.9	44.1	44.3	44.7	44.8	44.4	44.5
0387	JOE C. RICHARDSON PETROLEUM	43.7	44.2	45.3	45.3	45.4	45.1	45.3	45.4	45.4	45.6	45.8	45.9	45.4	44.9	44.4	44.1	43.9	43.5	43.4	43.5	43.5	43.6	43.6	43.5

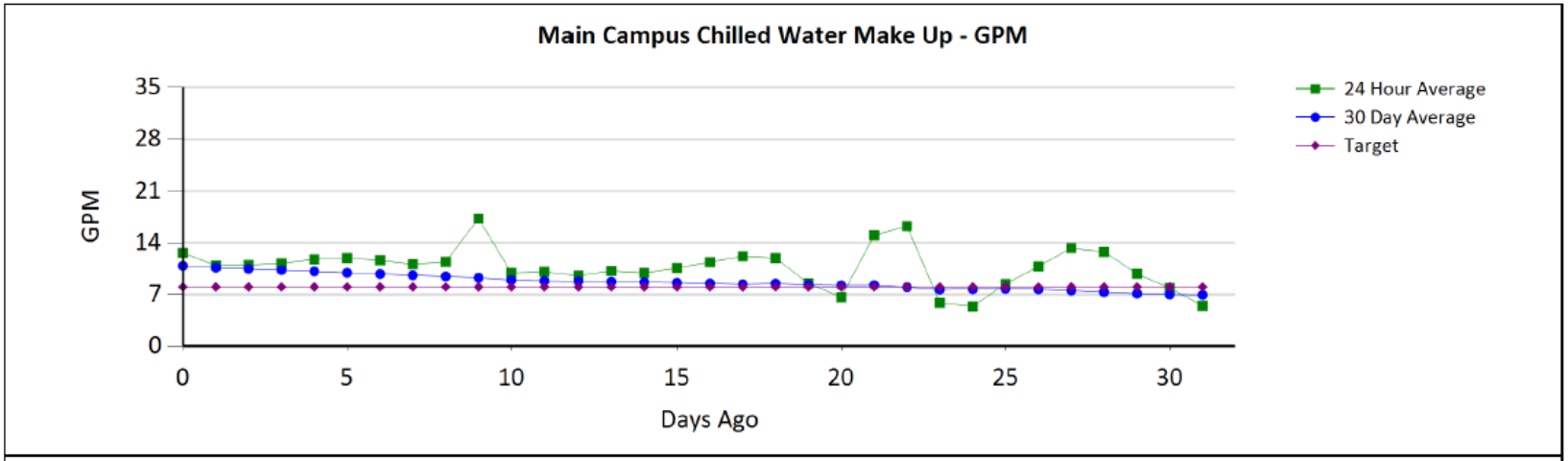
No Sample Reading | +/- 1 F from target | >1 F and < or = 2 F from target | >2 F from target

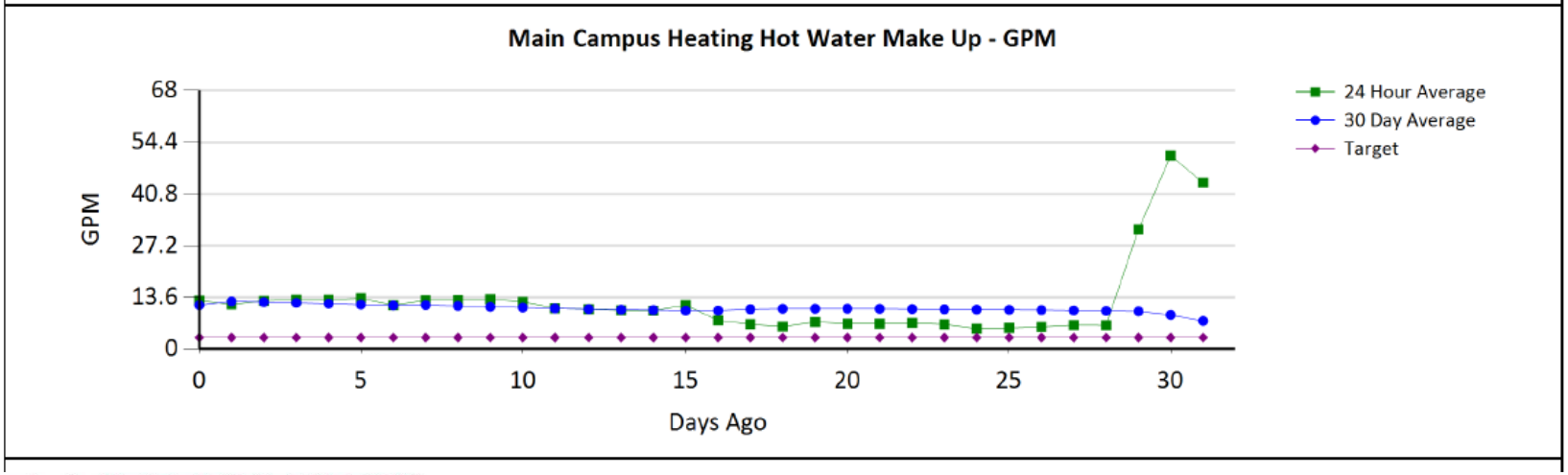
LOOP MAKE UP REPORTING

UTILITIES & ENERGY SERVICES
TEXAS A&M UNIVERSITY

Thermal Systems Makeup Water Performance

for: 1/28/2016 6:00:00 AM



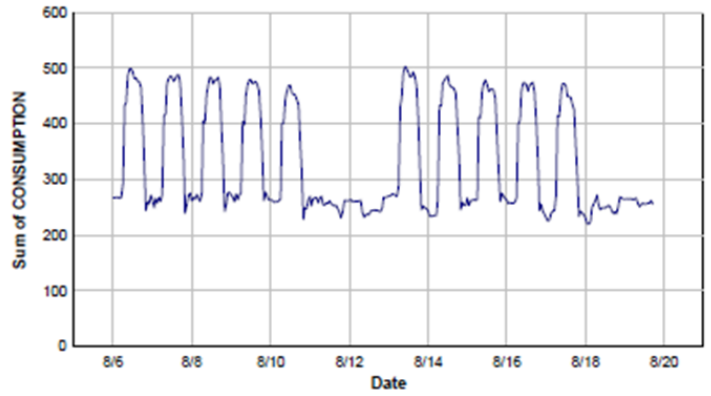


BUILDING EFFICIENCY REPORT

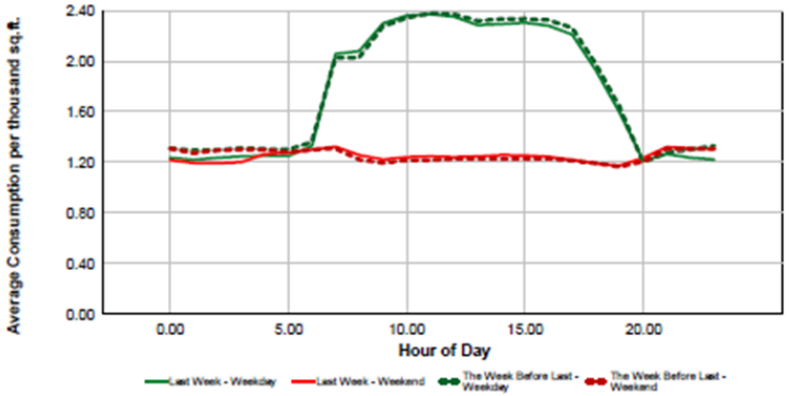
Last Two Weeks Profile Summary for Bldg 1800 GENERAL SERVICES COMPLEX

Electricity in kWh

Consumption Profile

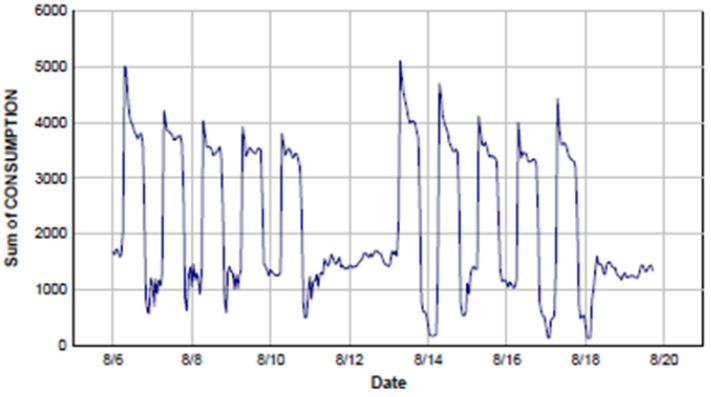


Average Consumption per thousand sq.ft. Profile

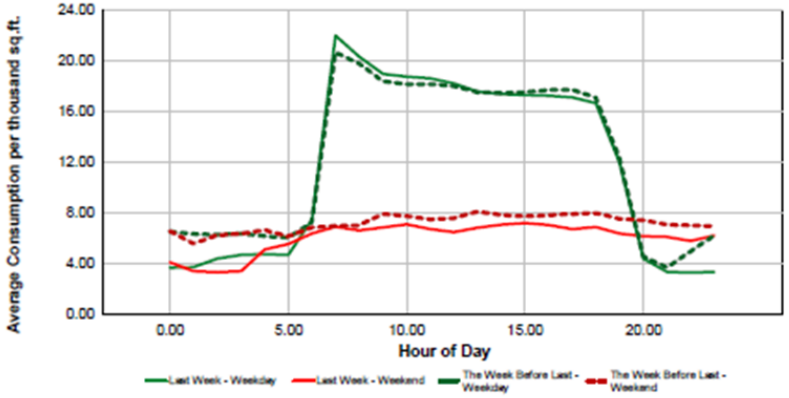


Chilled Water in mBtu

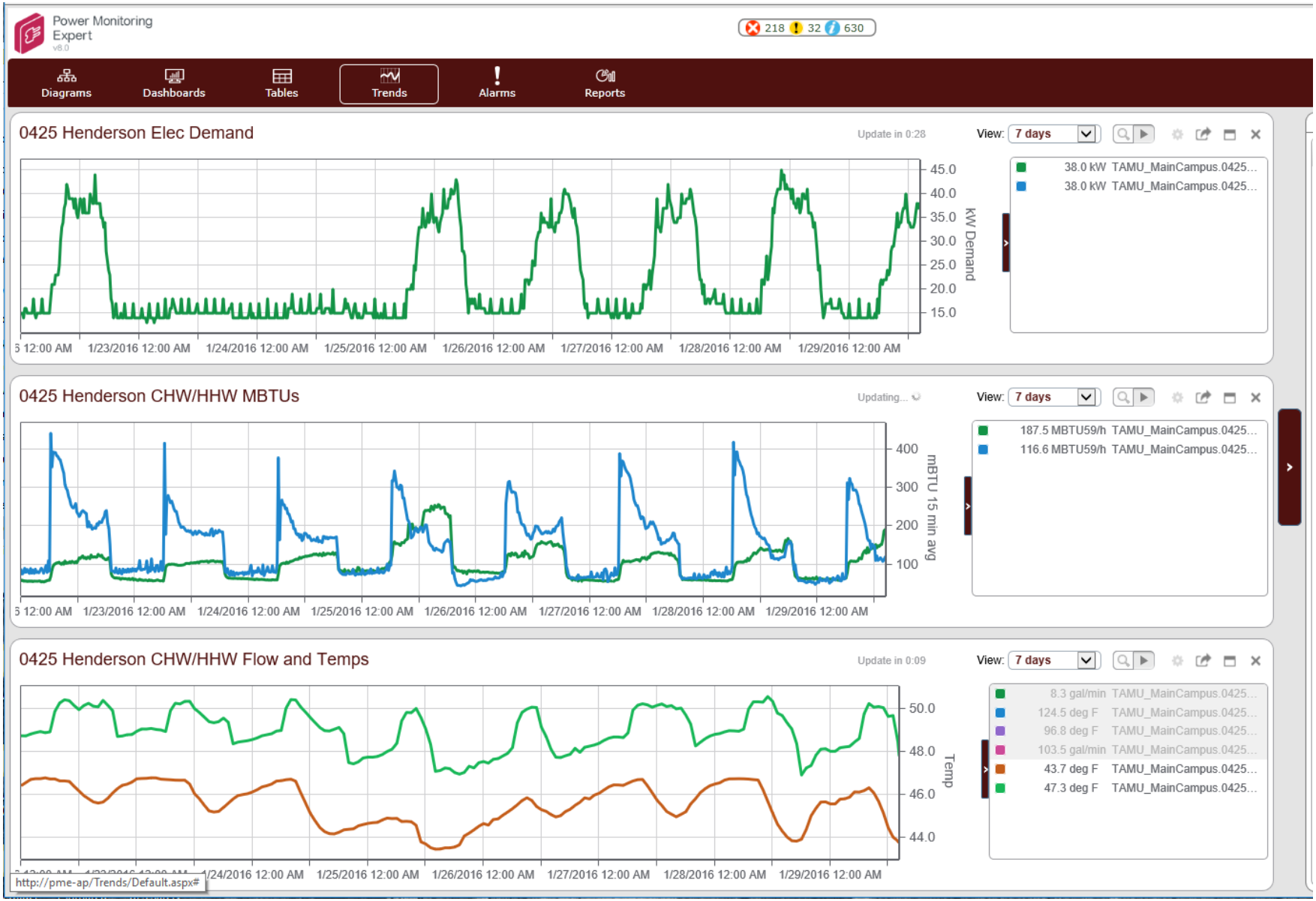
Consumption Profile



Average Consumption per thousand sq.ft. Profile



POWER MONITORING EXPERT (PME)



UTILITIES & ENERGY SERVICES

TEXAS A&M UNIVERSITY

Panel Discussion

Data for a Smart, Resilient & Sustainable Campus


Panel Discussion
Please join in thanking our panelists


CampusEnergy2016
The Changing Landscape
Conference & Trade Show
Austin, Texas | February 8 – 12, 2016
INTERNATIONAL DISTRICT ENERGY ASSOCIATION