We'll be starting in just a few minutes….

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Better Buildings®
U.S. DEPARTMENT OF ENERGY

Succeed with Submetering: How to Make the Business Case

August 4, 2020

1:00 – 2:00 pm EDT

U.S. DEPARTMENT OF ENERGY

Cedar Blazek

Project Manager, Commercial Buildings Integration

U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY

Why Focus on Submetering?

Wireless metering system during installation for communications test.

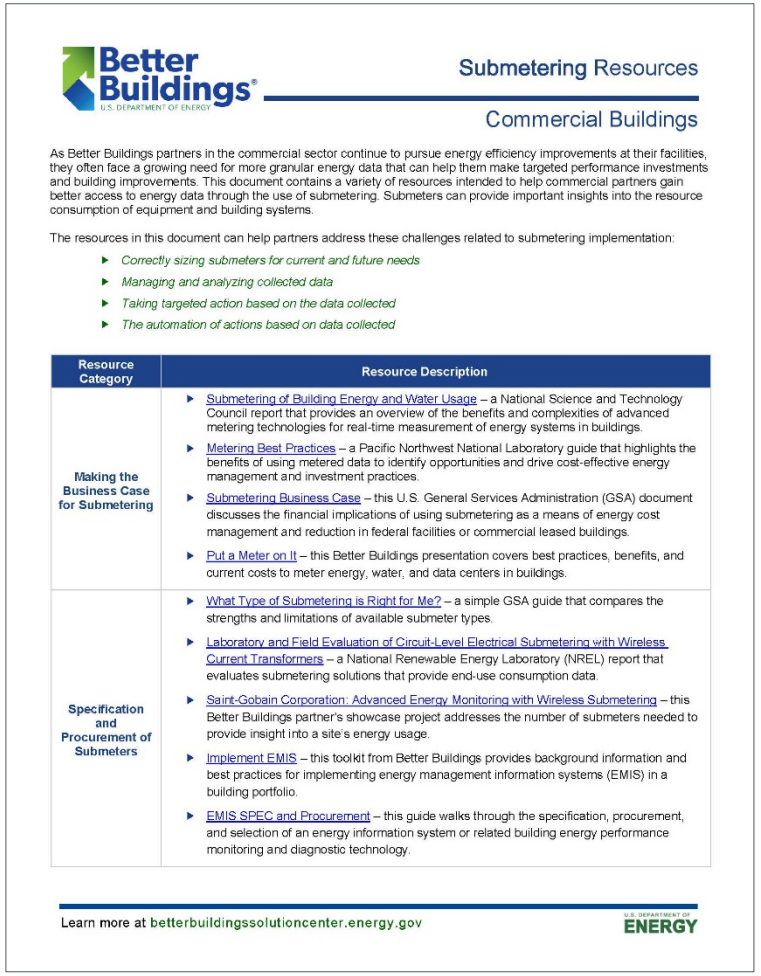
"You can't manage what you don't measure"

Commercial Buildings – FY2020 Sector Priorities

Access to more granular energy data to make targeted performance investments & improvements

Compile submetering resources

Webinar on submetering resources/case studies



Better Buildings U.S. DEPARTMENT OF ENERGY

Submetering Resources

Commercial Buildings

As Better Buildings partners in the commercial sector continue to pursue energy efficiency improvements at their facilities, they often face a growing need for more granular energy data that can help them make targeted performance investments and building improvements. This document contains a variety of resources intended to help commercial partners gain better access to energy data through the use of submetering. Submeters can provide important insights into the resource consumption of equipment and building systems.

The resources in this document can help partners address these challenges related to submetering implementation:

- *Correctly sizing submeters for current and future needs*
- *Managing and analyzing collected data*
- *Taking targeted action based on the data collected*
- *The automation of actions based on data collected*

Resource Category	Resource Description
Making the Business Case for Submetering	▸ Submetering of Building Energy and Water Usage – a National Science and Technology Council report that provides an overview of the benefits and complexities of advanced metering technologies for real-time measurement of energy systems in buildings. ▸ Metering Best Practices – a Pacific Northwest National Laboratory guide that highlights the benefits of using metered data to identify opportunities and drive cost-effective energy management and investment practices. ▸ Submetering Business Case – this U.S. General Services Administration (GSA) document discusses the financial implications of using submetering as a means of energy cost management and reduction in federal facilities or commercial leased buildings. ▸ Put a Meter on It – this Better Buildings presentation covers best practices, benefits, and current costs to meter energy, water, and data centers in buildings.
Specification and Procurement of Submeters	▸ What Type of Submetering is Right for Me? – a simple GSA guide that compares the strengths and limitations of available submeter types. ▸ Laboratory and Field Evaluation of Circuit-Level Electrical Submetering with Wireless Current Transformers – a National Renewable Energy Laboratory (NREL) report that evaluates submetering solutions that provide end-use consumption data. ▸ Saint-Gobain Corporation: Advanced Energy Monitoring with Wireless Submetering – this Better Buildings partner's showcase project addresses the number of submeters needed to provide insight into a site's energy usage. ▸ Implement EMIS – this toolkit from Better Buildings provides background information and best practices for implementing energy management information systems (EMIS) in a building portfolio. ▸ EMIS SPEC and Procurement – this guide walks through the specification, procurement, and selection of an energy information system or related building energy performance monitoring and diagnostic technology.

Learn more at betterbuildingssolutioncenter.energy.gov

U.S. DEPARTMENT OF ENERGY

https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Submetering%20Resources%20List_FINAL.pdf

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Enter Event Code

#DOE

Poll #1

What industry do you represent?

End-Users should select the applicable sector

Please go to www.slido.com and enter code #DOE to respond

Agenda

1. Maryland Department of General Services
2. Towson University
3. Argonne National Lab
4. Q&A using Slido

Today's Presenters

David St. Jean
Maryland Department of General Services

Steve Kolb
Towson University

Ted Bohn
Argonne National Lab

David St. Jean

Maryland Department of General Services

Submit Questions
www.slido.com event code **#DOE**

U.S. DEPARTMENT OF ENERGY

Maryland
DEPARTMENT OF
GENERAL SERVICES

Building Level Submetering

Getting Started

CHANGING
Maryland
for the Better

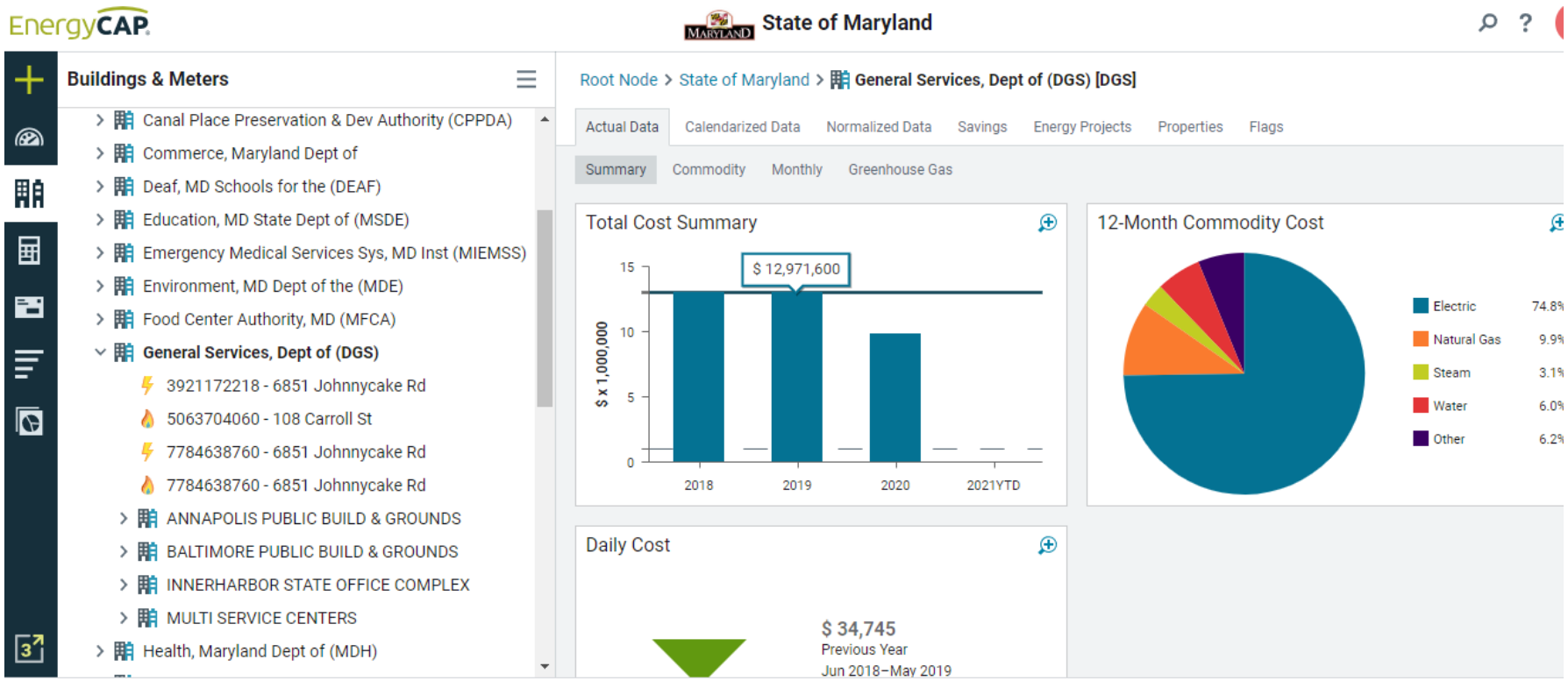
DEPARTMENT OF GENERAL SERVICES – OFFICE OF ENERGY AND SUSTAINABILITY

- MARYLAND ENERGY DATABASE
  https://dgs.maryland.gov/Pages/Energy/Database/index.aspx

- Twelve year old database of utility bill data
  - Initially created to help the State with energy hedging strategies
    - Monthly energy usage data for all fuel types based on utility billing
    - 2008 - Launch of State-Wide Database
    - 15,400 - Active Utility Accounts Tracked
    - 120 - Accounts Payable that DGS Monitors
    - 14,800 - Utility Meters Tracked
    - 1.9 Million - Utility Invoices Tracked since 2007
    - 11,000 - Utility Invoices Processed Monthly
    - 300+ Registered Users

  - The last two years moving towards an energy management tool
    - Collecting data on building size, age, primary use, etc.
    - Developing the ability to store submetered data as well.

State Energy Database



MARYLAND METER FACTS

Maryland
DEPARTMENT OF GENERAL SERVICES

- 79% of MD's 7,000+ State-owned buildings are on a master-metered campus
- 21% are independently metered by the utility

- OWNING A BUILDING WITH NO METER IS LIKE BUYING A CAR WITH NO GAS GUAGE OR SPEEDOMETER

Why now?

- June 2019 Governor Hogan issued Executive Order establishing a 10-year energy saving goal for State-owned buildings.

- EO requires DGS to track savings from efficiency projects associated with the EO

Submetering RFP

- 2020 DGS issued an RFP to hire submetering firms to install building-level submeters for all energy types – steam, chilled water, natural gas, electricity, water, etc.
- The winning firms compete against each other for individual projects.
- The stated purpose of the RFP is to give the State the ability to determine EUIs for each building metered.
- “Projects shall include system design, equipment purchase, installation, connection, calibration, commissioning, warranty services, maintenance, and support services for meter systems to include all energy types and water on State-owned buildings.”
- Contract requires the firms to send at a minimum monthly data from the meters to the State Utility Database

First Project: Annapolis Capitol Complex

Maryland
DEPARTMENT OF GENERAL SERVICES

- 20 buildings – 2 million square feet
- $3.8 million utility spend in 2019
- Central plant with steam and chilled water district loop

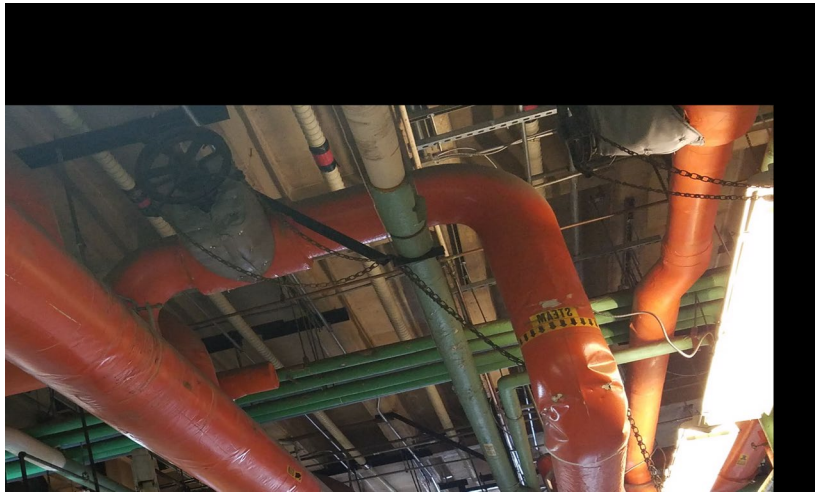
- Meter Plan
- Paid a separate engineering consulting firm to draft a Meter Plan
- 252 pages of details on meter locations and types with dozens of pictures

- Kick-off meeting held in June
- Site visits in July
- Final proposals received late July

Maryland
DEPARTMENT OF GENERAL SERVICES

Meter Schedule

Service	QTY	Line Size	Equip Served	Estimated Design Flow	Min Flow	Max Flow	Accuracy	Meter Type	Turn-down	Note
Natural Gas	1	6"	Steam Boilers	50,000 CFH	650 CFH	65,000 CFH	±2.0%	Thermal Dispersion Meter	100:1	1,7-11
Fuel Oil Supply & Return	2	2 1/2"	Steam Boilers	1,000 GPH	50 GPH	2,000 GPH	±0.5%	Positive Displacement	50:1	2,7-11
Steam	1	16"	District Loop	45,000 LBS/HR	2,000 LBS/HR	60,000 LBS/HR	±2.0%	Insertion Turbine Meter	30:1	3,7-11
Steam Condensate	1	6"	District Loop	90 GPM	5 GPM	900 GPM	±1.0%	Clamp-On Ultrasonic	200:1	4,7-11
Heating Water Supply & Return	1	4"	Entire Bldg.	200 GPM	5 GPM	500 GPM	±1.0%	Clamp-On Ultrasonic	200:1	5,7-11
Chilled Water Supply & Return	1	16"	District Loop	5,000 GPM	50 GPM	10,000 GPM	±1.0%	Clamp-On Ultrasonic	200:1	5,7-11
Chilled Water Supply & Return	1	8"	Entire Bldg.	1,000 GPM	5 GPM	2,500 GPM	±1.0%	Clamp-On Ultrasonic	200:1	6,7-11
City Water	1	4"	Entire Bldg.	200 GPM	5 GPM	500 GPM	±1.0%	Clamp-On Ultrasonic	200:1	6,7-11



Poll #2

If you are an end-user, what is the biggest barrier to installing sub-meters in all of your facilities?

Please go to www.slido.com and enter code #DOE to respond

Steve Kolb

Towson University

Submit Questions
www.slido.com event code **#DOE**

U.S. DEPARTMENT OF ENERGY

Towson University—By The Numbers

- 6 million square feet & growing
- 24,000 students/5,000 faculty & staff
- 58+ buildings
- 70 million kWh annual consumption
- 250 meters connected to BAS, appx. 350 electric, natural gas, Chilled Water, Domestic Water, and Steam
- 12,000 tons of cooling capacity—increasing to 15,000 tons
- 100,000 pounds/hr. boiler capacity at Central Plant
- 2.5 million therms annual consumption
- 140 million gallons of water annual consumption

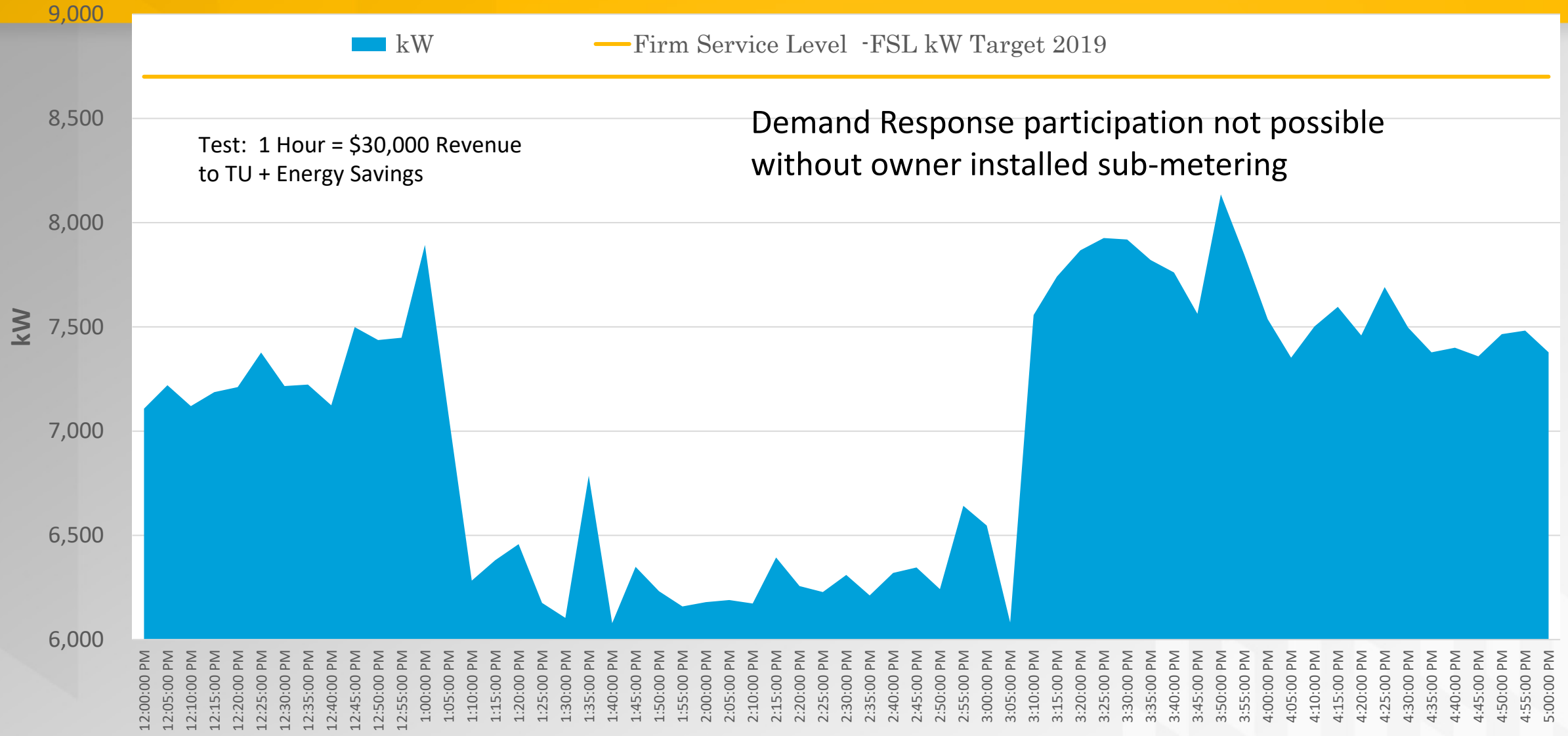
Towson University Sub-Metering Strategy

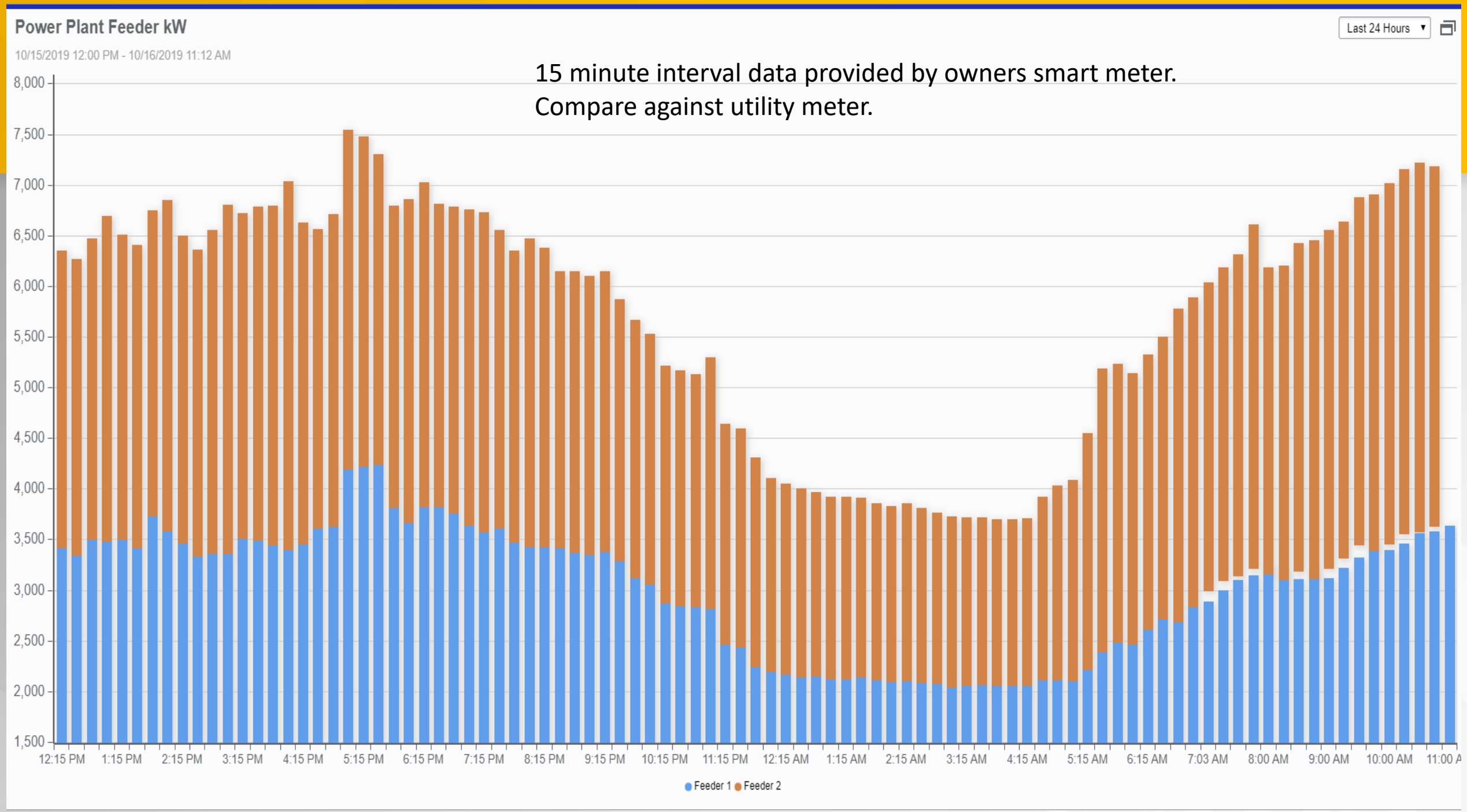
TOWSON UNIVERSITY

- Secure annual metering funds
- Owner installed Sub-Metering must be a priority ---it is one of the most important components in any energy program
- We should not depend on utility meters for billing, trending, analysis, back-charges, etc.
- All fuels and water should be metered—ultimately at the building level at a minimum
- All metering must be connected to a BAS or a Metering Network System
- Metering data must be analyzed, verified, questioned, reviewed!
- Budget adequate funds for BAS connected, quality (revenue grade) metering:
  - Electric $5K to $10K per meter, Steam $5K to $50, Chilled Water $5K to $25K
  - Domestic and Cooling Tower Water $1K to $10K

TU Demand Response Test Event - June 27, 2019

Demand Response

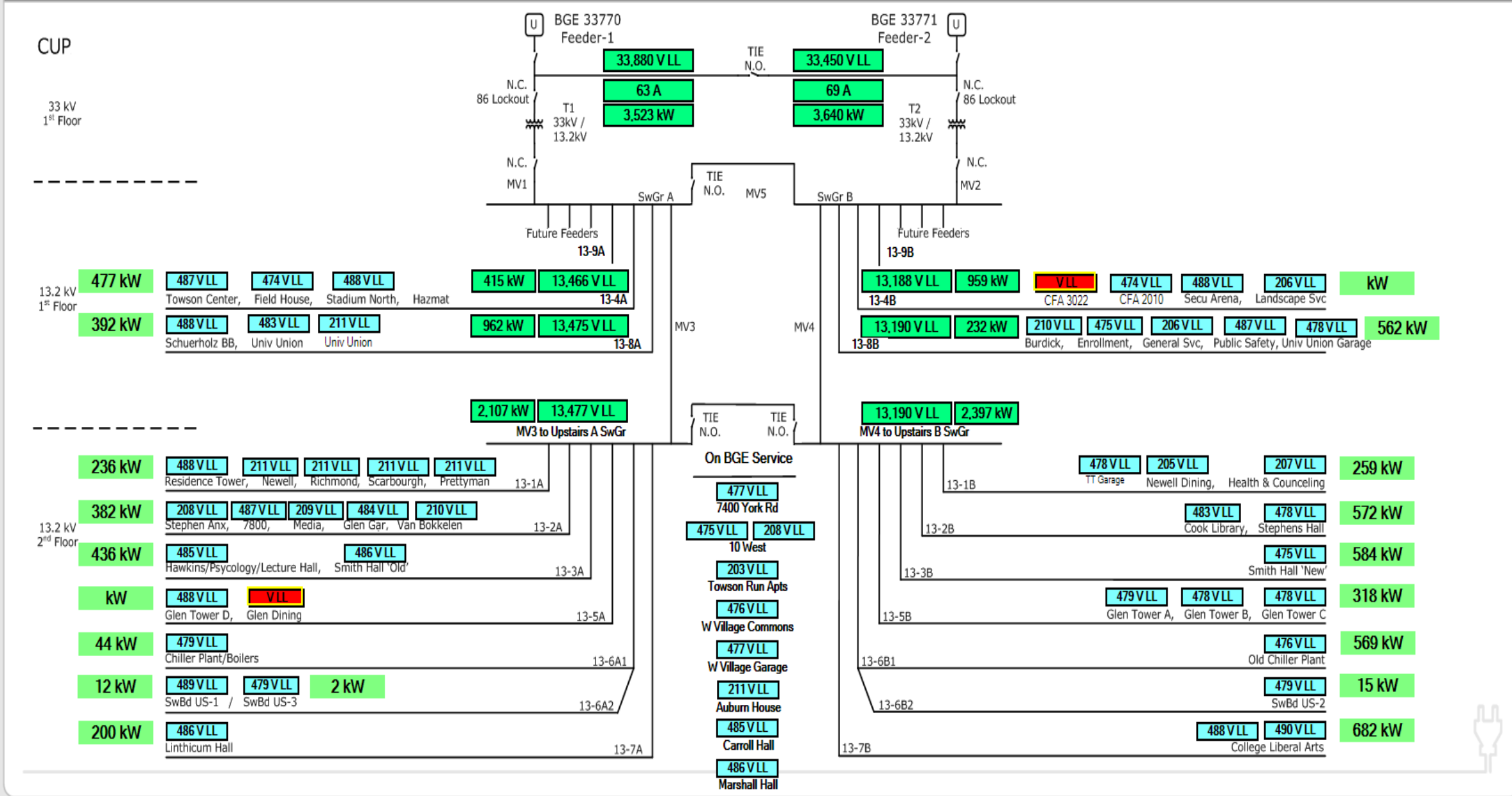



Power Plant Feeder kW
10/15/2019 12:00 PM - 10/16/2019 11:12 AM
Last 24 Hours
15 minute interval data provided by owners smart meter.
Compare against utility meter.
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
12:15 PM
1:15 PM
2:15 PM
3:15 PM
4:15 PM
5:15 PM
6:15 PM
7:15 PM
8:15 PM
9:15 PM
10:15 PM
11:15 PM
12:15 AM
1:15 AM
2:15 AM
3:15 AM
4:15 AM
5:15 AM
6:15 AM
7:03 AM
8:00 AM
9:00 AM
10:00 AM
11:00 A
Feeder 1
Feeder 2

Schneider Electric Metering Throughout the Campus

All electric building level metering connected to Schneider PME Network

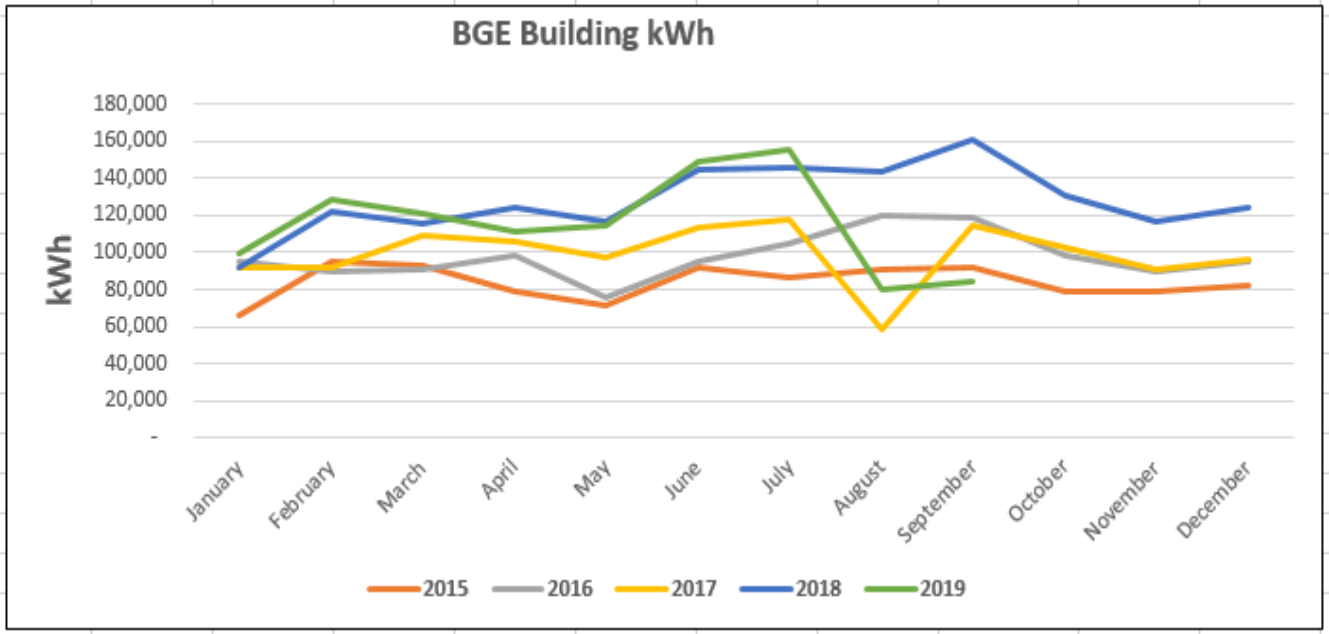
MV 33kV


CUP
33 kV
1st Floor
BGE 33770
Feeder-1
33,880 V LL
63 A
3,523 kW
TIE
N.O.
BGE 33771
Feeder-2
33,450 V LL
69 A
3,640 kW
N.C.
86 Lockout
T1
33kV /
13.2kV
T2
33kV /
13.2kV
N.C.
MV1
MV2
TIE
N.O.
MV5
SwGr A
SwGr B
Future Feeders
13-9A
13-9B
13.2 kV
1st Floor
477 kW
487 V LL
Towson Center,
474 V LL
Field House,
488 V LL
Stadium North,
Hazmat
415 kW
13,466 V LL
13-4A
392 kW
488 V LL
Schuerholz BB,
483 V LL
Univ Union
211 V LL
Univ Union
962 kW
13,475 V LL
13-8A
MV3
MV4
13,188 V LL
959 kW
13-4B
V LL
CFA 3022
474 V LL
CFA 2010
488 V LL
Secu Arena,
206 V LL
Landscape Svc
kW
13,190 V LL
232 kW
13-8B
210 V LL
Burdick,
475 V LL
Enrollment,
206 V LL
General Svc,
487 V LL
Public Safety,
478 V LL
Univ Union Garage
562 kW
2,107 kW
13,477 V LL
MV3 to Upstairs A SwGr
TIE
N.O.
TIE
N.O.
13,190 V LL
2,397 kW
MV4 to Upstairs B SwGr
On BGE Service
477 V LL
7400 York Rd
475 V LL
208 V LL
10 West
203 V LL
Towson Run Apts
476 V LL
W Village Commons
477 V LL
W Village Garage
211 V LL
Auburn House
485 V LL
Carroll Hall
486 V LL
Marshall Hall
236 kW
488 V LL
Residence Tower,
211 V LL
Newell,
211 V LL
Richmond,
211 V LL
Scarbourgh,
211 V LL
Prettyman
13-1A
382 kW
208 V LL
Stephen Anx,
487 V LL
7800,
209 V LL
Media,
484 V LL
Glen Gar,
210 V LL
Van Bokkelen
13-2A
13.2 kV
2nd Floor
436 kW
485 V LL
Hawkins/Psycology/Lecture Hall,
486 V LL
Smith Hall 'Old'
13-3A
kW
488 V LL
Glen Tower D,
V LL
Glen Dining
13-5A
44 kW
479 V LL
Chiller Plant/Boilers
13-6A1
12 kW
489 V LL
SwBd US-1 /
479 V LL
SwBd US-3
2 kW
13-6A2
200 kW
486 V LL
Linthicum Hall
13-7A
13-1B
478 V LL
TT Garage
205 V LL
Newell Dining,
207 V LL
Health & Counceling
259 kW
13-2B
483 V LL
Cook Library,
478 V LL
Stephens Hall
572 kW
13-3B
475 V LL
Smith Hall 'New'
584 kW
13-5B
479 V LL
Glen Tower A,
478 V LL
Glen Tower B,
478 V LL
Glen Tower C
318 kW
13-6B1
476 V LL
Old Chiller Plant
569 kW
13-6B2
479 V LL
SwBd US-2
15 kW
13-7B
488 V LL
490 V LL
College Liberal Arts
682 kW

Bills

kWh

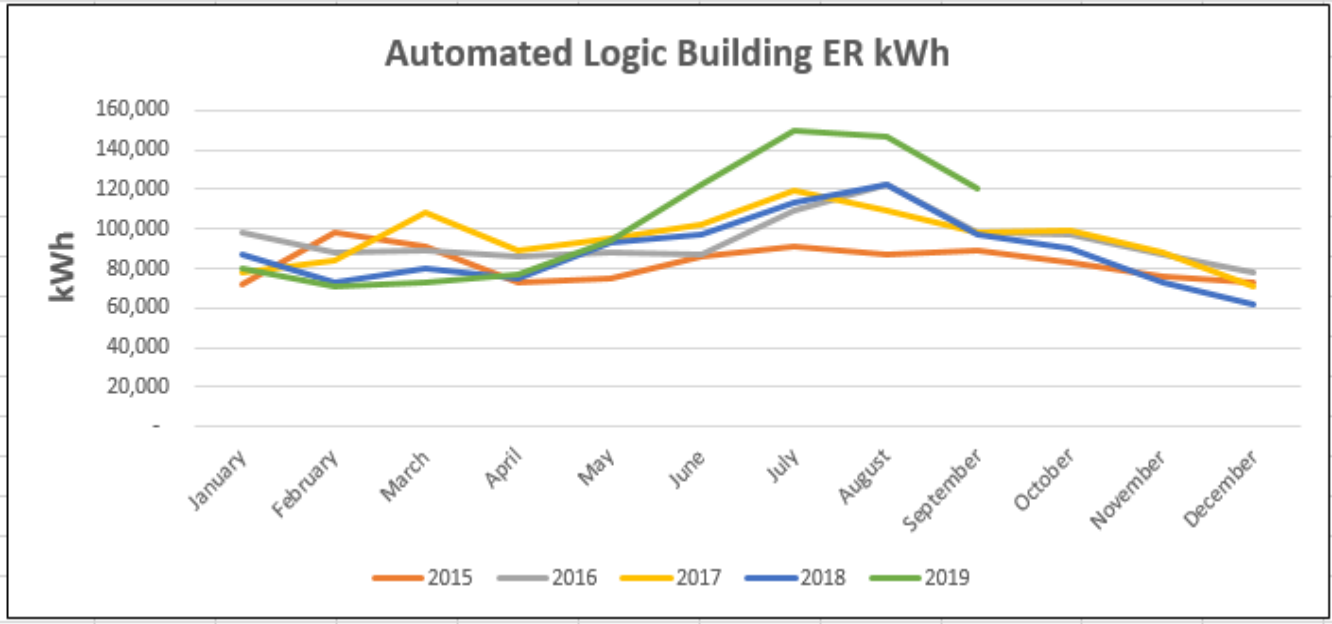
Year/Month	2014	2015	2016	2017	2018	2019
January	66,178	65,985	94,933	91,395	92,436	99,654
February	63,621	94,764	89,618	91,707	121,945	128,204
March	56,644	92,767	91,147	109,259	115,852	121,501
April	63,545	79,389	98,177	106,440	123,735	110,810
May	67,451	71,704	75,286	97,429	116,234	114,602
June	81,834	91,889	95,617	113,923	144,680	149,335
July	93,134	86,905	104,449	118,254	145,492	155,153
August	85,999	90,962	119,739	58,804	143,646	80,317
September	77,010	91,868	119,309	114,498	160,756	84,086
October	67,521	78,819	97,866	102,254	130,537	
November	60,962	79,212	89,400	90,926	117,192	
December	58,248	81,930	94,697	96,527	124,468	
TOTAL	842,147	1,006,194	1,170,238	1,191,416	1,536,973	1,043,662



Energy Reports

kWh

Year/Month	2014	2015	2016	2017	2018	2019
January	68,082	72,401	98,162	78,128	86,992	80,165
February	58,546	98,556	87,855	84,190	73,004	70,699
March	62,231	90,847	89,386	108,276	79,575	72,655
April	59,487	73,421	85,870	89,360	74,836	76,952
May	70,141	75,238	87,584	95,607	92,967	94,359
June	83,867	85,556	87,072	102,304	97,041	122,012
July	90,126	91,574	109,745	118,932	112,829	149,446
August	80,777	87,452	122,377	109,386	121,908	146,844
September	73,515	88,865	98,574	98,481	96,716	120,738
October	71,474	82,863	97,111	99,369	89,685	
November	52,952	76,449	87,386	88,004	72,475	
December	54,438	73,203	77,978	71,372	61,606	
TOTAL	825,636	996,425	1,129,101	1,143,410	1,059,635	933,869



Report Update Preferences Help

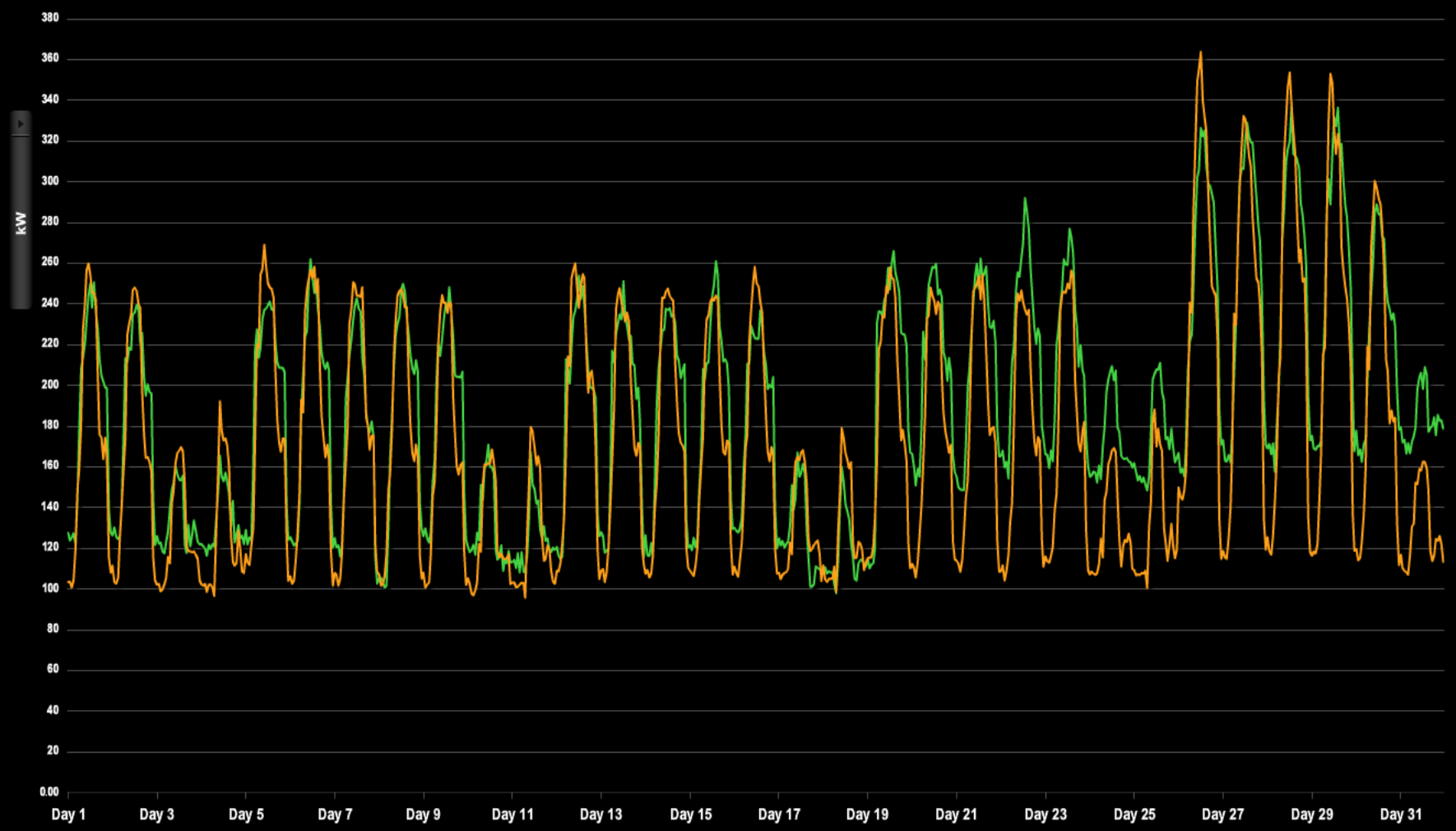
Energy | Water

All Building Types

- CUPA Feeders
  - CUPA 13-8A Feeder
  - CUPA A SWGR Feeder
  - CUPA B SWGR Feeder
  - CUPA 13-8B Feeder
  - CUPA 13-4A Feeder
  - CUPA 13-4B Feeder
  - CUPA F1 Feeder
  - CUPA F2 Feeder
  - CUPA F1 & F2 Total
- Academic Facilities
  - 7800 (Main Meter)
    - Sub Meter 1
    - Sub Meter 2
    - Sub Meter 3 (Bateman's)
    - Sub Meter 4 (Glen Garage)
    - Sub Meter 5
  - Center for the Arts (Total Meter)
    - Electric Meter (Rm 2010EL)
    - Electric Meter (Rm 3022EL)
  - College of Liberal Arts (Total Meter)
    - Electric Meter S1
    - Electric Meter S2
  - Cook Library (Main Meter)
    - Cook Data Center (EDP)
    - Cook Library w/o EDP
    - Cook Steam Meter
  - Hawkins Hall (Main Meter)
  - Linthicum Hall (Total Meter)
    - Linthicum Hall (Main Meter)
    - Linthicum Hall VRF
  - Smith Hall (Total Meter)
    - New Smith Hall Main 1
    - New Smith Hall Main 2
    - Old Smith Hall
    - Smith Chilled Pump 1
    - Smith Chilled Pump 2
    - Smith Condenser Pump 1

Show Selected

7800 York Road - August, 2019 vs. August, 2018



Data | Graph | Annotations | Benchmarks

Data Type: Demand

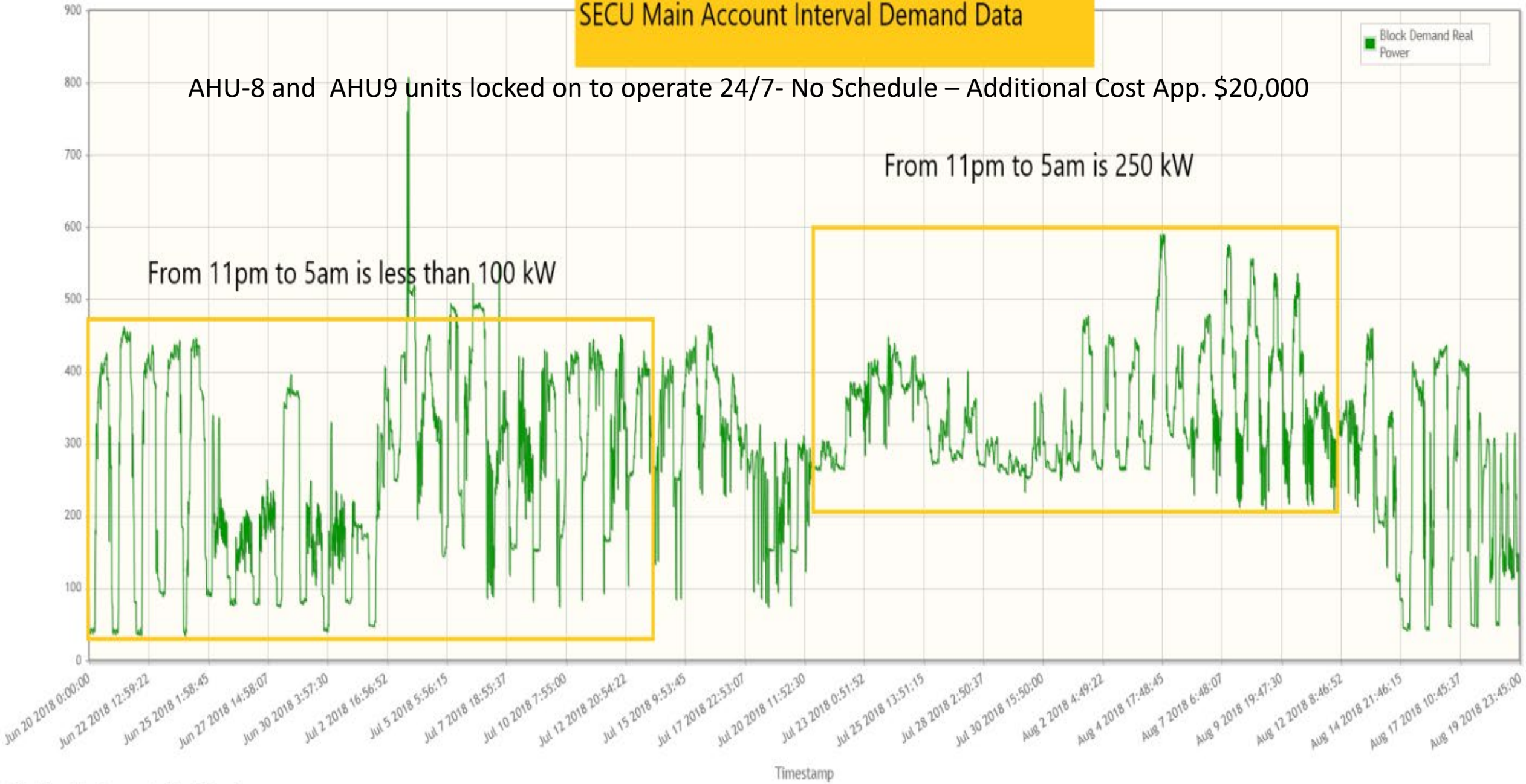
Date Range: 1 Aug 01, 2019 - Aug 31, 2019

Comparison Range: 1 Aug 02, 2018 - Sep 01, 2018

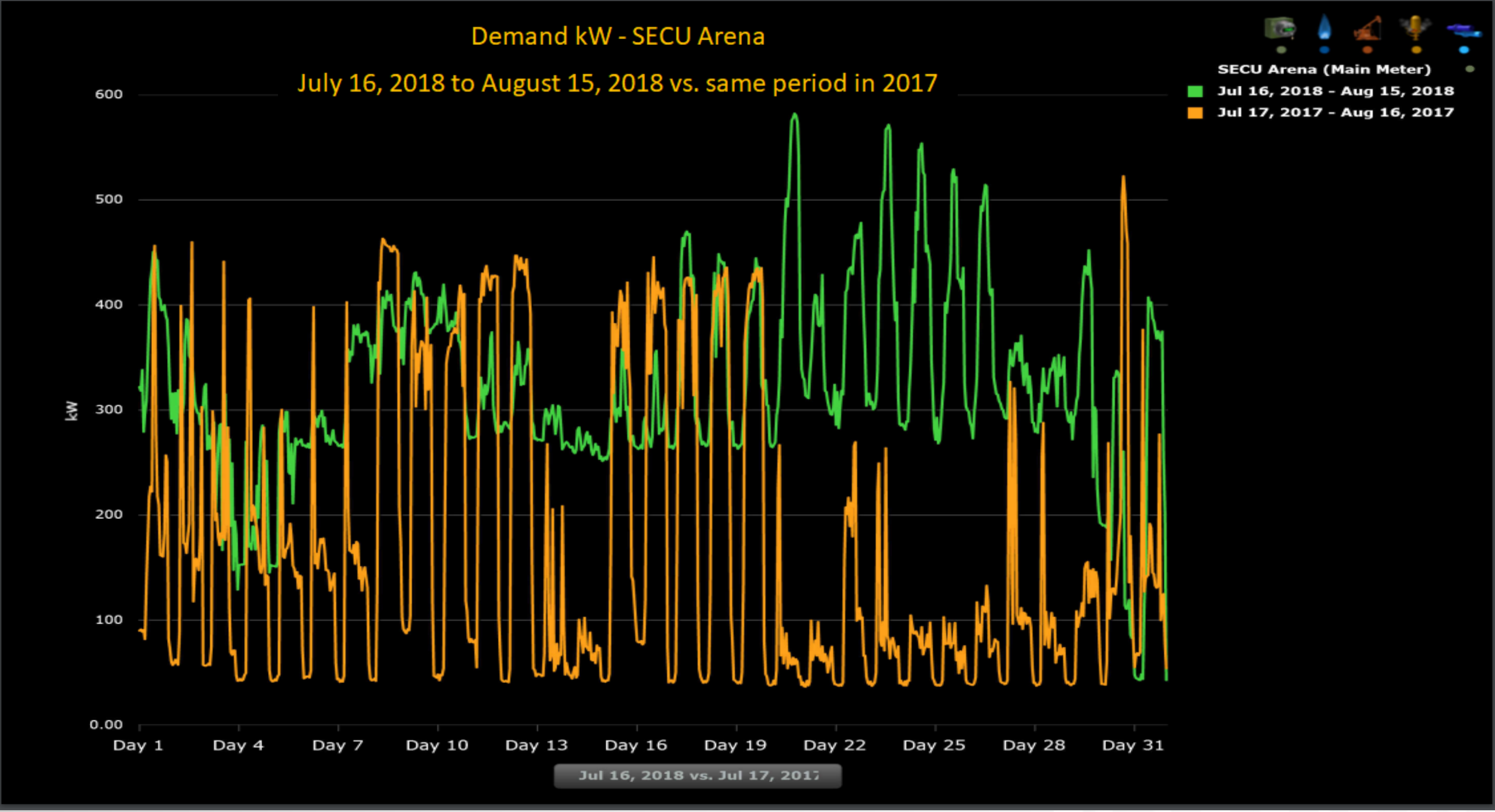
Device Diagram | Show Table

SECU Main Account Interval Demand Data

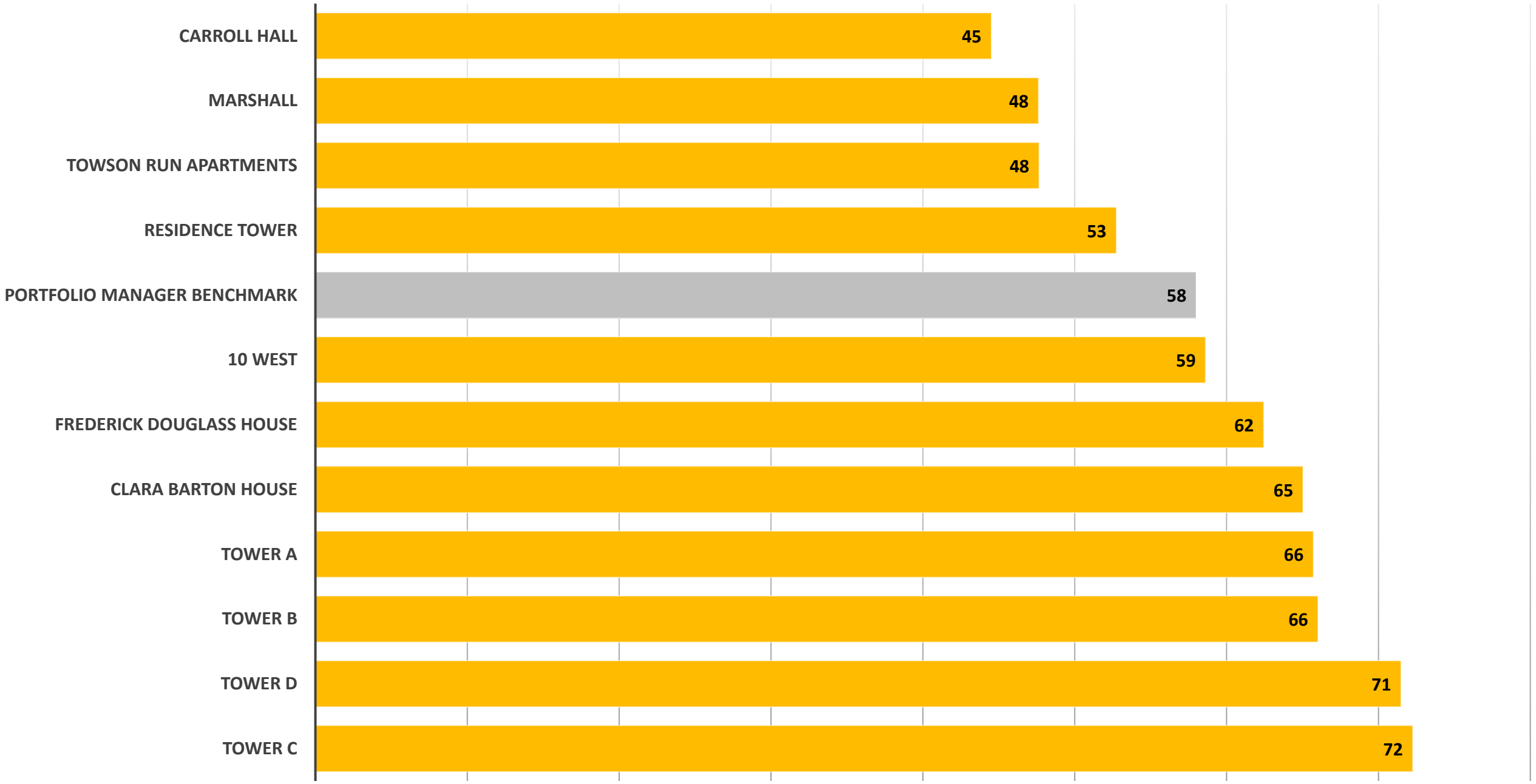
AHU-8 and AHU9 units locked on to operate 24/7- No Schedule – Additional Cost App. $20,000



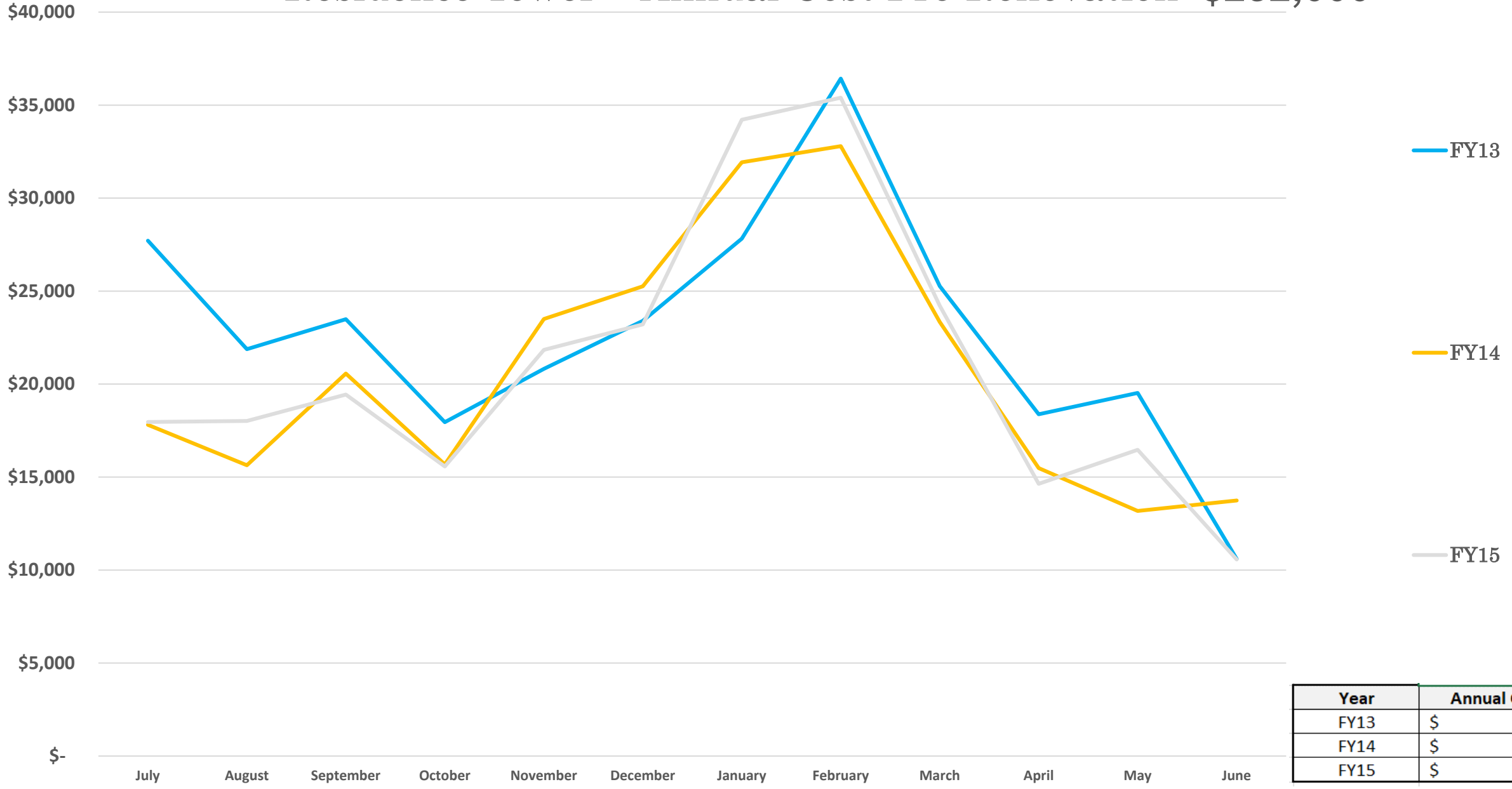
Left-click and drag to zoom. Double-click to restore.


Demand kW - SECU Arena
July 16, 2018 to August 15, 2018 vs. same period in 2017
SECU Arena (Main Meter)
Jul 16, 2018 - Aug 15, 2018
Jul 17, 2017 - Aug 16, 2017
kW
600
500
400
300
200
100
0.00
Day 1
Day 4
Day 7
Day 10
Day 13
Day 16
Day 19
Day 22
Day 25
Day 28
Day 31
Jul 16, 2018 vs. Jul 17, 2017

2018 EUI for Residence Halls at Towson University

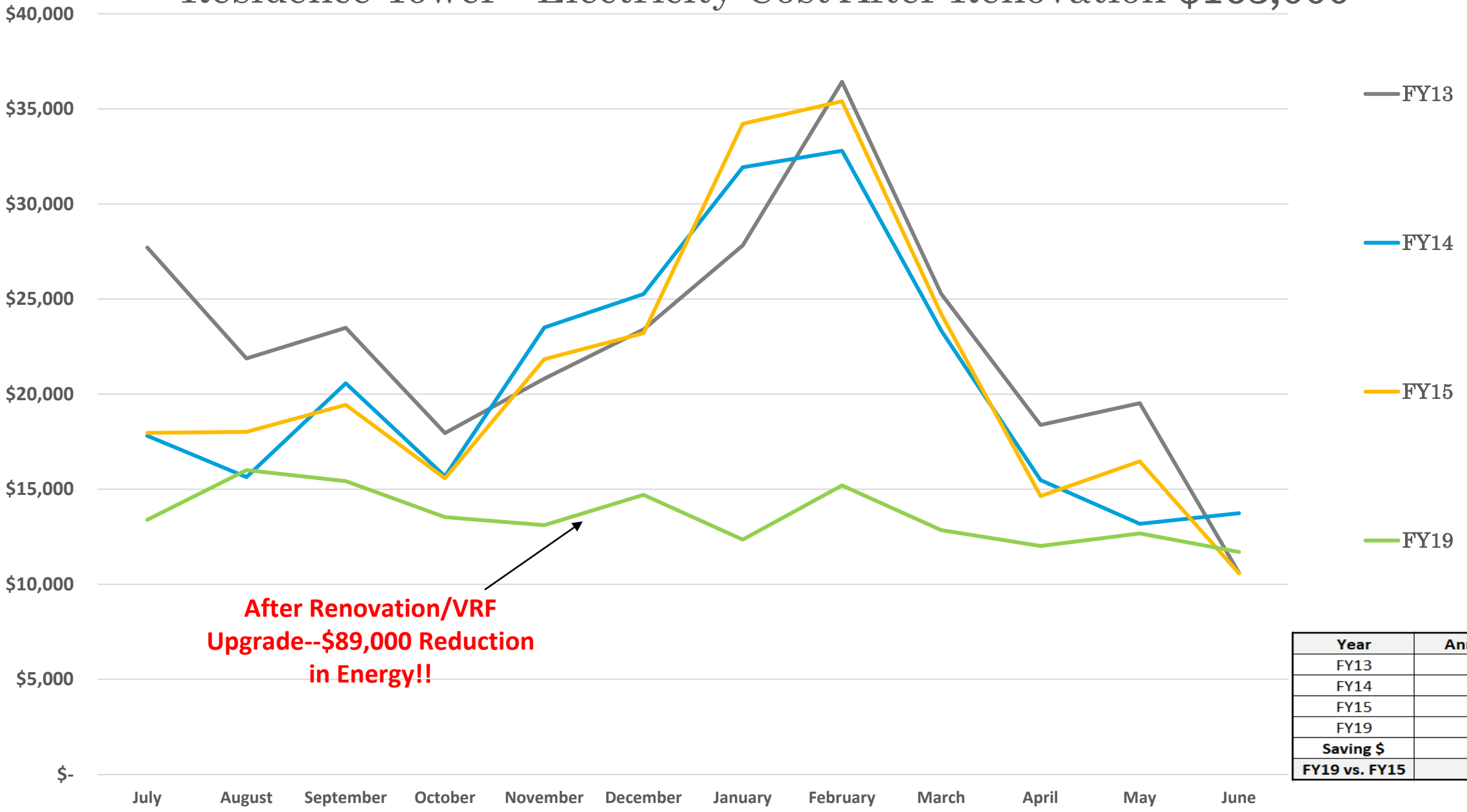


Residence Tower – Annual Cost Pre-Renovation $252,000



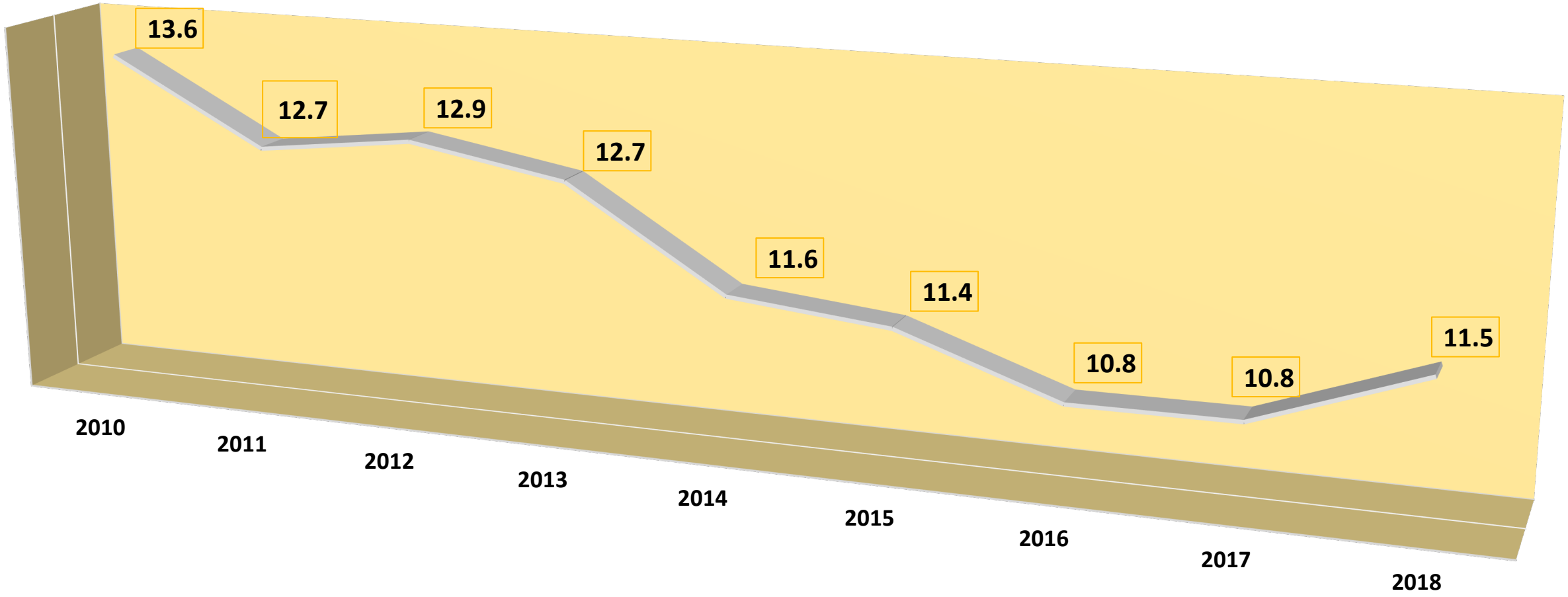
Year	Annual Cost $
FY13	$ 273,262
FY14	$ 248,924
FY15	$ 251,536

Residence Tower - Electricity Cost After Renovation $163,000

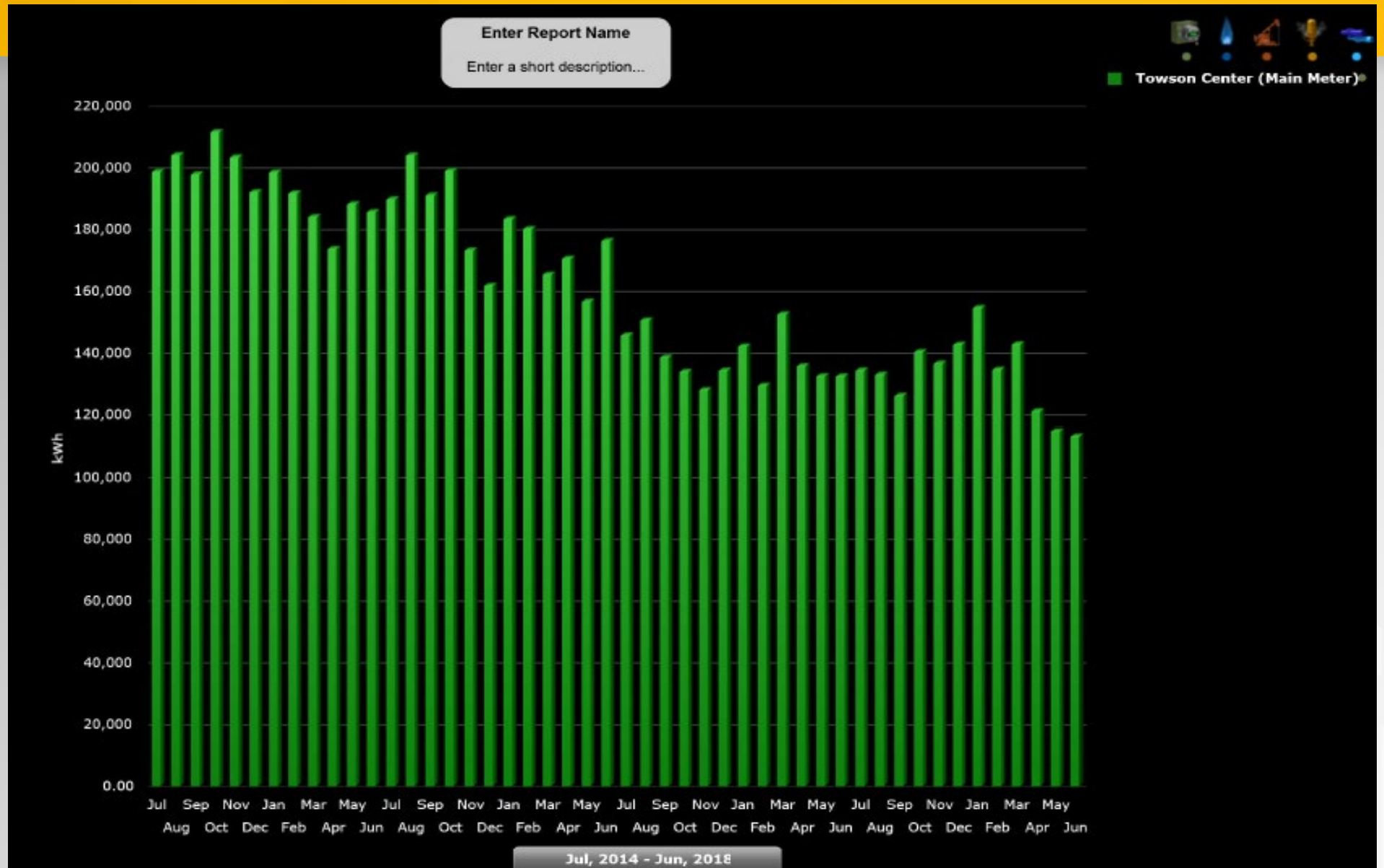


Year	Annual Cost $
FY13	273,262
FY14	248,924
FY15	251,536
FY19	162,966
Saving $	**88,570**
FY19 vs. FY15	-35%

TU Total kWh/Sq. Ft. 2010--2018



Towson Center Energy Reduction 38% from July, 2014 - June, 2018 totaling over $70 thousand a year in energy savings!



New Steam DP V-Cone Style Flow Metering in Central Utility Plant installed in 10 inch main steam header

Completed Steam Meter Installation

FLEXIM Ultrasonic Chilled Water Strap On Meter 16 inch CHW line

Ted Bohn

Argonne National Lab

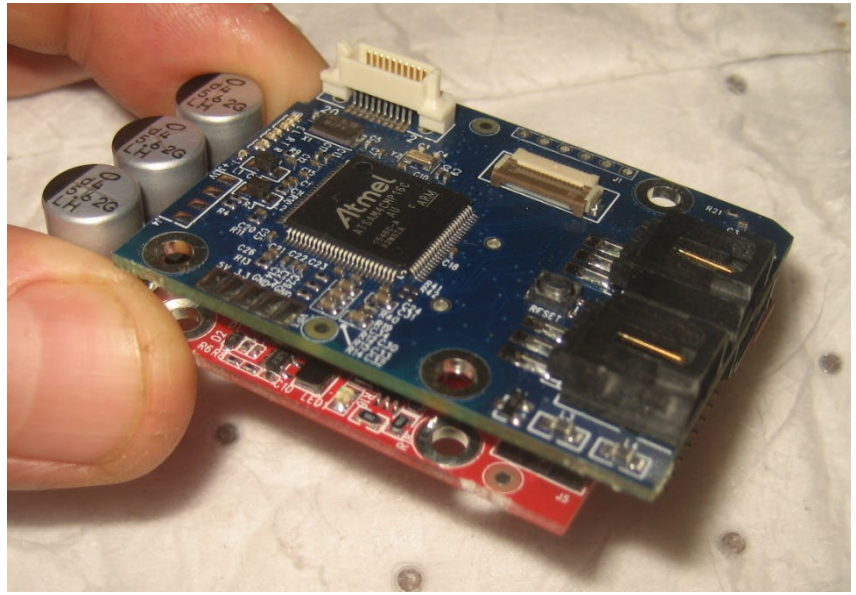
Submit Questions
www.slido.com event code **#DOE**

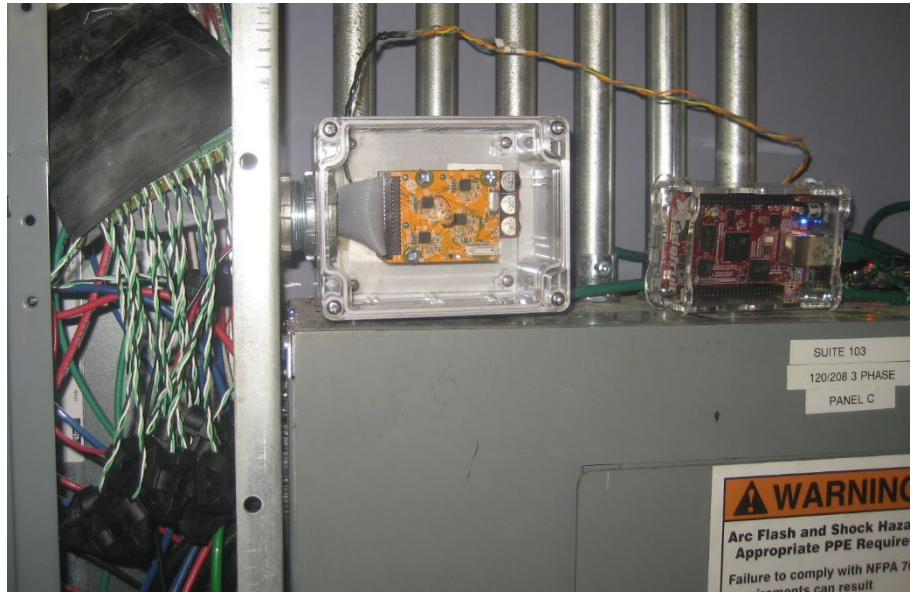
U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Low Cost Hardware and Software for Revenue Grade Accuracy Building Sub-metering





Better Buildings Seminar Series: *Succeed With Submetering*

Theodore Bohn, Principal Electrical Engineer

tbohn@anl.gov, 630-816-7382

Takeaway Concepts

- What does *"Succeeding with Submetering"* mean? (Context of success via submetering) Cost vs benefit.
- Use cases that benefit from lower net installed cost (renewables, DC systems, facility improvement M&V, NY LL88 mandatory reporting)
- Equipment and site requirement factors that impact net installed submetering costs (labor, service interruption, hardware, sensors, communication path, software, etc.)
- DOE-BTO funded research on lower net cost of installation hardware/software/processes; observations

“Succeed With Submeters” Requires Context

- Scale (circuit, area/zone, building or campus level) and expected use of collected information impact the effectiveness of submeter data gathering/actions.
- **Circuit or plug level**: Miscellaneous Electric Loads (MELs) information about specific activity/impacts, measurement& validation (M&V) of improvements as well as avoiding concurrent loads (peak demand/TOU).
- **Area-zone level:** Within facilities information can be extracted on building system loads vs occupant impacts.
- **Building or campus level:** Measurement of full building or mesh of buildings, with PV/storage other impacts at the campus level detail.

Submeters Uses Case, Applicable Standards

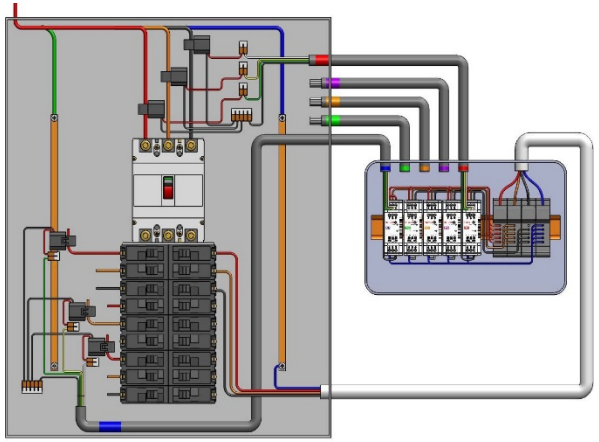
- Building systems in the 21st century use AC and DC level distribution systems, with behind-the-meter PV/storage.
- Utilities are controlled by Public Utility Commission (PUC) regulations, especially for revenue tracking meters.
- Non-utility owned meters, used in commercial transactions, are covered by Department of Commerce enforced by local jurisdictions under NIST Handbook 44.
- AC meter accuracy and durability are covered by ANSI C12.1, C12.20 standards (used by utilities/others).
- (DC) Renewable energy transactions are not covered by PUC/Utility guidelines today, but could be enabled by the 'DC as a Service' movement via ANSI C12.32 standard.

New York City Local Law 88 Submeter Rules

- 28-311.3 Sub-meters required for covered tenant spaces. On and after **January 1, 2025**, the electrical consumption of each covered tenant space shall be measured by one or more sub-meters. Sub-meters shall be installed in existing covered tenant spaces by the owner or the lessor of such space on or [prior to] before January 1, 2025 and thereafter as new covered tenant spaces are created within the building. If the covered tenant space is a floor with multiple tenancies, each tenancy that is [10,000] 5,000 gross ft^2 ([929] $465m^2$) or less shall (i) have a separate submeter, (ii) share a sub-meter with other tenant spaces on the floor, or (iii) share a sub-meter covering the entire floor.

BTO Low Cost Wireless Submeter Challenge

- DOE-BTO launched low cost wireless (data) submeter challenge in June 2013, with $100 target goal.
  - 30 Manufacturers submitted applications
  - 9 moved to round 2 product submission evaluation
  - 3 submissions passed cost/function evaluation
  - 2 submissions passed accuracy (1%) UL evaluation
  - 1 Finalist (Meazon) passed (Zigbee) Comm. testing
- Better Buildings "Mission Accomplished"- July 2017

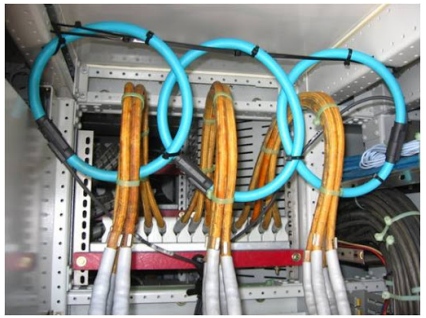


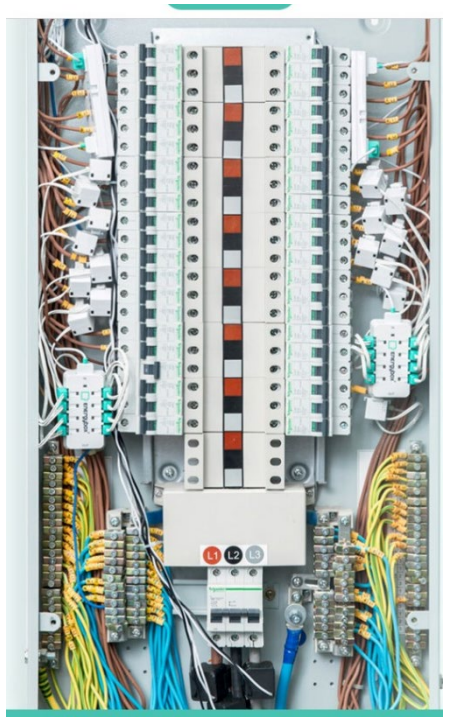
Key Net Installation Cost Factors

- **Subcontracting-Overhead:** Cost of managing the project.
- **Productivity Loss/Service Interruption:** Downtime costs
- **Direct Labor Costs:** Electrician hourly costs, travel, billing
- **Software/Commissioning:** Non-hardware costs
- **Hardware/Sensors:** Submeter equipment, enclosures
  - Current sensor (can exceed cost of the meter itself)
  - Submeter 'system'; can be multichannel, packaging
  - Communication connection; gateway/hot spot?
  - Logic power source (meter, comm., sensors, display)

Current Sensor Type/Accuracy/Cost Factors

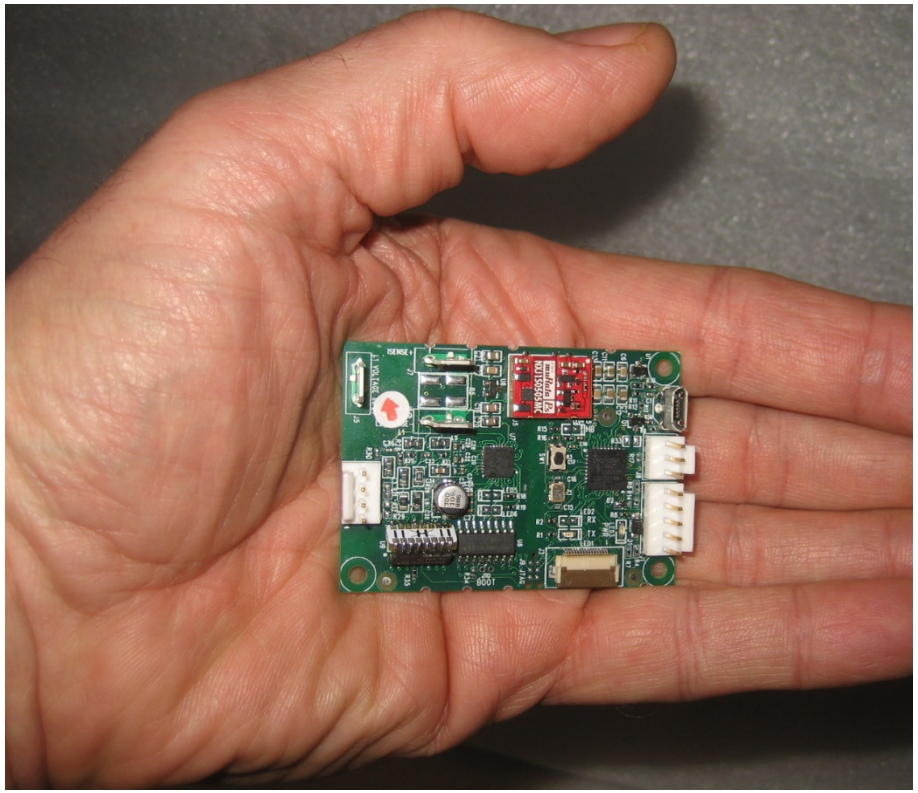
- Current sensor types;
  - Solid -split core current transformers, burden resistors
  - Coreless Rogowski ‘rope’ current sensors (ext. power)
  - Passive Rogowski sensors; low output/phase immunity
  - Passive current shunt resistors
  - Hall type, flux gate magnetometer sensors (aux. power)
- Space for current sensors inside load center is an issue

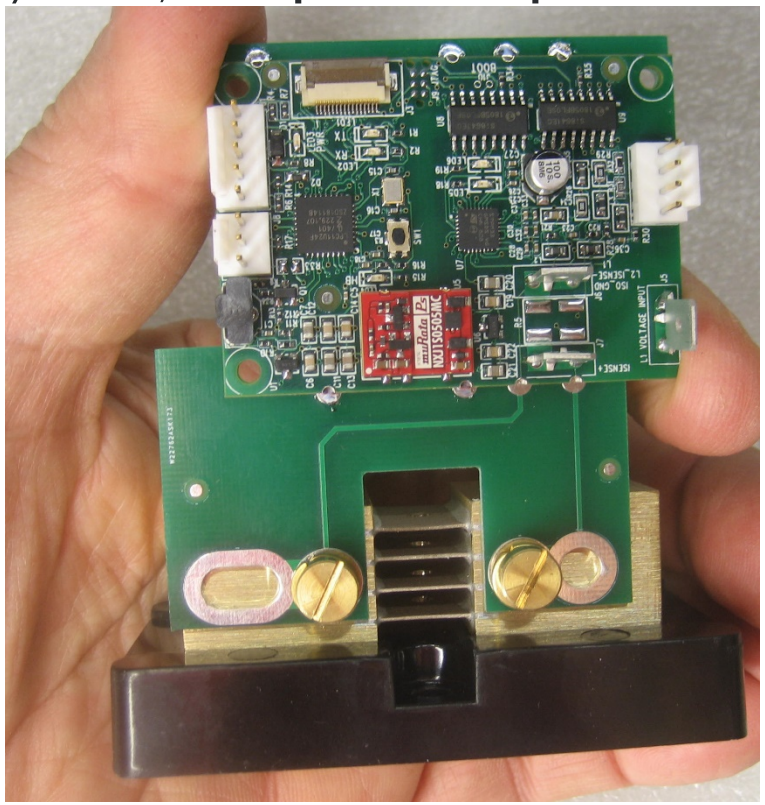




ANL/Tech Partner Approach: Smaller/Cheaper

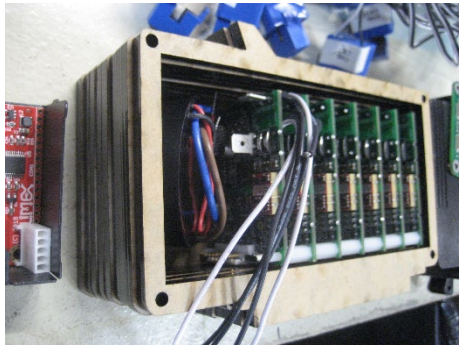
- DOE-BTO funded research on lower net cost of installation hardware, software, and other processes. Headed to commercialization.
- Split measurement functions from off-the-shelf IoT (Sub$20 gateway)
- Configurable core AC/DC single channel meter from 3-3000A, 30v-to-300v-1500v; focus on connector costs/labor; USB powered option

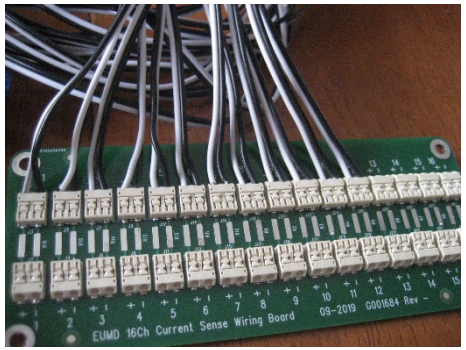


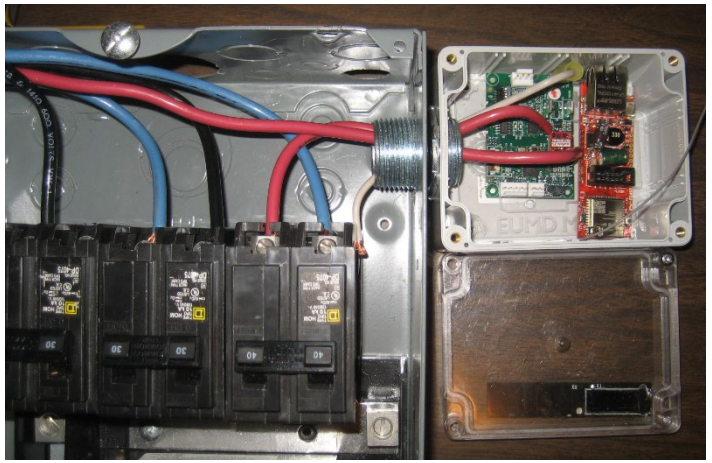


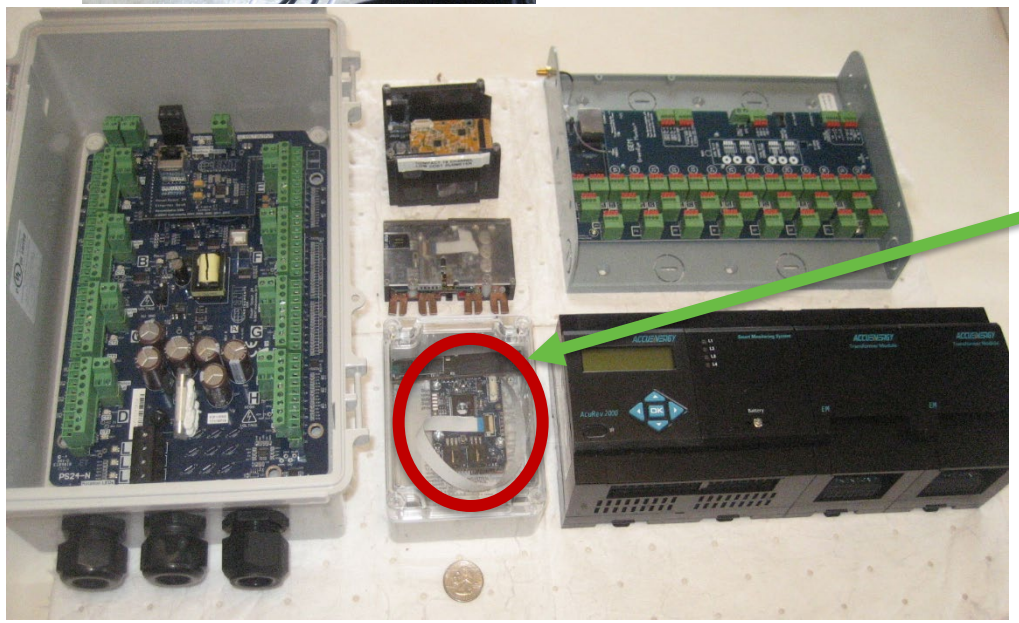
Compact Footprint Enables Faster Installation

- Examples of rapid installation, NEMA 4 sealed ANL Submeter and gateway. Comparison of multi-circuit units.





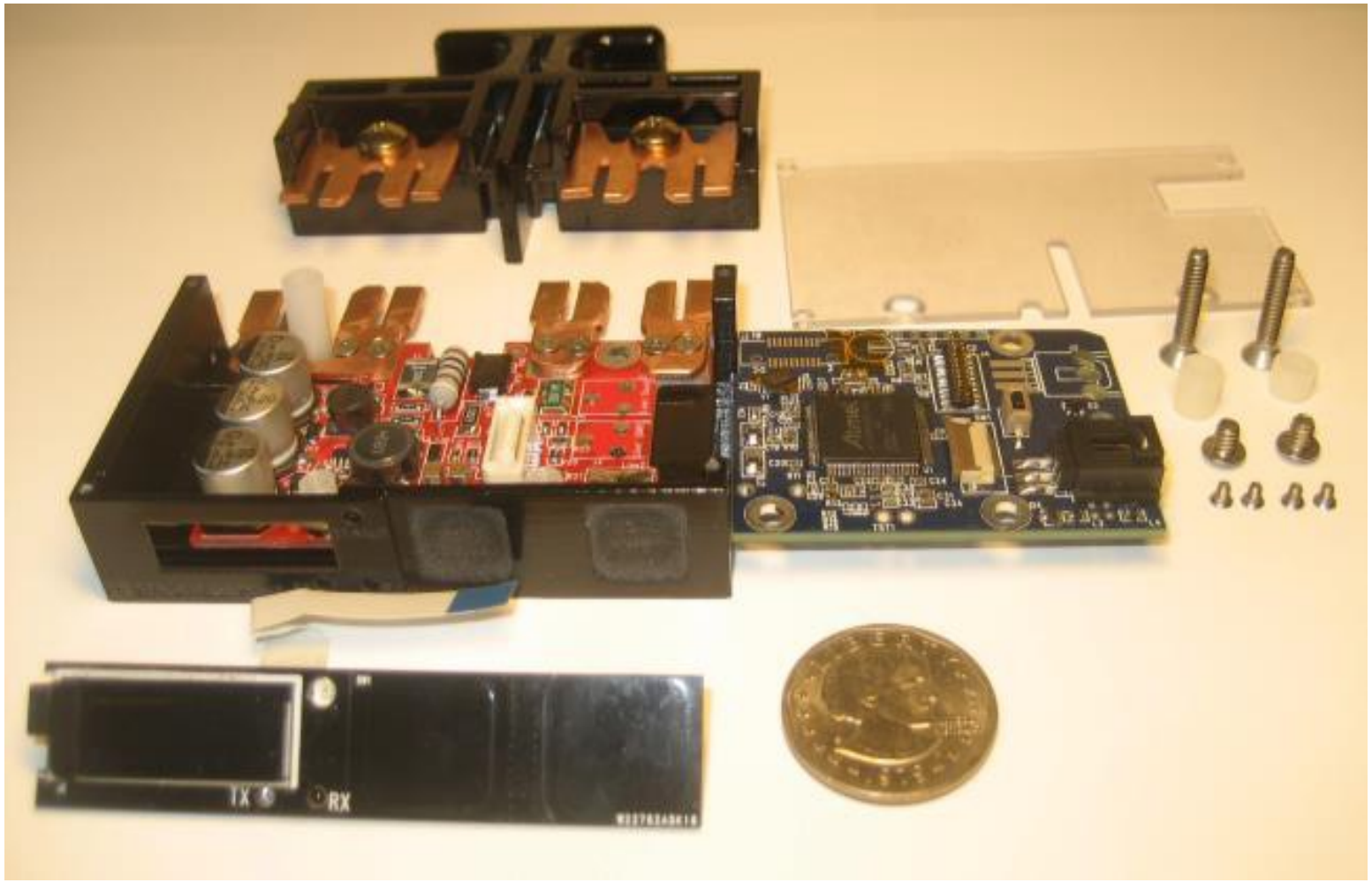




Comparison of ANL Compact Submeter (in center, 1.5”x2”) to other $1000+ submeters; Dent PowerScout 24 (left), GreenEye Monitor (upper right), AccuRev2020-2D (right)

{A quarter is shown below for scale}

End Device Metering Package (60A disconnect)



Q & A

Submit Questions
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U.S. DEPARTMENT OF ENERGY

Additional Resources

- Submetering Resources for Commercial Buildings
- Maryland Energy Database
- Smart Energy Analytics Campaign – Top Resources
- Metering Best Practices 3.0 - Report and Guide
- DOE-BTO Low Cost Wireless Submeter Challenge
- NYC Local Law 88 (Submeter requirements for 2025)
  - https://www1.nyc.gov/html/gbee/html/plan/ll88.shtml
  - https://www1.nyc.gov/html/gbee/downloads/pdf/ll132of2016.pdf
- Dent Instruments: Case Studies, reference solutions
  - https://www.dentinstruments.com/blog/10-ways-the-powerscout-12-hd-solves-common-metering-challenges
  - https://www.dentinstruments.com/resources/case-studies

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BEST PRACTICES FOR INTEGRATING DERS INTO COMMERCIAL BUILDINGS

July 8 Watch here

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MAXIMIZING ENERGY SAVINGS AND ENVIRONMENTAL IMPACTS

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HOW TO MAKE THE BUSINESS CASE

August 4

THE DYNAMIC DUO:
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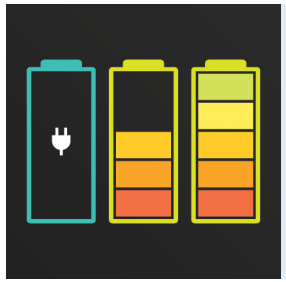

CASE IN POINT:
OREGON'S RECENT EFFORTS TO REDUCE PLUG LOAD ENERGY CONSUMPTION

July 22 Watch here

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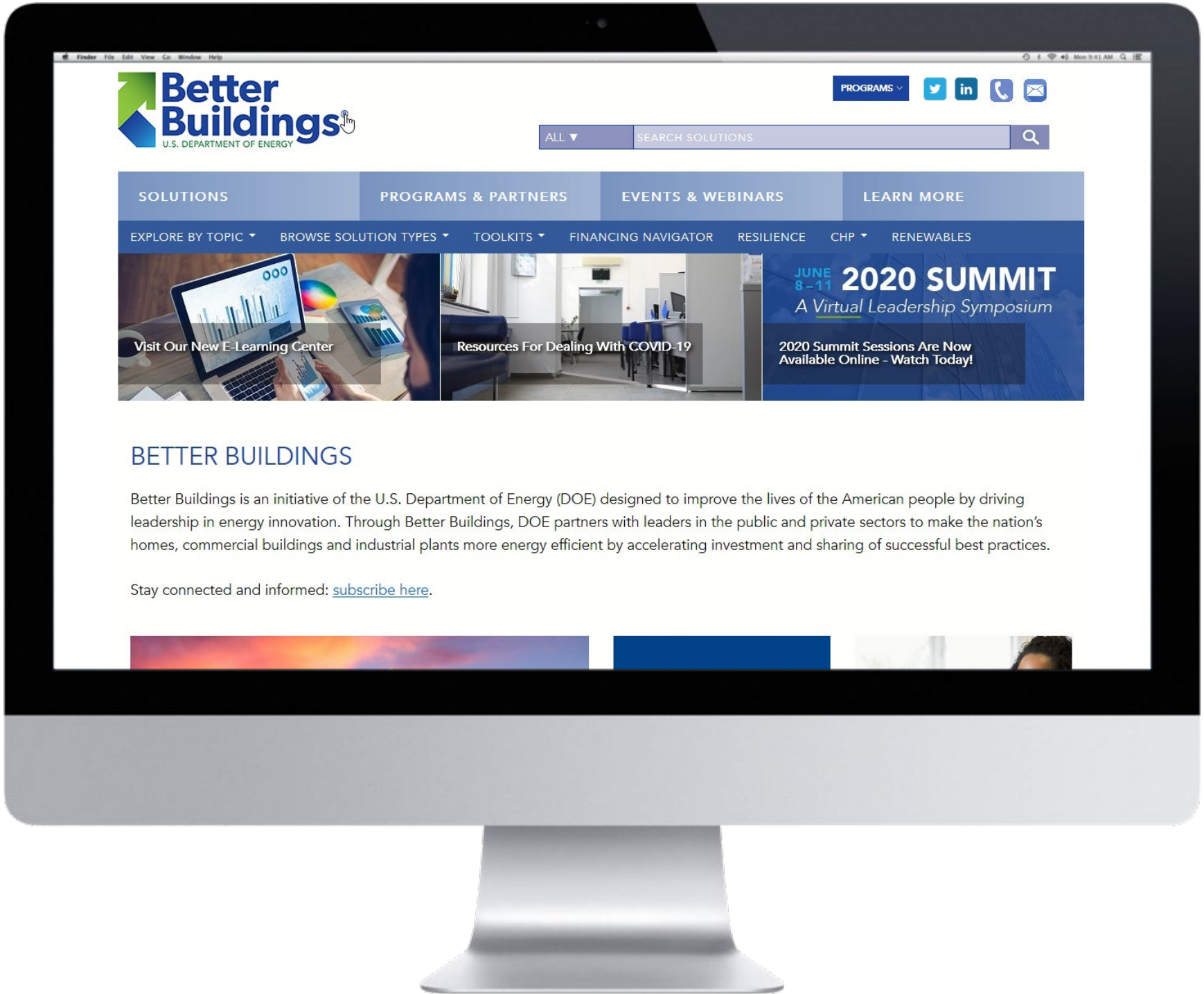

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Better Buildings Solution Center
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General Inquiries
BetterBuildings@retechadvisors.com

Program Support
ksanderson@retechadvisors.com

David St. Jean
Maryland Department of General Services
david.stjean1@maryland.gov

Steve Kolb
Towson University
skolb@towson.edu

Ted Bohn
Argonne National Lab
tbohn@anl.gov

Cedar Blazek
U.S. Department of Energy
cedar.blazek@ee.doe.gov