GPG Outbrief 27

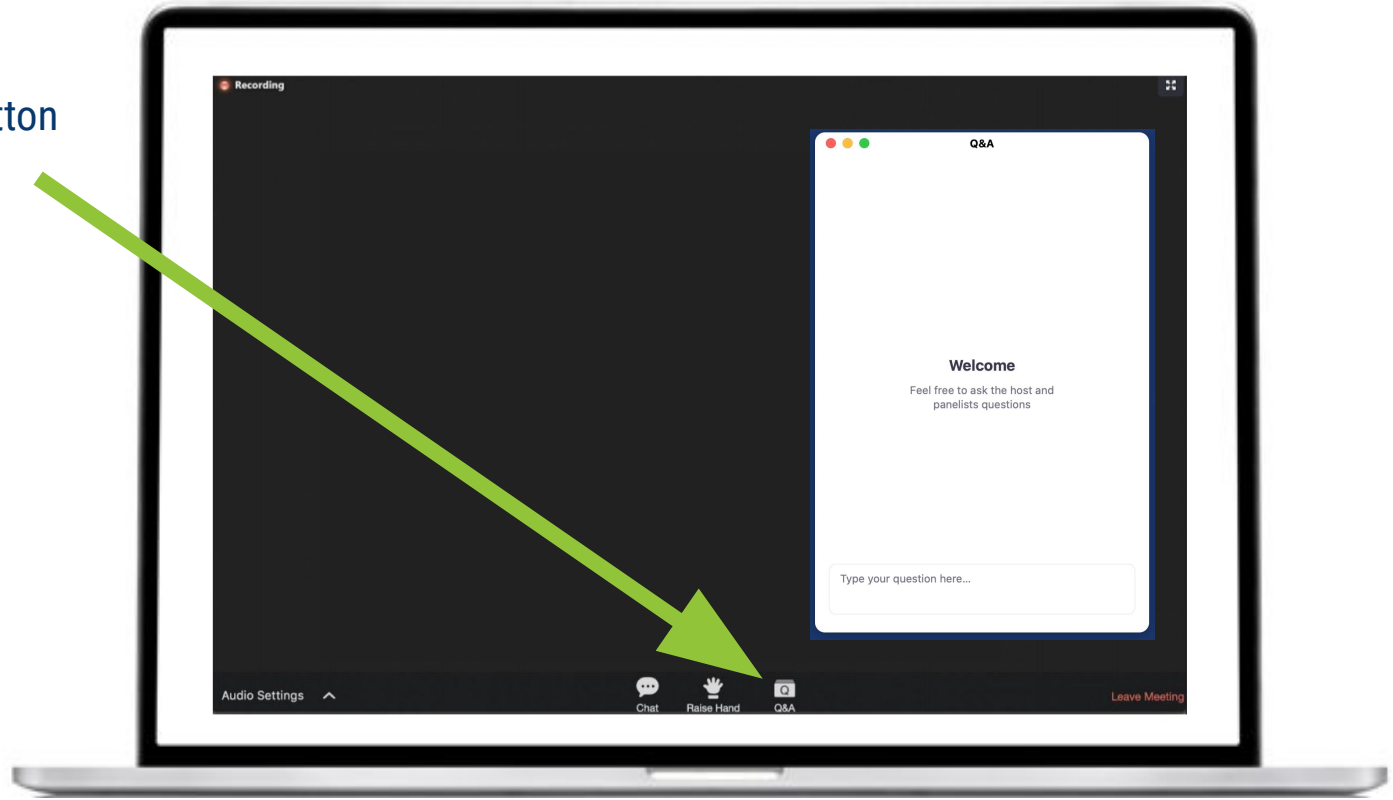
Energy Management Information System with Automated System Optimization

Emerging Building Technologies, GPG Program | U.S. General Services Administration | December 1, 2022

GSA

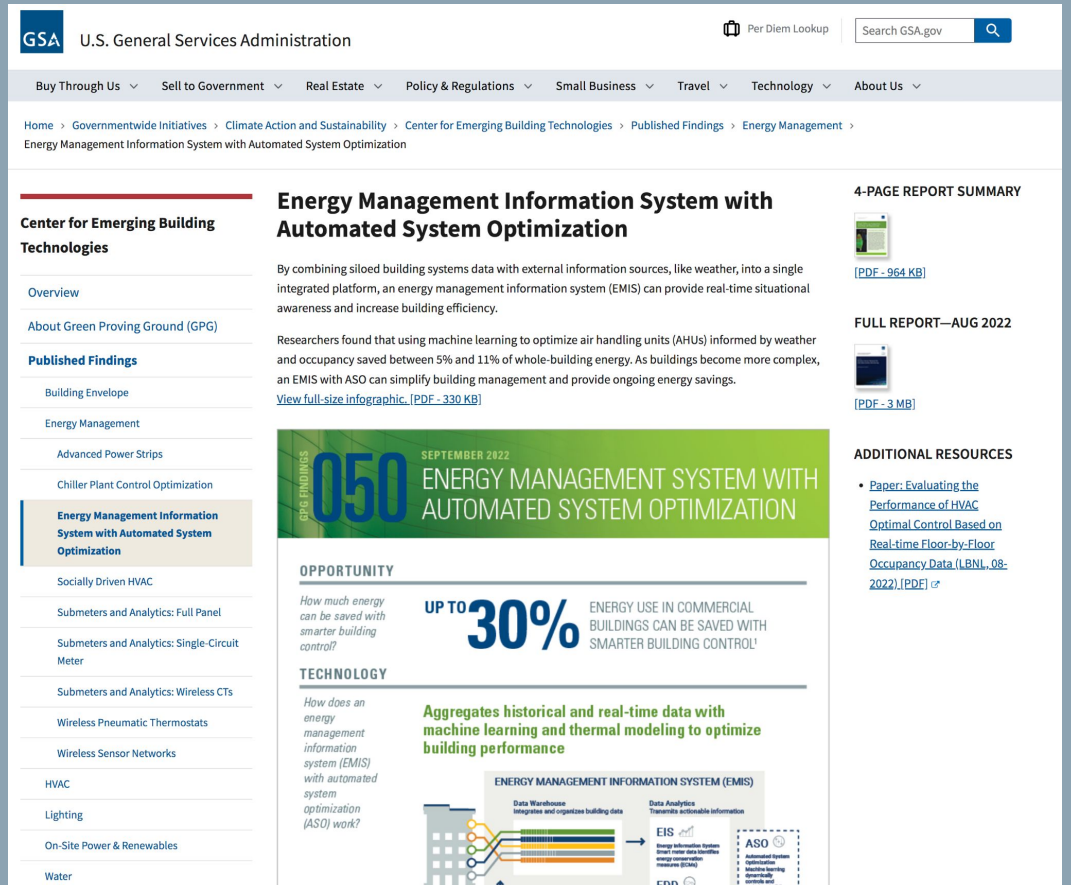
How to Ask Questions

Click the Q&A button to ask questions.

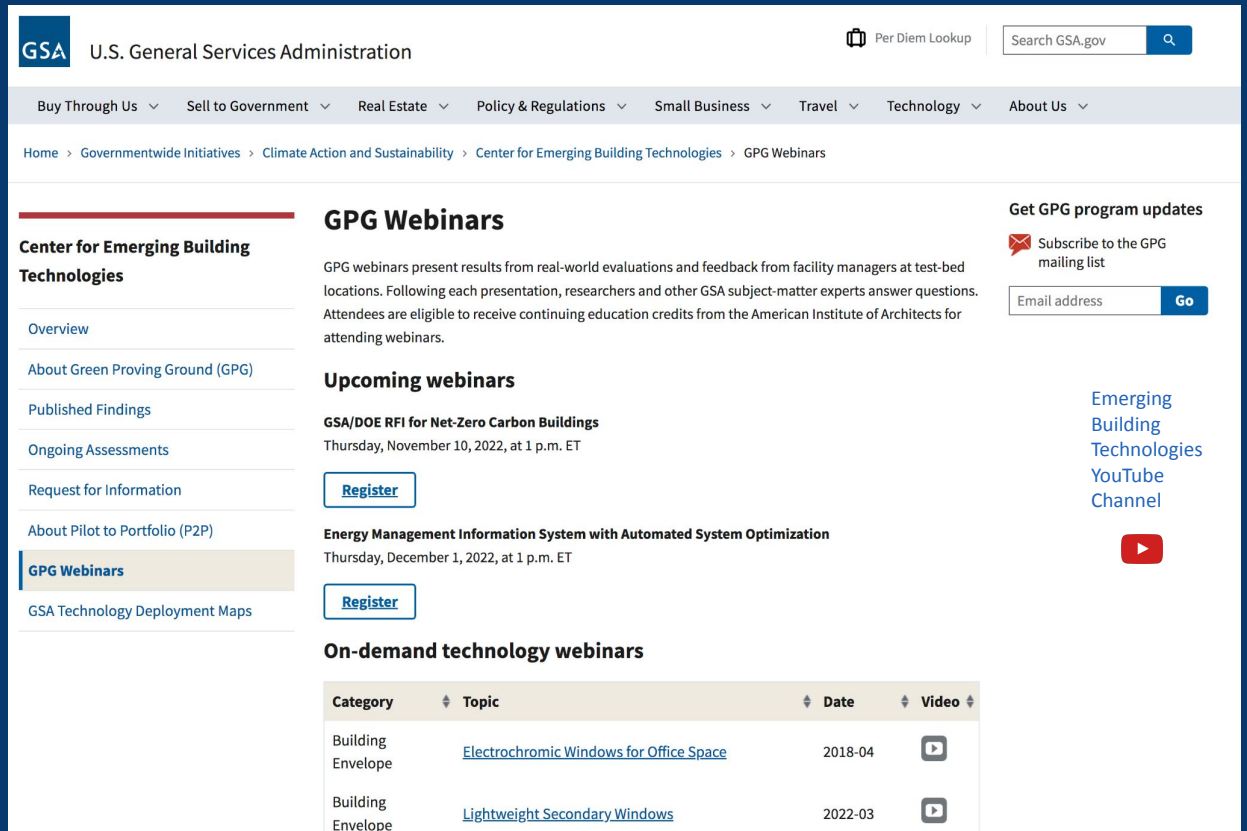


GPG-050 EMIS with ASO @ gsa.gov/gpg

- Infographic
- 8-page Findings
- Full Report
- Additional Resources



Webinar Recording and Slides Available on gsa.gov/gpg



The webinar is being recorded and the recording and slides will be shared by email and posted to gsa.gov.

Webinar Agenda

- Introduction (5 minutes)
  Kevin Powell, Director, Center for Emerging Building Technologies
- Energy Management Information System with Automated System Optimization (25 minutes)
  Alicen Kandt and Sean Pachuta, National Renewable Energy Laboratory
- On-the-Ground Feedback (15 minutes)
  Tyler Harris and Joshua Banis, GSA
- Q&A (15 minutes)

Opportunity

UP TO 30% ENERGY USE IN COMMERCIAL BUILDINGS CAN BE SAVED WITH SMARTER BUILDING CONTROL

Source: Commercial Buildings Integration Program, U.S. Department of Energy (https://www.energy.gov/eere/buildings/about-commercial-buildingsintegration-program, accessed 9-2022)

Cloud-Based SaaS Solutions

- Evaluated EMIS with ASO is a cloud-based SaaS application and will need authorization from the Federal Risk and Authorization Management Program (FedRAMP) in order to operate in federal facilities.
- Testbed pilots were conducted with provisional authorization.
- General inquiries: info@fedramp.gsa.gov

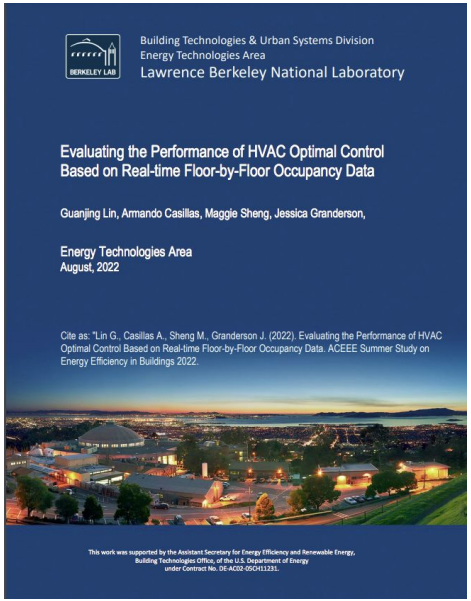
Project Coordinated with Private Sector Site

HIT Catalyst site results congruent with GPG results

DOE/HIT Site: 300,000 square foot commercial office building, Washington, DC

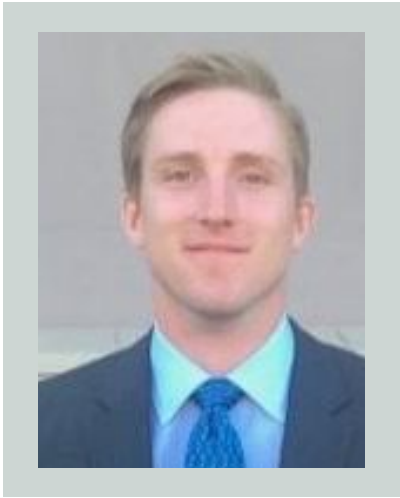
Similar challenges, evaluation conducted during COVID

- Total modeled savings 2.8%
  - Later start time: if the HVAC units started at 3:00am instead of 6:00am, the modeled savings of optimal start would increase to 5.7% which aligns with the savings magnitude in GSA study
  - Reduced fan-savings for mid- and end-of day ramps: Space cooling is provided by both AHU and fan coils so the opportunity for fan savings is smaller.



Measurement & Verification

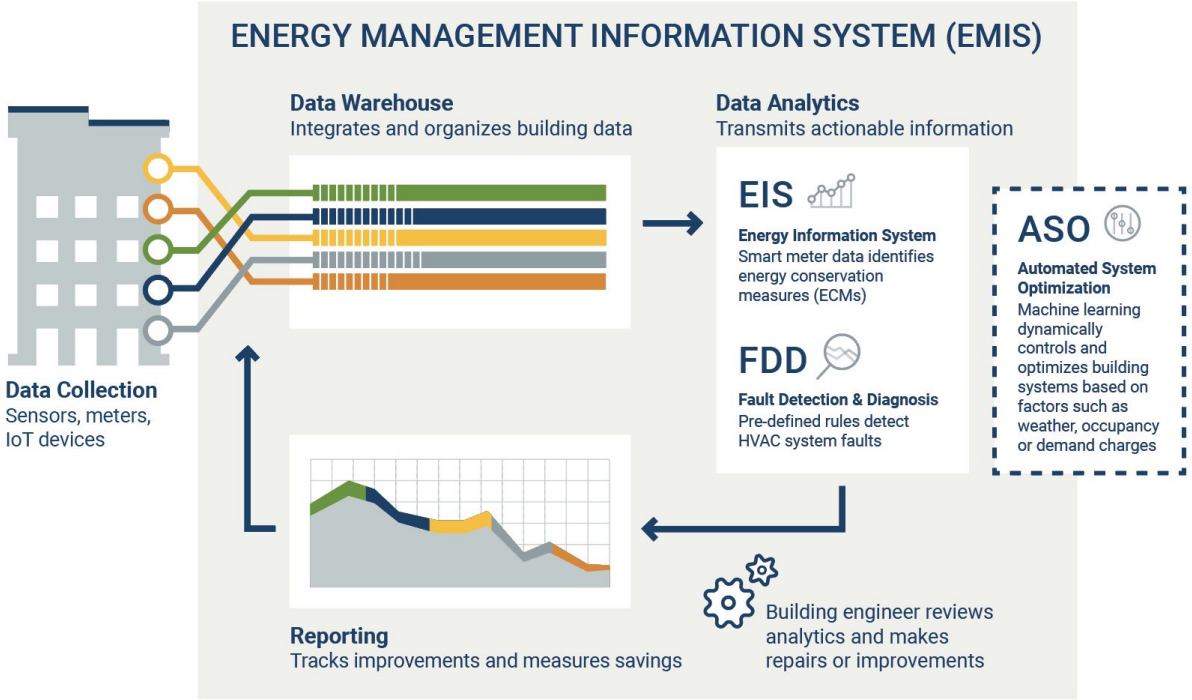
Alicen Kandt
Senior Research Engineer
National Renewable Energy Laboratory



Sean Pachuta
Research Engineer
National Renewable Energy Laboratory

What is an EMIS with ASO?

Aggregates data to optimize building performance



Adapted from LBNL (Kramer et al. 2020)

EMIS with ASO Selected for Field Validation

Nantum from Prescriptive Data

Architecture:

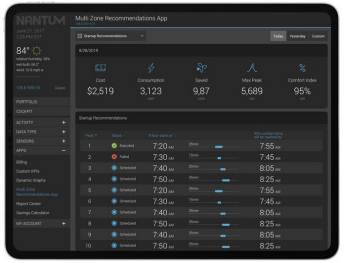
- Cloud-based SaaS solution
- Converges live data from BAS, AMI, lighting controls, sub meter, etc.
- ASO: uses machine learning to predict building load profile

UI:

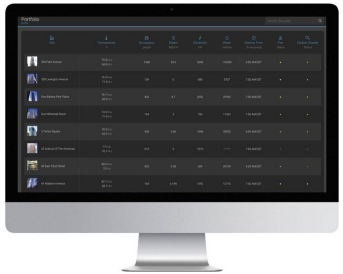
- Provides a “single pane of glass” interface to monitor multiple real-time data streams

Key Use Cases:

- Predictively ramp the building HVAC systems up and down to optimize efficiency based on occupancy, weather, and electrical consumption
- Remotely view equipment operation and KPIs across a portfolio of buildings



Nantum Core



Nantum Portfolio

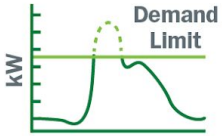
EMIS with ASO Use Cases Evaluated

Occupancy Counting

Manage facility based on real time occupancy

Energy-Comfort and ECMs

Ensure that facility operates as designed



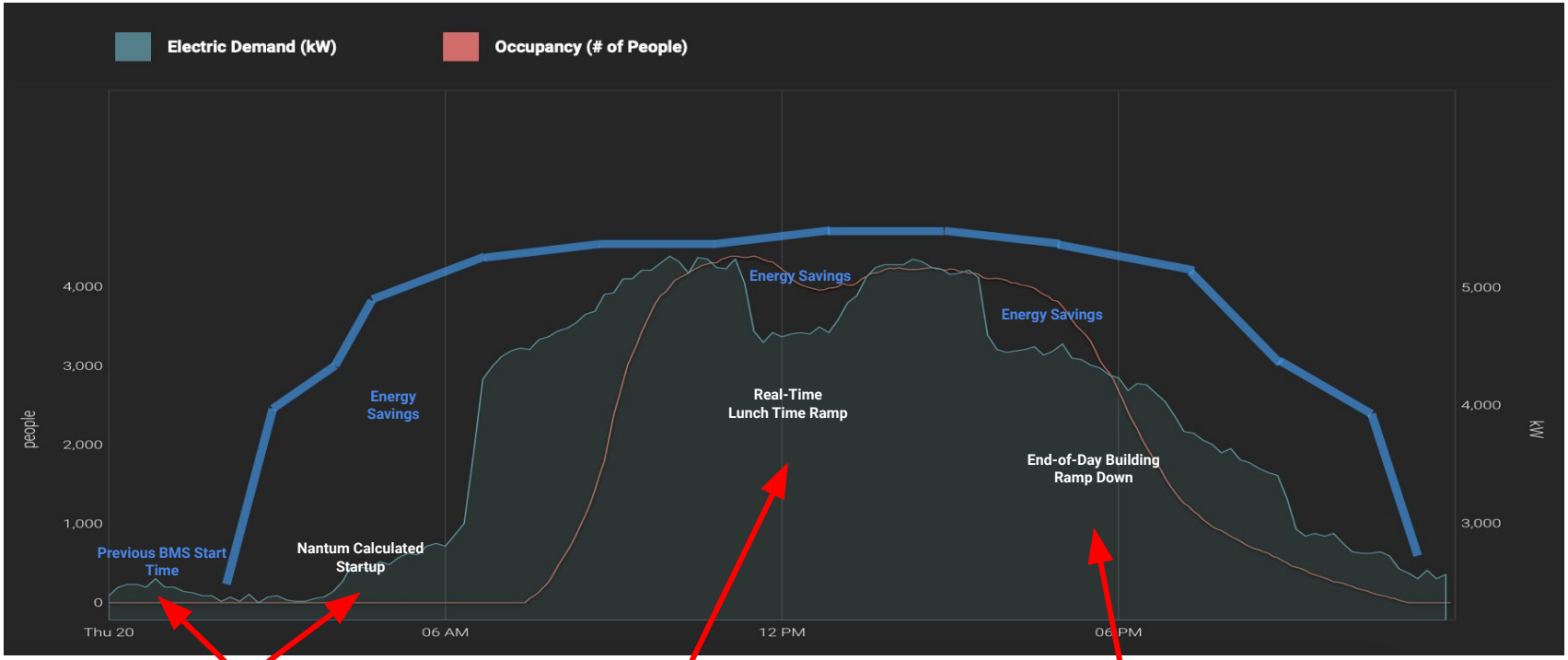
Peak Predictions

Predictively manage peak demand charges

Portfolio-Wide Dashboard

Remotely monitor facility equipment and track portfolio KPIs

Occupancy and A.I. Based Building Energy Reduction



EMIS with ASO Testbeds

Austin Courthouse
Texas

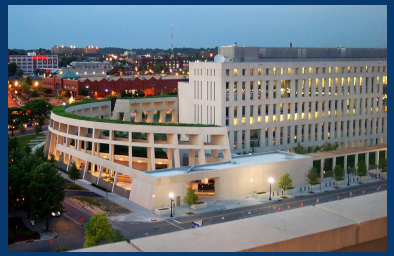
- 251k ft^2
- Constructed 2012
- 80 kBtu/ ft^2 EUI
- Niagara BAS
- 1/3 of GSA real-estate is courthouses

Dallas Terminal Annex
Texas

- 253k ft^2
- Constructed 1937
- 42 kBtu/ ft^2 EUI
- Niagara BAS

Harvey Wiley FB
Maryland

- 441k ft^2
- Constructed 2001
- 200 kBtu/ ft^2 EUI
- 40% Lab / 60% Office



ATF Headquarters
DC

- 422k ft^2
- Constructed 2008
- 82 kBtu/ ft^2 EUI
- Under-Floor Air Distribution

Implemented Feature Sets

Austin Courthouse

- Whole building occupancy (5 Density sensors)
- 1,882 points integrated
- Supervisory control: optimum start on AHU fans, mid-and end-of-day ramps
- Graphical anomaly detection
- kW demand prediction

Dallas Terminal Annex

- Whole building occupancy (4 Density sensors)
- 998 points integrated
- Supervisory control: optimum start on AHU fans, mid-and end-of-day ramps
- Graphical anomaly detection
- kW demand prediction

Harvey Wiley

- Whole building occupancy (3 FLIR sensors)
- 4,290 points integrated
- Optimum start on AHU fans not implemented due to COVID-19
- Midday and end-of-day ramps on AHU fans through static pressure reset (on Fridays)
- kW demand prediction

ATF Headquarters

- Whole building occupancy (3 FLIR sensors)
- 1,221 points integrated
- Optimum start on AHU fans not implemented due to COVID-19
- Intermittent issues with midday ramps, consistent issues with programming
- kW demand prediction

M&V Test Bed Quantitative Performance Objectives

QUANTITATIVE OBJECTIVES		
OBJECTIVE	**METRIC**	**SUCCESS CRITERIA**
Energy Savings	Modeled EUI Reduction	Whole Building Energy Savings: >5%
	Modeled kWh Reduction	AHU fan energy savings >8%
Peak Demand Prediction	Daily Peak Demand (kW)	Predicted electrical demand within 5% of measured electrical demand
Cost-Effectiveness	Simple payback	Payback <5 years
Integration / Platform Functionality	3rd party systems integration	Integration of two 3rd party application systems
ADDITIONAL CAPABILITIES		
GSAlink Compatibility	API integration from BOS API to GSALink	Successful API integration from BOS API to GSALink (SkySpark)

M&V Test Bed Qualitative Performance Objectives

QUALITATIVE OBJECTIVES		
OBJECTIVE	**METRIC**	**SUCCESS CRITERIA**
Single Pane of Glass / Portfolio View	Ability to review similar data across multiple buildings via multiple choice (1-5 Likert) survey and interview questions for GSA PBS and O&M	No factor with an aggregate score below 3
Ease of Installation	Time required to install and commission	Less than 12 weeks to install and commission the system
Operability	Multiple choice (1-5 Likert) survey and interview questions for GSA PBS and O&M	No factor with an aggregate score below 3

Integration of Multiple 3rd Party Application Systems

INTEGRATED VENDOR APPLICATIONS

- Schneider ION & Struxureware (Schneider Ecostructure)
- Density occupancy sensor (Density API)
- FLIR occupancy sensor (TCP/IP)
- Vataverks gas meter (Modbus/TCP)
- Johnson Controls Metasys (BacNet)
- Niagara
- Skyspark

INTEGRATED BUILDING SYSTEM PROTOCOLS

- BACnet/IP
- BACnet/MSTP
- Modbus/RTU
- Modbus/IP

GSA Link Compatibility

- Dallas Terminal Annex building data was imported to SkySpark using the EMIS API.
- Data could be used to integrate a non-GSAlink site to GSAlink.

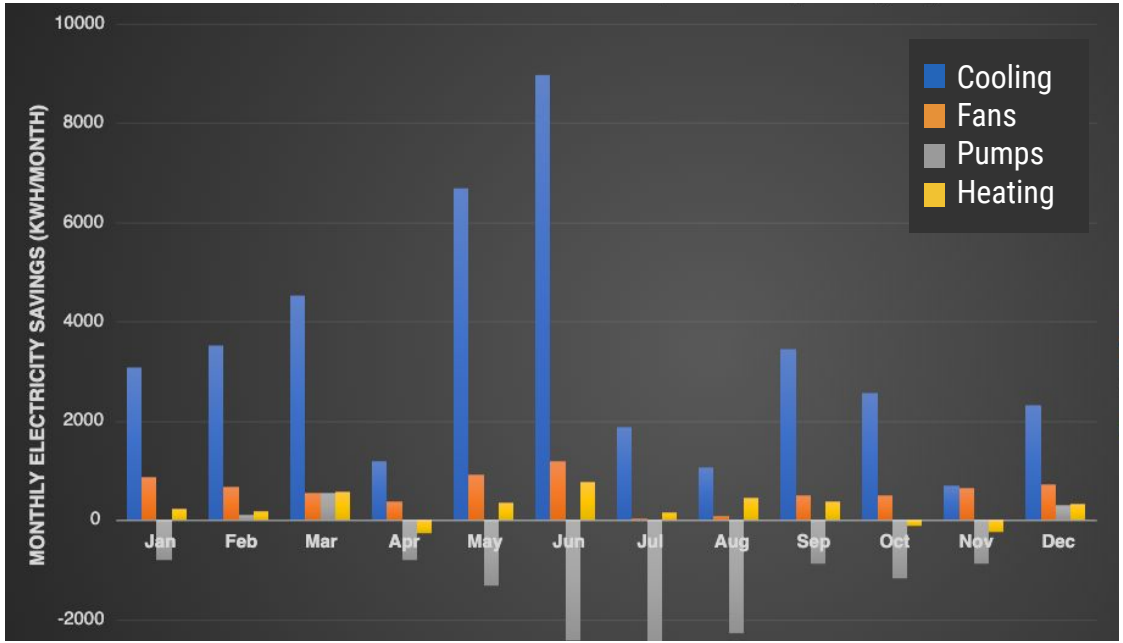
Simulated Model Results: Energy Savings

Building	Metric	2019 Baseline	Modeled Supervisory Control Case	Annual Savings	Percent Reduction (%)
Austin Courthouse	Total Site Energy Usage (kBtu/yr)	17,248,644	15,344,111	1,904,533	**11%**
Dallas Terminal Annex	Total Site Energy Usage (kBtu/yr)	10,682,098	10,140,544	541,554	**5.1%**
Harvey Wiley	Total Fan (kWh/yr)	857,570	91,702	65,868	**8%**

Terminal Annex Results Summary

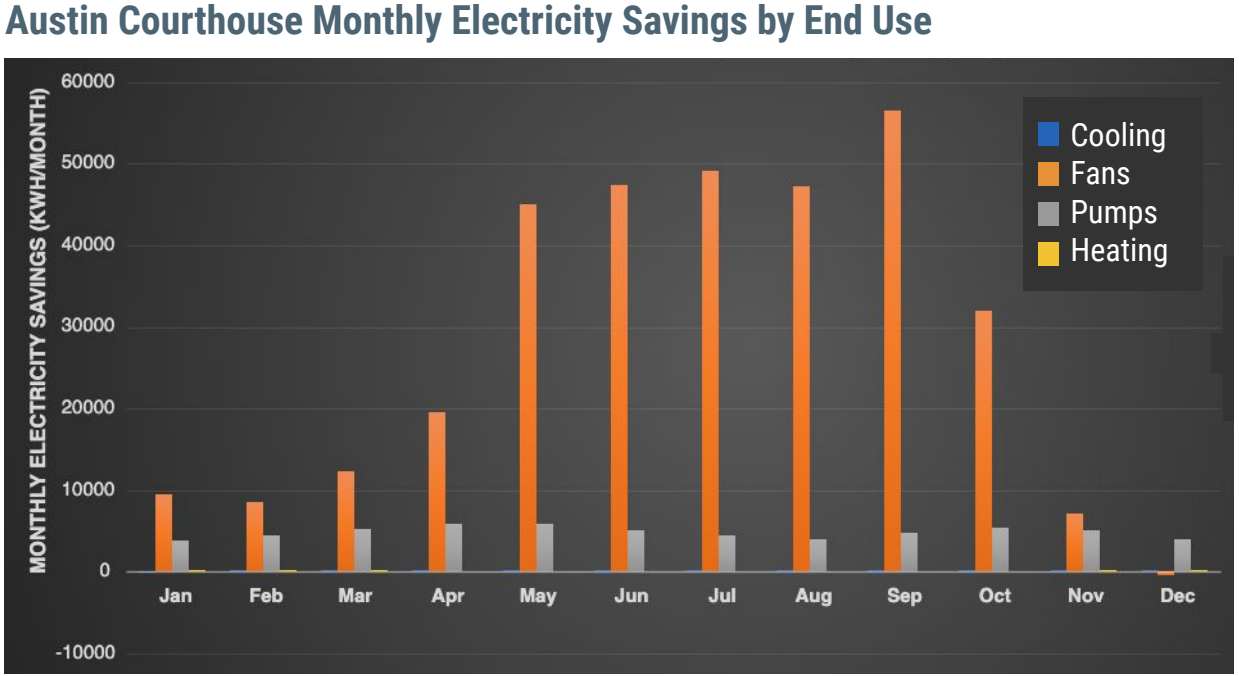
- Majority of savings come from chillers in swing months
- Peak demand increased June through September due to modified start time

Terminal Annex Monthly Electricity Savings by End Use



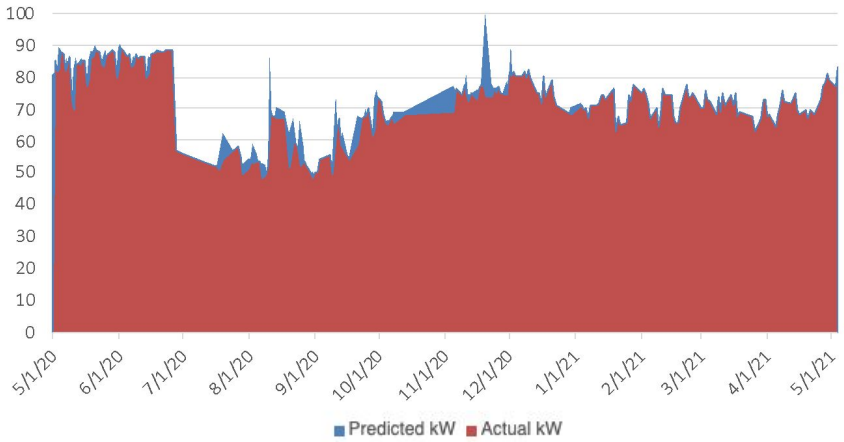
Austin Courthouse Results Summary

- Majority of savings come from fans
- DOAs, ERV, variable-speed chilled water plant & other factors result in no increase in summer demand

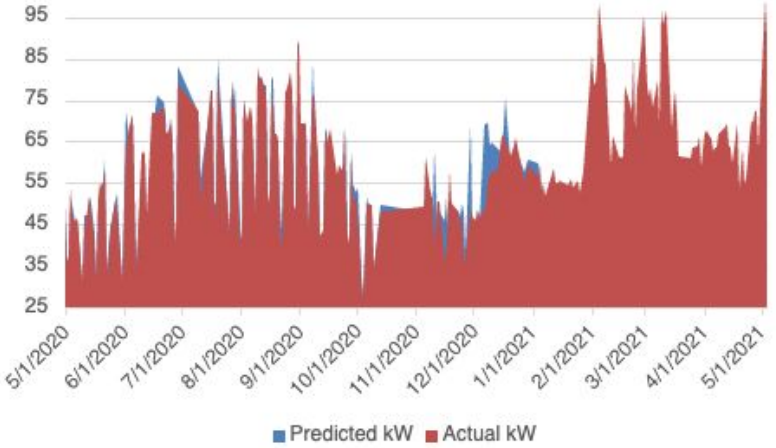


Peak Demand Prediction, Austin & Dallas

98.5% Accuracy: Austin Courthouse

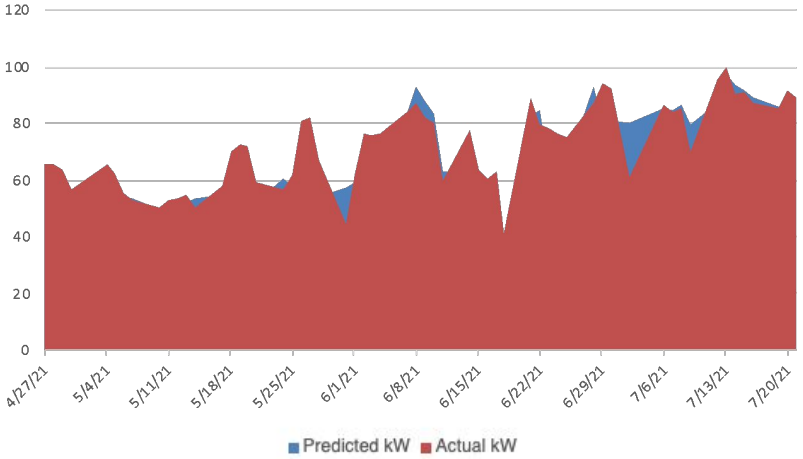


97.5% Accuracy: Dallas Terminal Annex

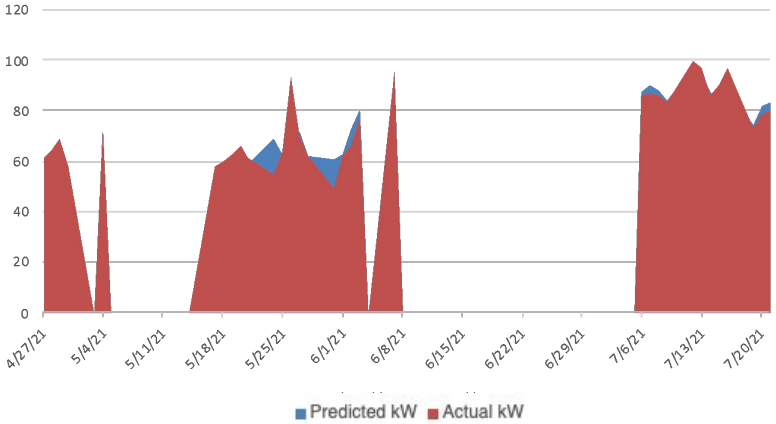


Peak Demand Prediction, ATF & Wiley

95% Accuracy: ATF Headquarters



96.5% Accuracy: Harvey Wiley Federal Building



Cost Effectiveness of Automated System Optimization*

	Dallas Terminal Annex ~5% savings	Austin Courthouse ~11% savings
Installation Cost	$37,082	$42,925
Annual Subscription Cost ($0.10/sf/yr)	$25,311	$25,100
Annual Energy Cost Savings, @ local utility rate ($/yr)*	$7,343	$23,822
Annual Cash Flow, Test Bed ($/yr)	-$17,968	-$1,278
Simple Payback, Testbed ($0.066/kWh Dallas, $0.082/kWh Austin)	Annual SaaS fee exceeds savings	Annual SaaS fee exceeds savings
Simple Payback, GSA Blended Avg Utility ($0.11/kWh)	Annual SaaS fee exceeds savings	4.84 yrs

* At the time of the evaluation, the SaaS cost was $0.02/ft^2 for the EMIS and $0.10/ft^2 to include ASO

Market Analysis

	5% Annual Cost Savings	7.5% Annual Cost Savings	10% Annual Cost Savings	12.5% Annual Cost Savings
# of cash-flow positive facilities (out of 504)	**90**	**223**	**322**	**424**
Total Building Area (ft^2)	30,488,470	77,028,119	106,211,953	139,233,885
Gross Annual Cost Savings pre SaaS ($/yr)	$4,538,021	$12,467,287	$19,949,064	$28,689,424
Net Annual Cost Savings after SaaS ($/yr)	**$1,489,174**	**$4,764,475**	**$9,327,869**	**$14,766,035**
Annual Subscription Cost ($0.10/$ft^2$/yr)	$3,048,847	$7,702,812	$10,621,195	$13,923,389

- Cost savings use blended energy rates
- Break even point depends on utility cost per ft^2, annual savings amount from software, and geographic region
- Does not factor installation/contractor cost due to varying expenses of integration and building technology sophistication

Deployment Recommendation

For ASO to be cost-effective, prioritize facilities with:

- High EUI and energy costs
- Recent re-commissioning in the last 4 years and no major operational issues
- Advanced smart building technologies, such as automated lighting controls, plug load controls, or onsite batteries that would benefit from automated optimization

If automated demand management is proven successful in the subsequent GPG-evaluation, sites with high-demand charges will have a higher return on investment.

GSA Feedback

Tyler Harris
Energy Management Officer and
Director of Energy for GSA

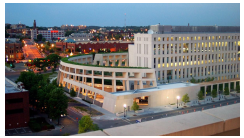
Joshua Banis
Lead Sustainability Program Manager
GSA Region 7

Installation Schedule

Austin Courthouse: November 1, 2019 — February 15, 2020

Dallas Terminal Annex: November 1, 2019 — February 15, 2020

Harvey Wiley: March 15, 2020 — June 15, 2020



ATF: April 22, 2020 — July 30, 2020

Ease of Installation Survey Results

Category	Number of Questions	Number Surveyed	Results
System Integration	3	2	4.67
IT Integration	2	1	4.5
Cybersecurity	2	3	5
Contracting	4	3	3.5
Total	**11**		**3.92**

Installing as a holistic project, bundled together simplified installation in R7 instead of separate contracts

For cloud-solutions: vendor has to be supportive and responsive

Commissioning ML/AI based OSS and Mid-Day and End of Day ramps occurred after each system was commissioned and critical zones were identified.

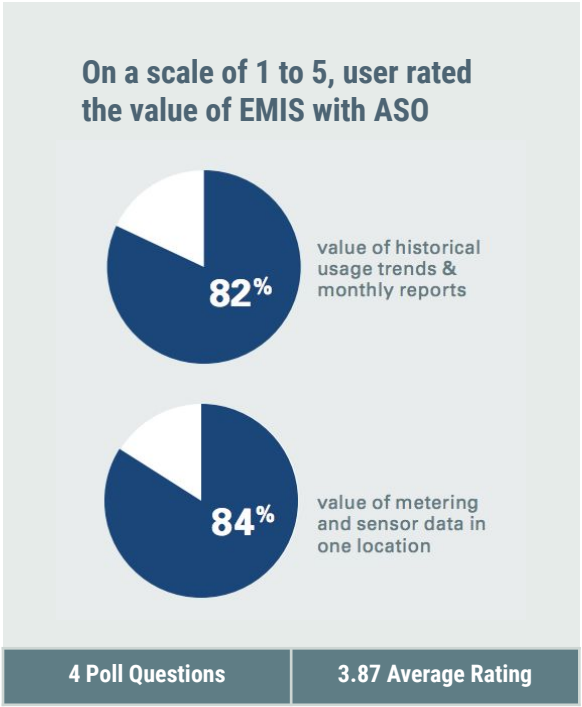
Installation

- Installation is faster without ASO and when integrating fewer BAS points. **Fifteen additional facilities were integrated into the unified user interface in a few hours each.**
- Integrates natively with Tridium Niagara 4 and Schneider EcoStructure and can be installed without hardware and in less time relative to other BAS applications.
- Faster installation for facilities where meter and sensor data is already integrated into the BAS and where standard GSA point naming conventions are used.

Qualitative Feedback: Single Pane of Glass

Consistent Themes:

- **20/21** participants would continue to use the Single Pane of Glass capability
- Trending data is “superior to the BAS or other AMS application”
- We wish we could have had more buildings in the portfolio included in the pilot

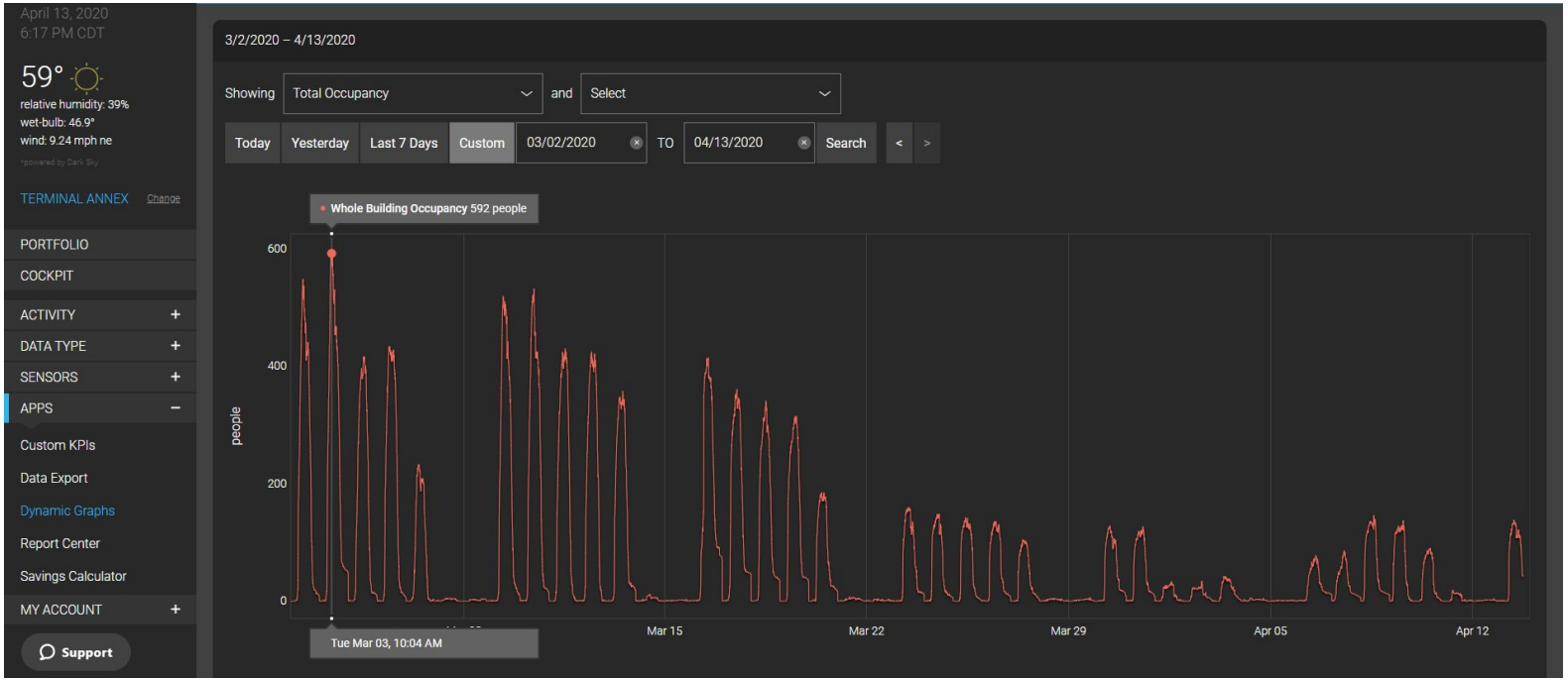


Qualitative Feedback: Single Pane of Glass

How well did this help you track your KPIs, such as energy consumption, in your building and across your portfolio?	*"Data can be shared with O&M to pinpoint issues and then I can remotely track the building to see that issues are resolved."*
Rate the value of the ability to show all metering and sensor data in one application	*"It's much easier and quicker than accessing data in the BAS, which allows me to do more work."*
Rate the usefulness in day-to-day operations over current practices	*"The ability to see what happens in a remote building in real-time is invaluable. Previously, if I wanted to see what was happening in Gallup, New Mexico I would have to fly to Albuquerque and then drive for 3 hours."*

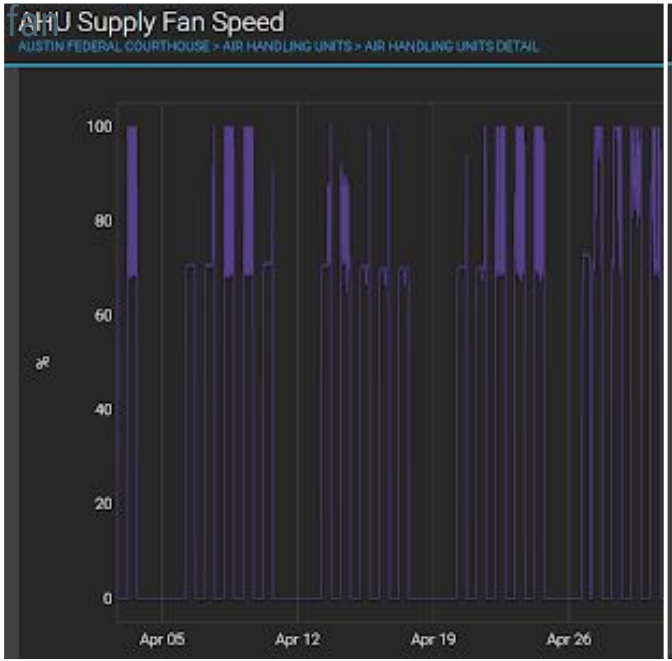
Data Made Operational Issues Visible

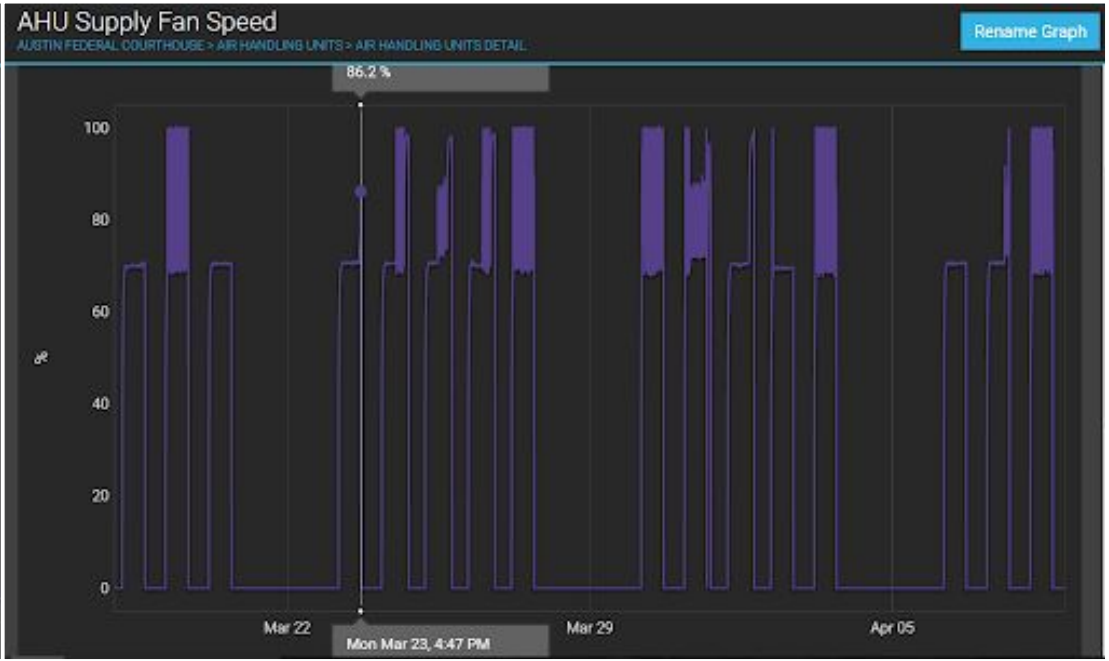
Terminal Annex: COVID Occupancy



Data Made Operational Issues Visible

Austin Courthouse: AHU fan cycling



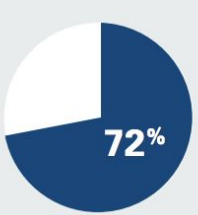


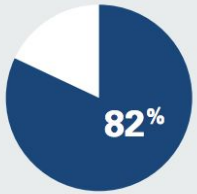
Qualitative Feedback: Operability

Consistent Themes:

- Provides a one-stop-shop for all building data requirements
- Participants wanted kW prediction to facilitate automation of the changing of setpoints to save money and energy features
- Solution could be improved with enhancements to customized reporting

On a scale of 1 to 5, user rated the value of EMIS with ASO





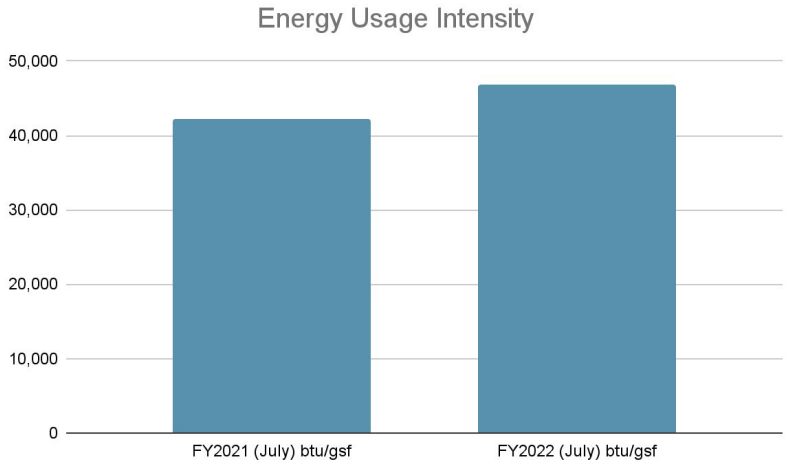
5 Poll Questions	3.99 Average Rating

Operability

Rate the usefulness in day-to-day operations over current practices	*“Wish we had this sooner”* *“Definitely an improvement over current practices”*	*“Takes the pressure off running a building. It’s impossible to track 30,000 building points. The margin of error is small and the scope is huge."*
Rate the ability to view historical usage trends and create monthly reports	*“Found this useful for finding 24/7 issues. By looking at the data we found problems and saved utility costs”*	*“Helps in reporting out, though to satisfy KPI, reporting would need a larger subset of buildings represented.”*
Rate the value of of real-time occupancy data to control fan speeds and setpoints	*“Because it’s real-time it can help protect equipment.”* *"The most useful function was the automated end-of-day ramp.”*	*"Before [this technology] we gave our buildings a huge buffer and started our buildings every day at the same time for the worst-case scenario. It’s so much better to know that using predictive data, we will hit the temp when we need to."*

Terminal Annex After Automated System Optimization

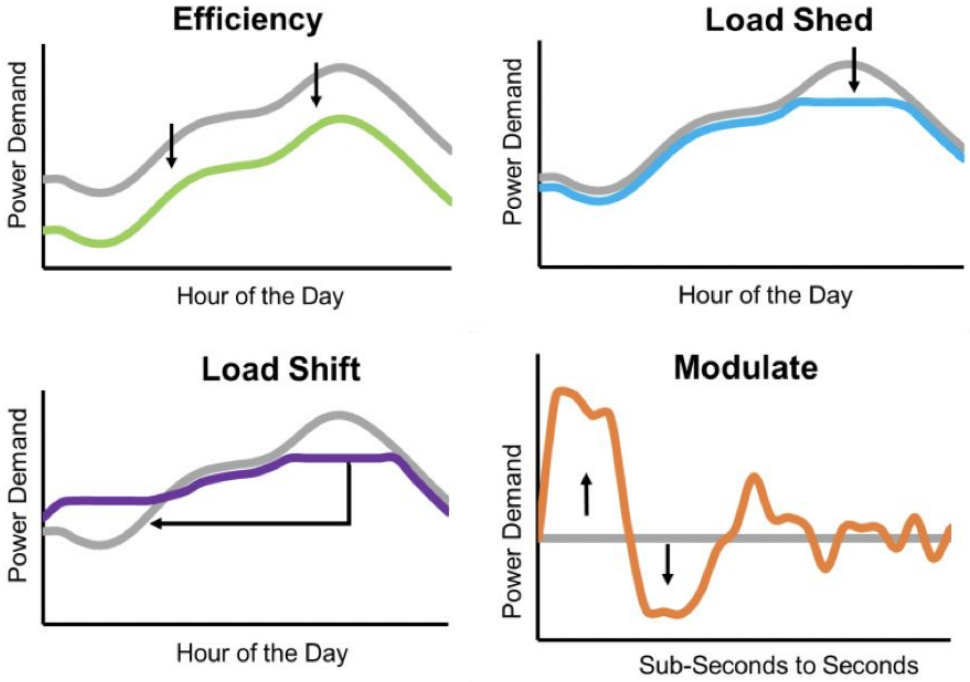
The R7 team noticed a 10.95% energy increase from the time that the EMIS ASO platform was brought offline compared to one year following decommission.



Best Practices/Lessons Learned

- Meet with building operators early on to get buy-in and provide adequate training.
- Test automated control at night and on weekends to make sure commands are working.
- The start-up algorithm should account for both electricity consumption and demand. Limiting pre-cooling can reduce the charging of the thermal mass which can impact peak demand in the summer months.
- Select an EMIS with ASO that can be integrated with different levels of effort and expense. In the case of the EMIS evaluated, not all sites were cost-effective for automated system optimization.

Grid-Interactive Efficient Buildings (GEB)



- GEBs flexibly reduce, shed, shift, modulate or generate electric load
- EMIS solutions with ASO are a cornerstone to GEB and electrification
- GPG is extending the evaluation of this technology to validate automated demand response (ADR) and realtime utility demand interaction
- GSA is also participating in the DOE Federal Smart Buildings Accelerator to field validate other EMIS with ASO and GEB solutions

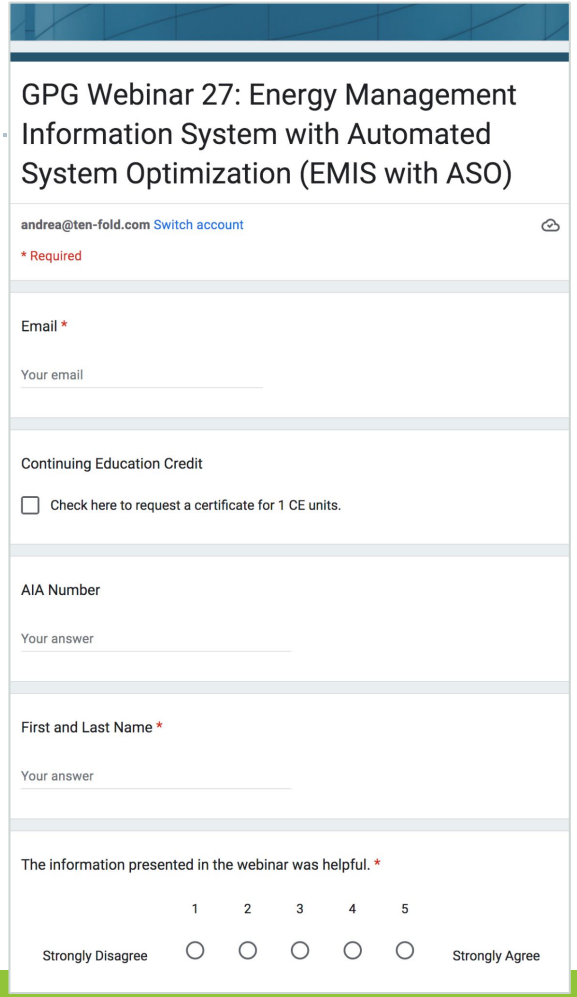
Q & A

Survey and Continuing Education Credit

GPG webinars offer 1 Continuing Education Learning Unit through the American Institute of Architects. GSA attendees are eligible for 1 Continuous Learning Point (CLP).

To receive credit:

Complete the post-webinar email survey.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	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Thank you

For more information: gsa.gov/GPG

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