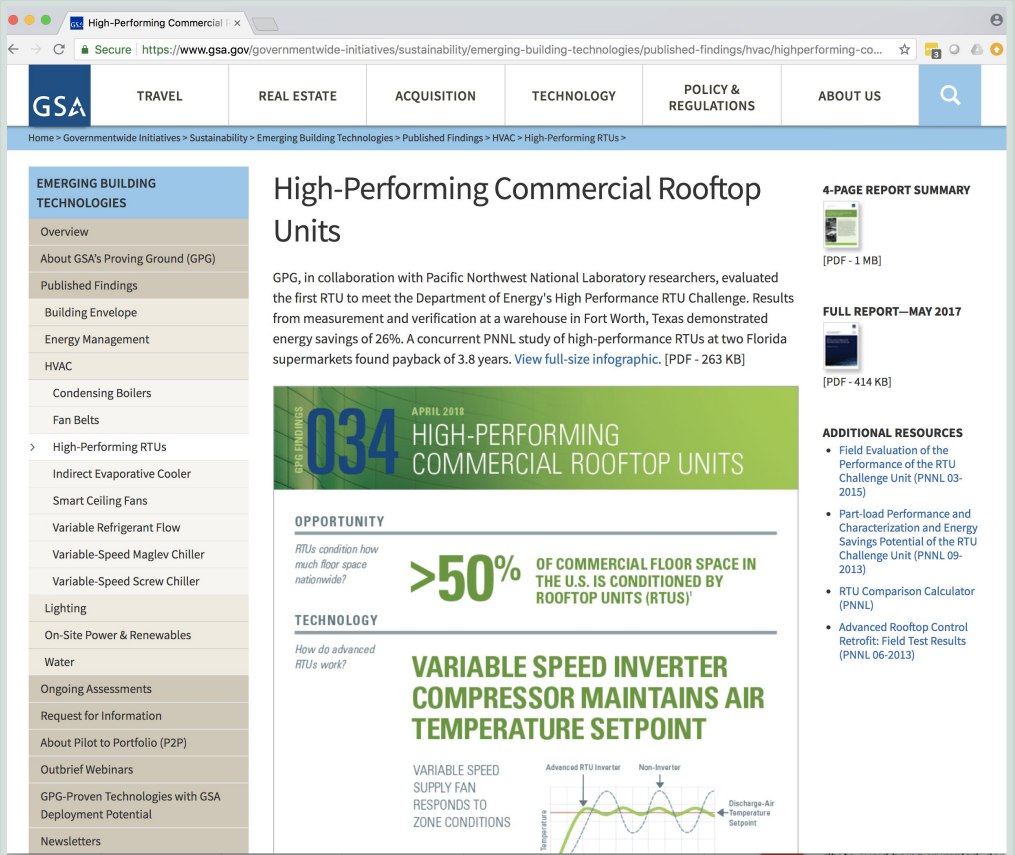
GPG Outbrief 15

High-Performing Commercial RTUs

Emerging Building Technologies, GPG Program | U.S. General Services Administration | September 6, 2018

GPG-034 High-Performing Commercial RTUs @ gsa.gov/gpg

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



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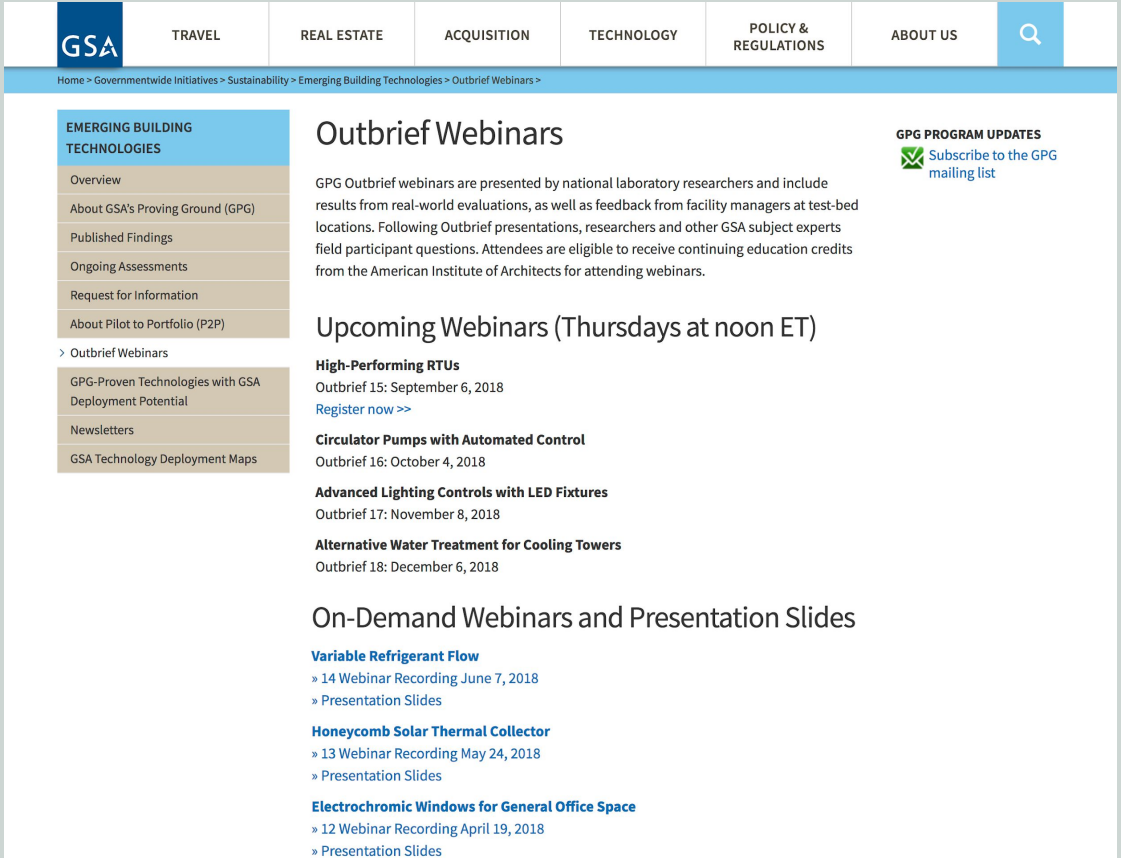

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Outbrief Webinars

GPG Outbrief webinars are presented by national laboratory researchers and include results from real-world evaluations, as well as feedback from facility managers at test-bed locations. Following Outbrief presentations, researchers and other GSA subject experts field participant questions. Attendees are eligible to receive continuing education credits from the American Institute of Architects for attending webinars.

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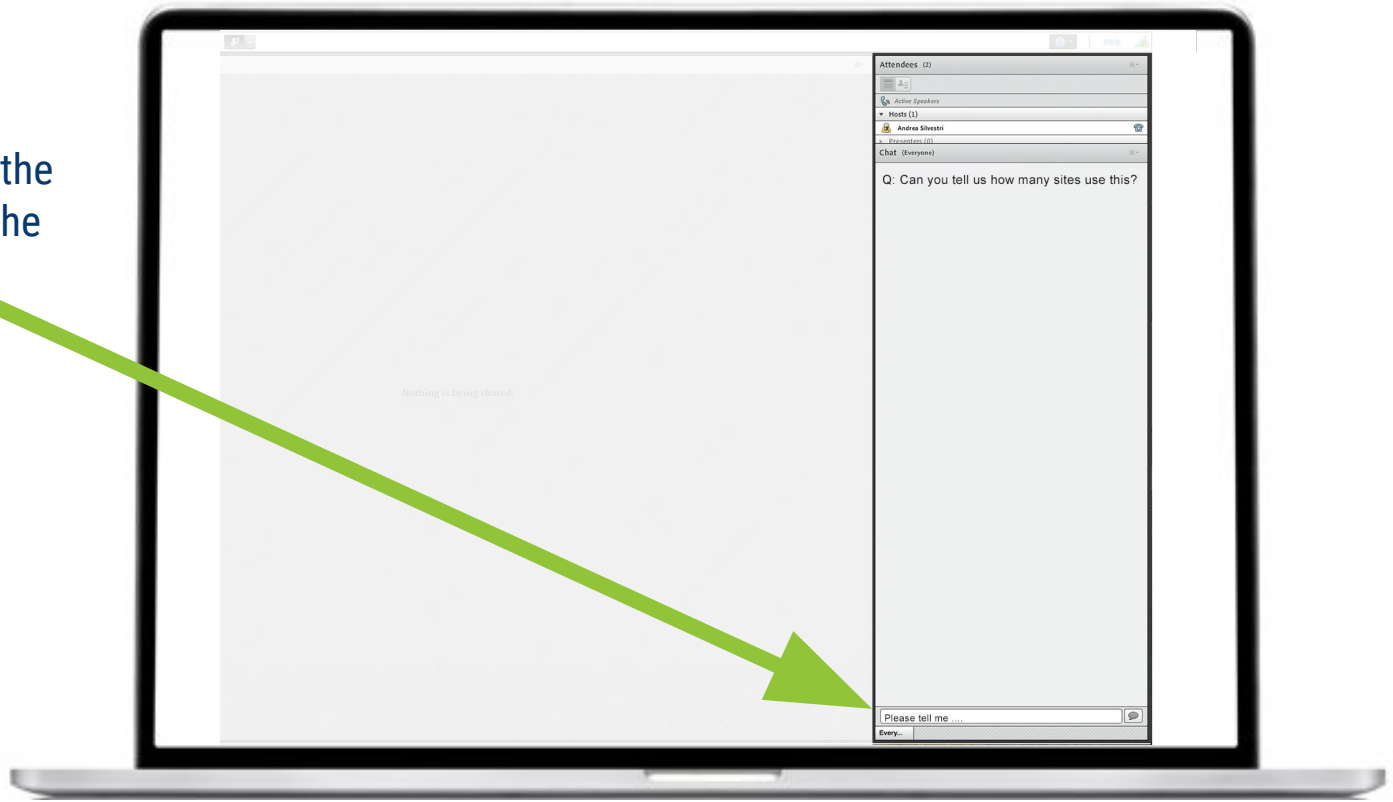

Introduction

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Webinar Agenda

- Introduction (5 minutes)
  Kevin Powell, Program Manager, Emerging Building Technologies
- RTU Challenge Report (15 minutes)
  Srinivas Katipamula, Pacific Northwest National Laboratory
- On-the-ground Feedback R7, Fort Worth Depot (15 minutes)
  Frank Campagna, Stuart Lamkin
- Q & A (20 minutes)

Introduction

Kevin Powell
Program Manager, Emerging Technologies
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Emerging Building Technologies' two programs—GSA Proving Ground (GPG) and Pilot to Portfolio (P2P)—enable GSA to make sound investment decisions in next-generation building technologies based on their real-world performance

Partnership With DOE

2011

DOE's Building Technologies Office developed a specification for high-performance commercial RTUs

2013

Daikin was first RTU to meet the challenge

2015

GPG: 5-ton unit tested at GSA warehouse in Fort Worth, Texas

HIT Catalyst: Two 7.5-ton units tested at Florida supermarkets

Measurement & Verification

Srinivas Katipamula
Senior Research Engineer
Pacific Northwest National Laboratory

GPG-034

High-Performing Commercial RTUs

General Services Administration
Public Buildings Service

GSA

GPG-034 | APRIL 2018

HIGH-PERFORMING COMMERCIAL RTUs

Advanced RTU Yields Substantial Savings

Rooftop units (RTUs)—also known as packaged air conditioners—are used to condition nearly half of all commercial floor space in the United States and constitute the most common HVAC equipment found in low-rise commercial structures. RTUs are easy to install and have low first costs but legacy models, built with constant speed drives and without advanced controls, are inherently inefficient. To stimulate the market for higher-performing RTUs, the Department of Energy's (DOE's) Building Technologies Office issued a challenge to manufacturers to build an RTU 50% more efficient than ASHRAE 90.1 standards. The first RTU to meet DOE's "High Performance RTU Challenge"specification was installed in a GSA warehouse in Fort Worth, Texas, and compared, under real-world conditions, with an existing RTU typical of those in the field. Researchers from the Pacific Northwest National Laboratory (PNNL) found that the seasonal energy efficiency ratio (EER) of the "challenge RTU" was 16% higher than the baseline unit, which was already 4% more efficient than ASHRAE 90.1 standards. When ventilation energy from both units, with fans running 24-hours a day, was taken into account, savings increased to 26%. A concurrent study by PNNL of advanced RTUs at two Florida supermarkets demonstrated energy savings of 31% and payback of 3.8 years.[1]

Opportunity

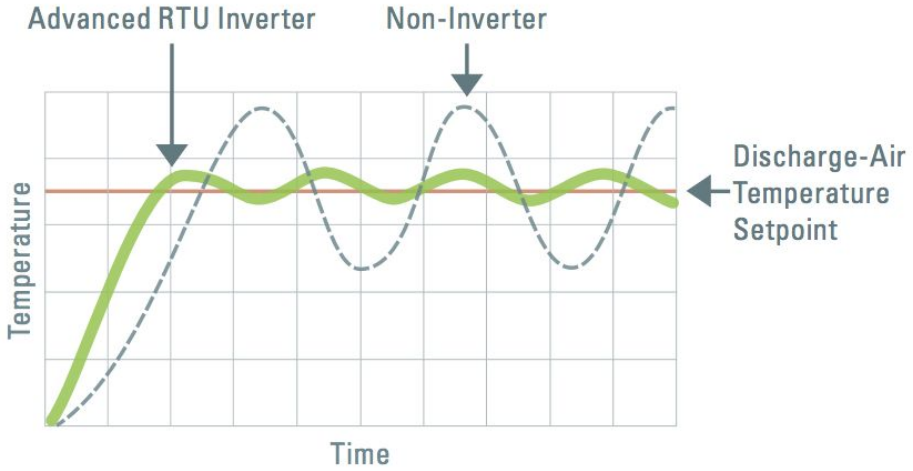
50% of U.S. commercial floor space conditioned by RTUs

Two Variations on High-Performing RTUs

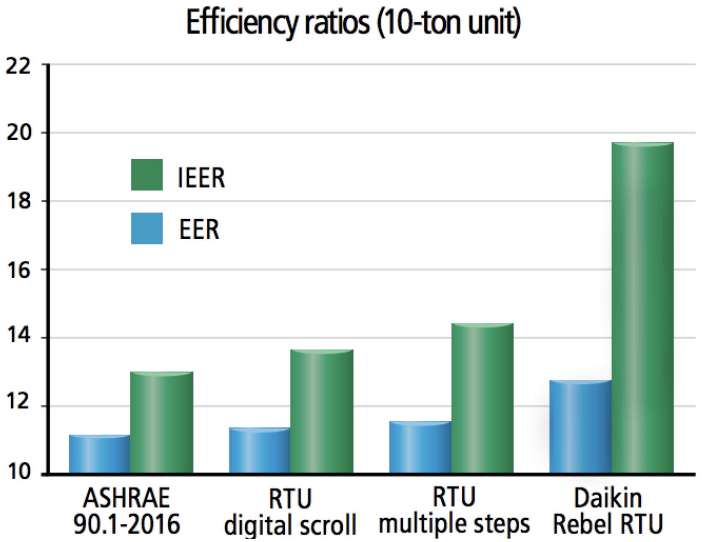
Variable-Speed Fans

Fans are a fraction of compressor energy use but operate more hours and account for ~45% of annual energy use

Variable-Speed Fans & Variable-Speed Compressor



High-Performing RTU Components



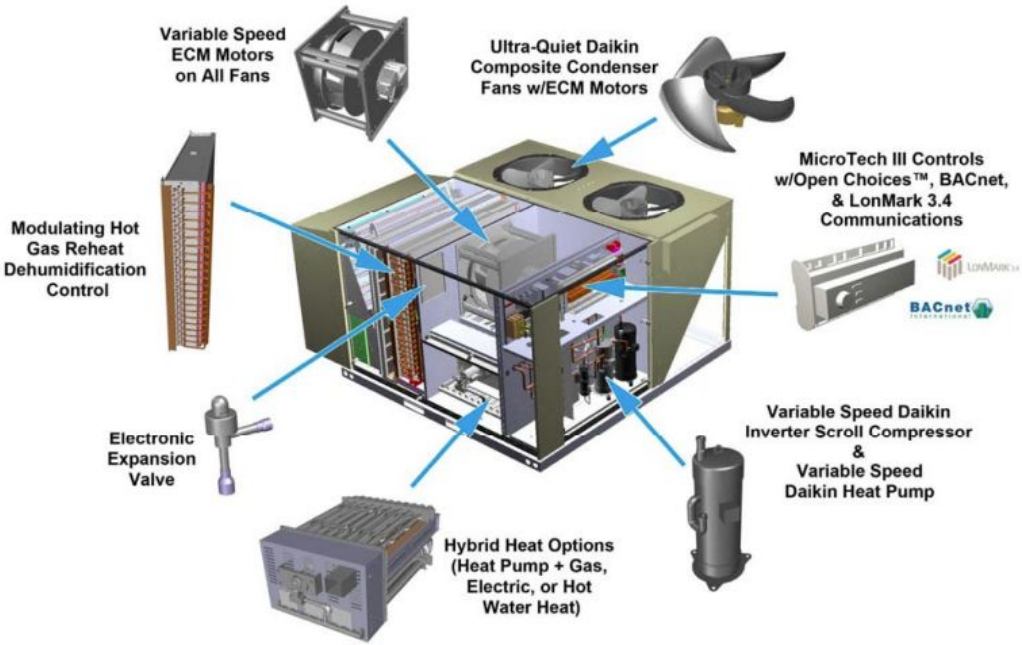
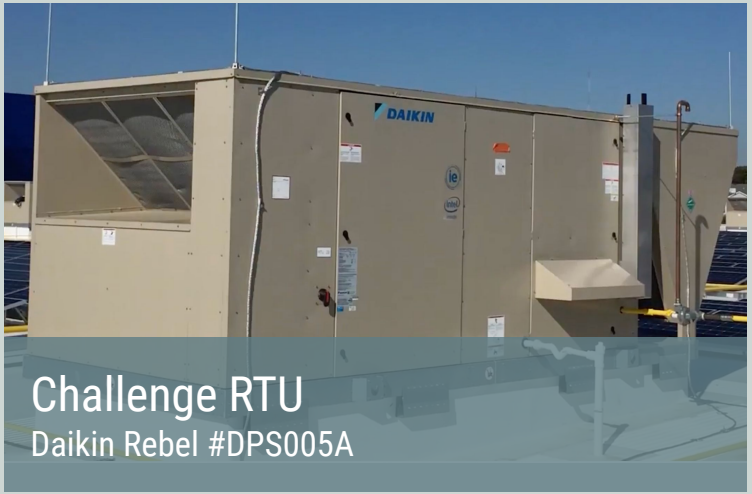


Image source: Daikin

Measurement & Verification

Researchers Monitored Performance at Fort Worth Depot. Concurrent PNNL Study at Two Florida Supermarkets.



Challenge RTU
Daikin Rebel #DPS005A

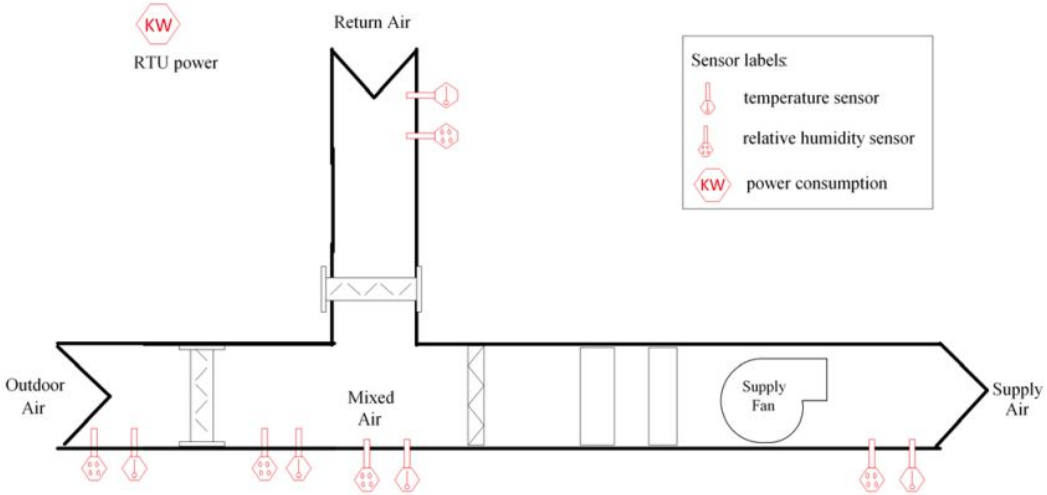
Baseline RTU
Rheem #RLNL-A060CK

Technology for test-bed measurement and verification provided by Daikin

M&V Process

Simultaneous Monitoring for 10-months

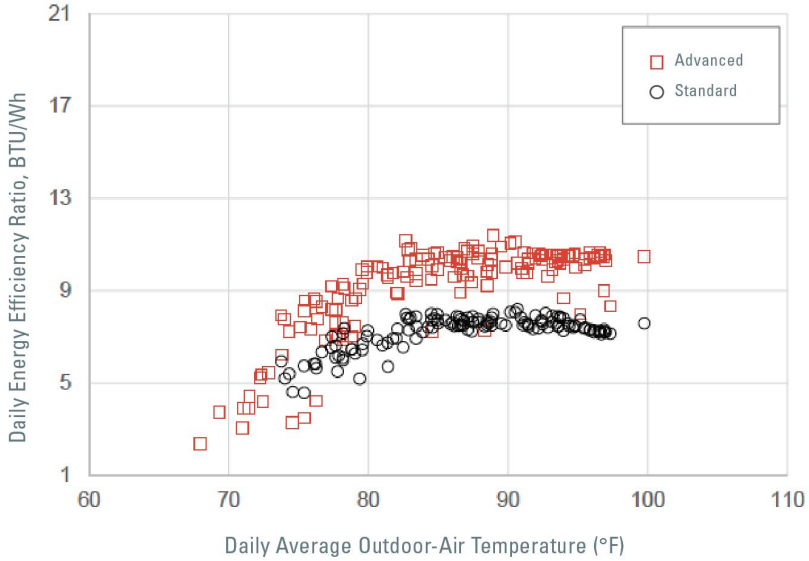
Temperature, humidity and power consumption sensors



Energy Efficiency Ratio as a Function of Outdoor Air Temperature

Seasonal Energy Efficiency Ratio (EER) 16% Higher Than Baseline

Advanced RTU exceeds baseline efficiency, particularly at higher outdoor air temperatures



Baseline at test bed was 4% more efficient than ASHRAE 90.1 standards

Energy Savings Increases to 26% with Ventilation Energy

Savings Not as Great as Models Predicted

- The two units at the test bed served different loads, whereas in the simulation they served the same load.
- The baseline unit at the test bed had higher operating efficiency than the simulation: EER of 11.4 vs 11.
- The baseline unit recirculated 100% of the air, whereas the challenge unit introduced outside air, which creates additional friction and can consume more energy.
- The simulation assumed a 10-ton unit, which was slightly more efficient than the 5-ton unit: EER of 12.5 vs 12.3.

26%

ENERGY SAVINGS

Models predicted 40% savings compared to a standard RTU

Installation

Infrastructure Reinforcement and Other Adjustments

- The challenge unit had a different footprint from the legacy RTU and was considerably heavier, requiring roof infrastructure reinforcement.
- Commissioning required minor changes to the initial startup configuration and BAS.
- Support team modified Tridium network and power sensors to correct issues related to trending and power meter accuracy.
- Duct changes are sometimes required.

Return on Investment

Installation Costs Vary

Heavier unit and different footprint may require infrastructure reinforcement or duct changes

	Standard RTU	Challenge RTU
Annual Consumption (kWh)	34,000 kWh	18,000 kWh
Savings (kWh)		16,000 kWh
Savings @ local electricity rate $0.10/kWh		$1,600
Incremental Cost		$6,000
End-of-Life Payback		3.8 years

3.8 YR

PAYBACK

demonstrated at two Florida supermarkets

Deployment for High-Performing RTUs

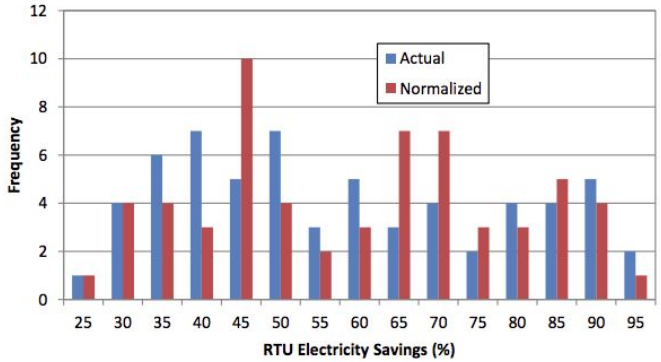
End-of-life Replacement

- Modeling indicates that savings will be greatest in hot, humid climates.
- High-Performance RTU with variable-speed compressor provides better humidity control and comfort.

Advanced Rooftop Control (ARC) Retrofits

For RTUs that Have Not Reached End-of-life, Less than 10 years old

A PNNL field study of 66 RTUs retrofitted with ARC found energy savings ranging from 22% to 90%, with an average 57% savings and 3 year payback (@ $0.10/kWh).

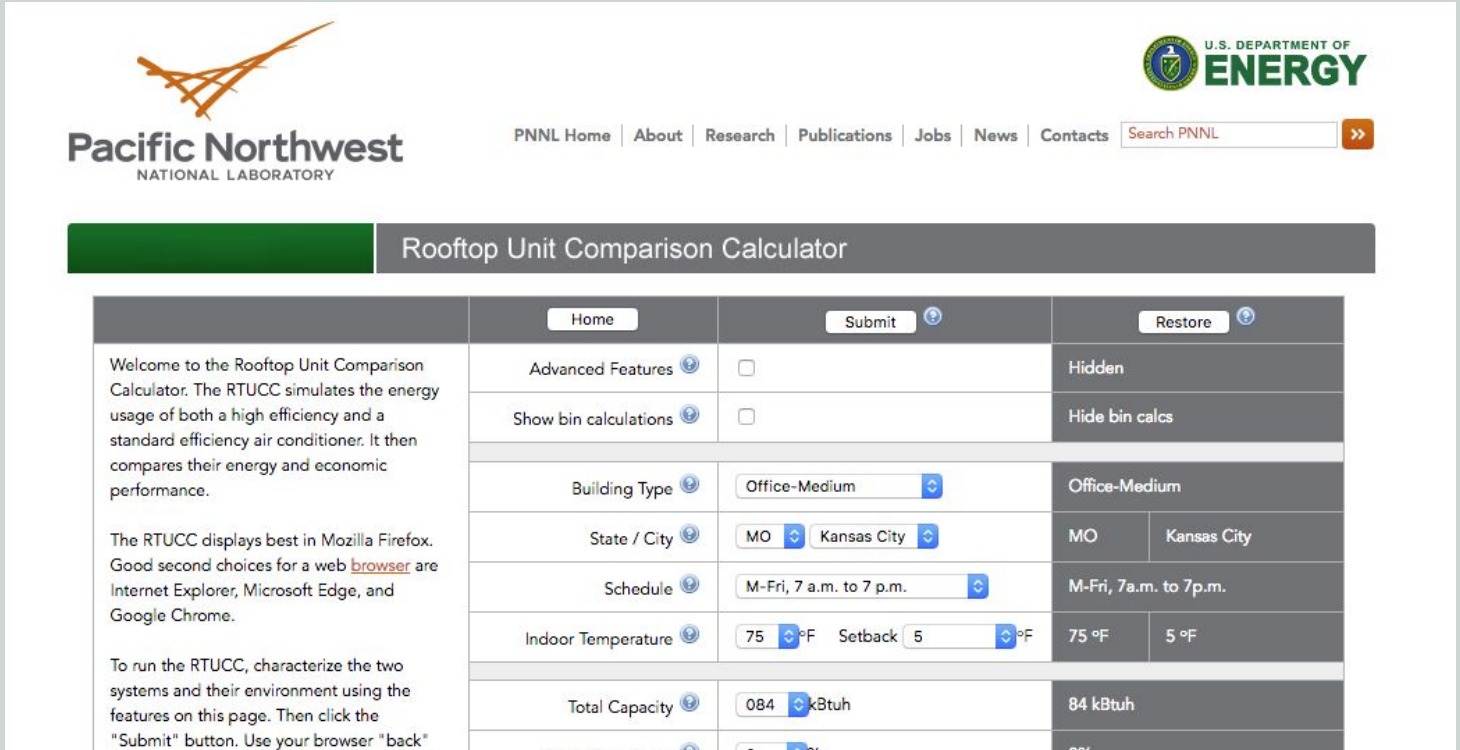


RTU Capacity (tons)	Supply Fan Size (hp)	Controller[1] ($)
≤ 5	1	$2,200
> 5 and ≤ 10	2	$2,600
> 10 and ≤ 15	3	$3,500
> 15 and ≤ 20	5	$4,000
> 20 and ≤ 25	7.5	$4,142

[1]2012 costs for reference only:
Controller Labor $750, Metering $1,071, Metering Labor $275, Fixed Monitoring $2,403, Variable Monitoring $50/month

RTU Comparison Calculator

https://www.pnnl.gov/uac/costestimator/main.stm



GSA Feedback—Fort Worth Depot

Frank Campagna
Supervisory Energy PM
GSA Region 7

Stuart Lamkin
Property Manager
GSA Region 7

Felipe Gaytan
Controls Integration
JMS Building Solutions

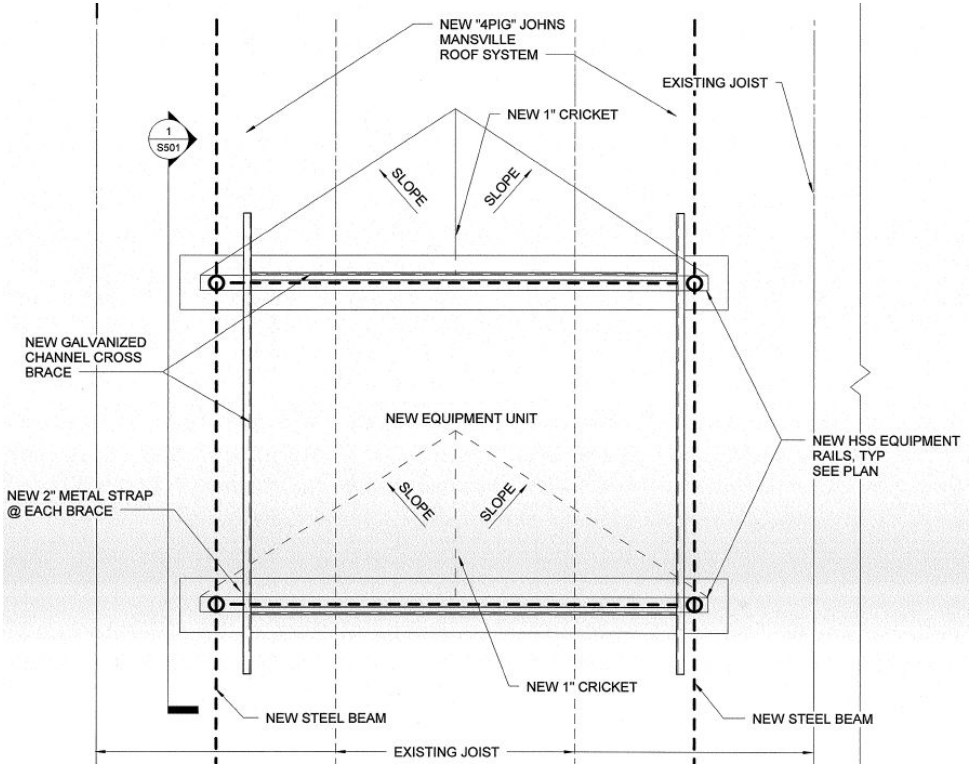
Installation of the High-Performing RTU

Biggest Challenge

- Integrating the RTU into the BAS (more points to customize)

Heavier Unit

- Had to install more girders into the roof to support the unit



Operations & Maintenance

No Maintenance Issues

- Quarterly PMs and replace filters as needed.
- Seeing more monitoring points gives you more information and helps operate the building better
- May be a bit quieter because not always running full-bore
- As in any construction project, it's important to keep tenants informed

Image source: Daikin

BAS Controls Integration

No Major Issues With Integration

- Unit lacked required sensors which had to be added on a separate controller

Limited Operator Control

- Time schedule and set point adjustments

Q & A

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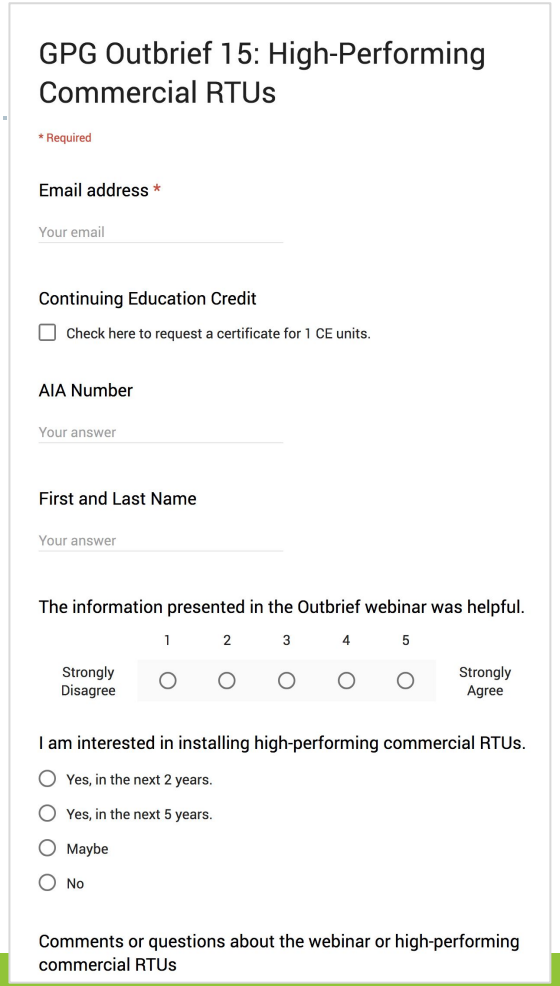

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Your answer

The information presented in the Outbrief webinar was helpful.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am interested in installing high-performing commercial RTUs.

- Yes, in the next 2 years.
- Yes, in the next 5 years.
- Maybe
- No

Comments or questions about the webinar or high-performing commercial RTUs

Thank you

For more information: gsa.gov/GPG

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