

GPG Outbrief 08

Socially Driven HVAC Optimization

GPG Program | U.S. General Services Administration | December 7, 2017

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

GPG-025 Socially Driven HVAC Optimization @ gsa.gov

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

The screenshot shows a web browser displaying the GSA website. The page title is "Socially Driven HVAC Optimization". The URL is "https://www.gsa.gov/governmentwide-initiatives/sustainability/gpg-program/published-findings/energy-management/socially-driven-hvac-optimization". The page features a navigation menu with categories like TRAVEL, REAL ESTATE, ACQUISITION, TECHNOLOGY, POLICY & REGULATIONS, and ABOUT US. A sidebar on the left lists various GPG programs, with "025. Socially Driven HVAC" selected. The main content area includes a section for "GPG PROGRAM" with sub-items like Overview, What is GPG?, Published Findings, Building Envelope, Energy Management, and Ongoing Assessments. The main heading is "Socially Driven HVAC Optimization" with a date of "GPG-025, December 2015". The text describes the program's goals and results, mentioning a 20% cooling savings and a 59% reduction in hot and cold calls. There are links to "READ 4-PAGE FINDINGS" (PDF - 542 KB) and "DOWNLOAD FULL REPORT" (PDF - 4 MB). A diagram at the bottom illustrates the system architecture, showing a BMS (Building Management System) connected to HVAC units, which are in turn connected to smartphones representing occupant input.

Home > Governmentwide Initiatives > Sustainability > GPG Program > Published Findings > Energy Management > 025. Socially Driven HVAC >

GPG PROGRAM

- Overview
- What is GPG?
- Published Findings
 - Building Envelope
 - Energy Management
 - 028. Control Optimization for Chillers
 - > 025. Socially Driven HVAC
 - 003. Advanced Power Strips
 - 001. Wireless Sensor Networks
 - HVAC
 - Lighting
 - On-Site Power & Renewables
 - Water
- Ongoing Assessments
- Request for Information
- Outbrief Webinars
- Technology Deployments

Socially Driven HVAC Optimization

GPG-025, December 2015

Socially driven HVAC optimization uses input from occupants in dynamic temperature management. Results showed 20% cooling savings, a 59% reduction in hot and cold calls and 83% of occupants more satisfied with their thermal conditions. *Click on the infographic below to enlarge.*

READ 4-PAGE FINDINGS
[PDF - 542 KB]

GPG Findings
025 - Socially Driven HVAC Optimization > [PDF - 542 KB]

DOWNLOAD FULL REPORT
[PDF - 4 MB]

Socially Driven HVAC Optimization
Federal Office Building
Bankruptcy Courthouse
Phoenix, Arizona > [PDF - 4 MB]

ADDITIONAL RESOURCES

- Case Study: Keeping Employees Productive through Thermal Comfort (Smart Buildings Center/NEEC, 2015)
- Overview: Smart Offices, How Intelligent Building Solutions are Changing the Occupant Experience (Navigant Research, 4Q 2015)

OPPORTUNITY

How is temperature typically controlled in commercial buildings?

SET TO A PREDETERMINED RANGE OR "DEADBAND"

Does not account for individual thermal preferences
Wastes energy by over-conditioning, particularly in unoccupied spaces

TECHNOLOGY

How does Socially Driven HVAC Optimization work?

USES DIRECT INPUT FROM OCCUPANTS IN TEMPERATURE MANAGEMENT

TRACKS USER PREFERENCES OVER TIME, FINE-TUNES THE DEADBAND
Optimizes energy savings by widening the deadband when there is no occupant input

Upcoming GPG Outbriefs—Thursdays, 12 PM ET

January 18	Next-Generation Chillers
February 8	Plug Load Control
March 22	Honeycomb Solar Thermal Collector
April 19	Electrochromic Windows

Webinar Recordings

Access all webinars on [GSA.gov](https://www.gsa.gov)

[GSA.gov/GPG](https://www.gsa.gov/GPG)

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How to Chat Your Questions

Please chat your questions during the presentation for the Q&A segment



Introduction



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Webinar Agenda

- ❑ Overview of GPG (5 minutes)
- ❑ Socially Driven HVAC Optimization (15 minutes)
Dan Howett, Oak Ridge National Laboratory
- ❑ On-the-ground Feedback (15 minutes)
Gabriel Sanchez and Mark Levi, GSA
- ❑ Q & A (15 minutes)

Introduction




Kevin Powell

Program Manager, Emerging Technologies

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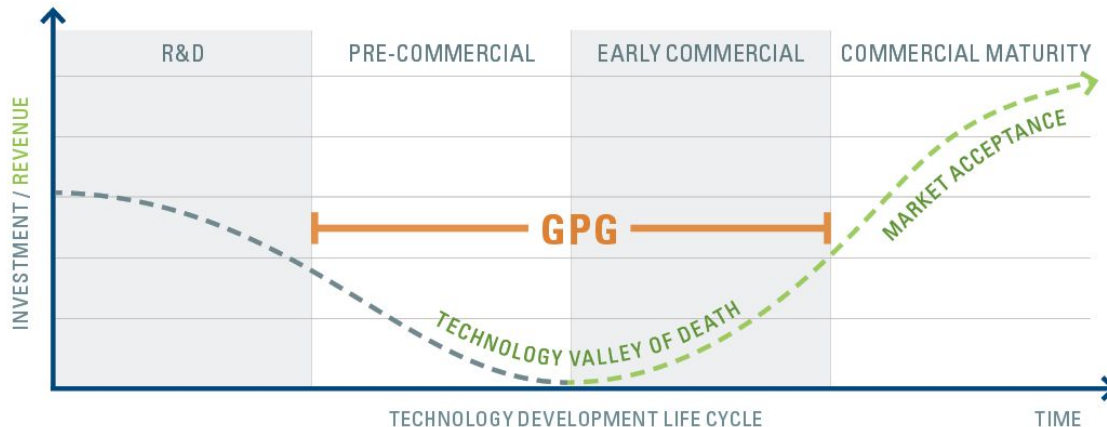
510.423.3384



Emerging 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

Leading by Example

GSA's Proving Ground accelerates market acceptance by objectively assessing innovative building technologies in real-world environments, and deploying those that deliver. To date, GSA has installed 9 technologies across more than 200 buildings. In aggregate, these technologies are delivering \$7.4 Million in annual O&M savings.



GPG Process



Identify promising technologies at the edge of commercialization



Pilot technology installations within GSA's real estate portfolio

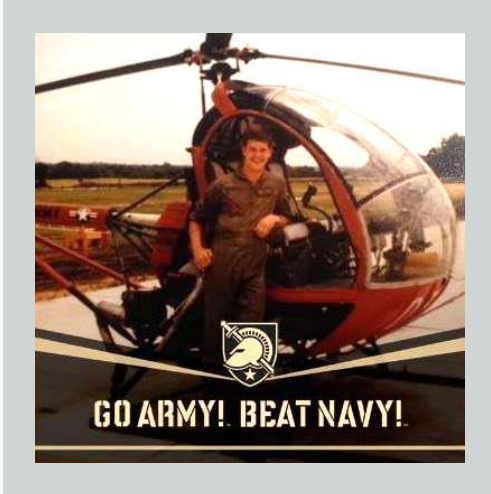


Partner with Department of Energy national laboratories to objectively evaluate real-world performance



Identify technologies with broad deployment potential for GSA, coordinate results with broader federal and CRE community.

Measurement & Verification



Daniel Howett

R&D Staff, Oak Ridge National Laboratory

GPG-025

Socially Driven HVAC Optimization

General Services Administration
Public Buildings Service



GPG-025 | DECEMBER 2015

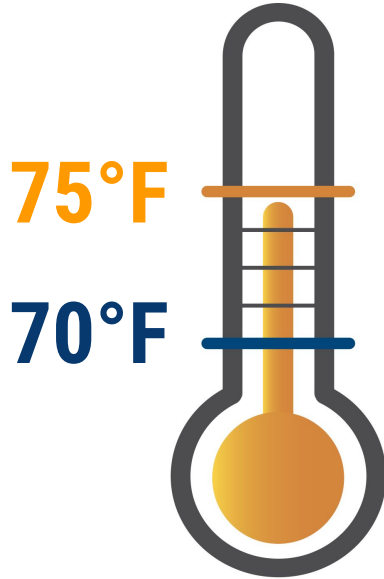
SOCIALLY DRIVEN HVAC OPTIMIZATION



Smart Temperature Control Optimizes Comfort and Saves Energy

Traditionally, heating, ventilation, and air conditioning (HVAC) systems in commercial buildings are set to maintain indoor air temperature within a predetermined range, or "deadband." Relying on a fixed deadband, however, does not take into account individual thermal preferences and often leaves occupants feeling too hot or too cold. It can also waste energy by over-conditioning, particularly in spaces that are intermittently occupied or unoccupied altogether. Socially driven HVAC optimization addresses these problems by including direct input from occupants. From a web page or smartphone, occupants request temperature changes to their local environment; in response, the system immediately delivers a 10-minute stream of hot or cold air. Control software tracks user preferences over time, fine-tuning the deadband to provide occupant comfort and widening it to optimize for energy savings when there is no input. To put socially driven HVAC to the test, GSA's GPG program commissioned Oak Ridge National Laboratory (ORNL) to conduct measurement and verification (M&V) at the Federal Building and

Opportunity



How is temperature typically controlled in commercial buildings?

Temperature is set to a predetermined range or “deadband”

- Individual thermal preferences are not used
- Wastes energy by over-conditioning, particularly in unoccupied spaces

Background: Current “Temperature Management” for Occupants

1. Occupant goes to wall and adjusts thermostat setting

Thermostat stays that way until re-adjusted by occupant, coworker, or building staff

2. Occupant enters a work order and waits for building staff

And waits, and waits, and waits...

3. Occupant tires of waiting, opens window, or buys electric heater

Building staff wonders about increased energy usage

4. Occupants in a cube farm debate the “best temperature”, and use Option 1 or 2

“Losers” of the debate implement Option 3

Uses Direct Input from Occupants in Temperature Management

Premise: If occupants have direct control of their space conditions, they will be comfortable under a wider range of conditions.

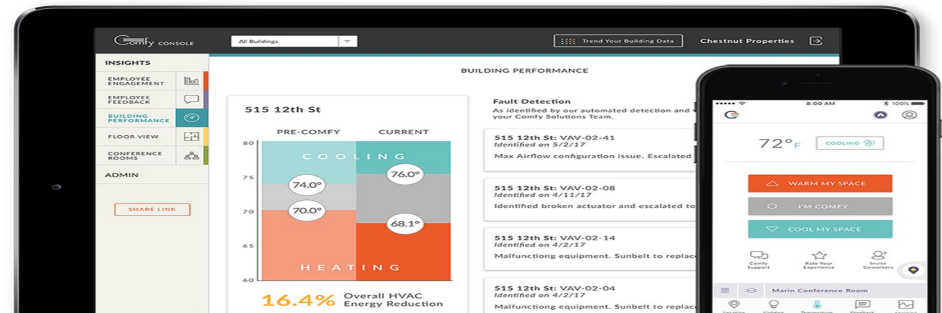
1. Occupants use desk-top or mobile app to send warm or cool request

Receive immediate 10-minute stream of warm or cool air.

2. Technology constantly adjusts temperatures to save energy

But keeps occupants “comfortable” based on feedback.

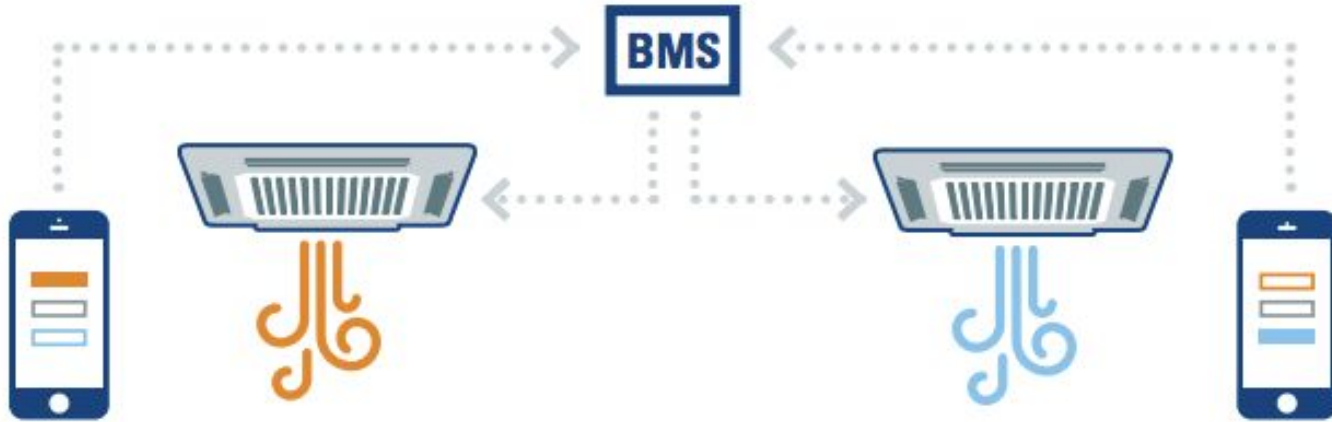
Tracks user preferences over time,
fine-tunes the deadband by widening
it when there is no occupant input.



How it Works

Connects to the Existing BMS

Request from the app translated into a BACnet command to temporarily adjust the setpoint.



Measurement & Verification, Phoenix Arizona

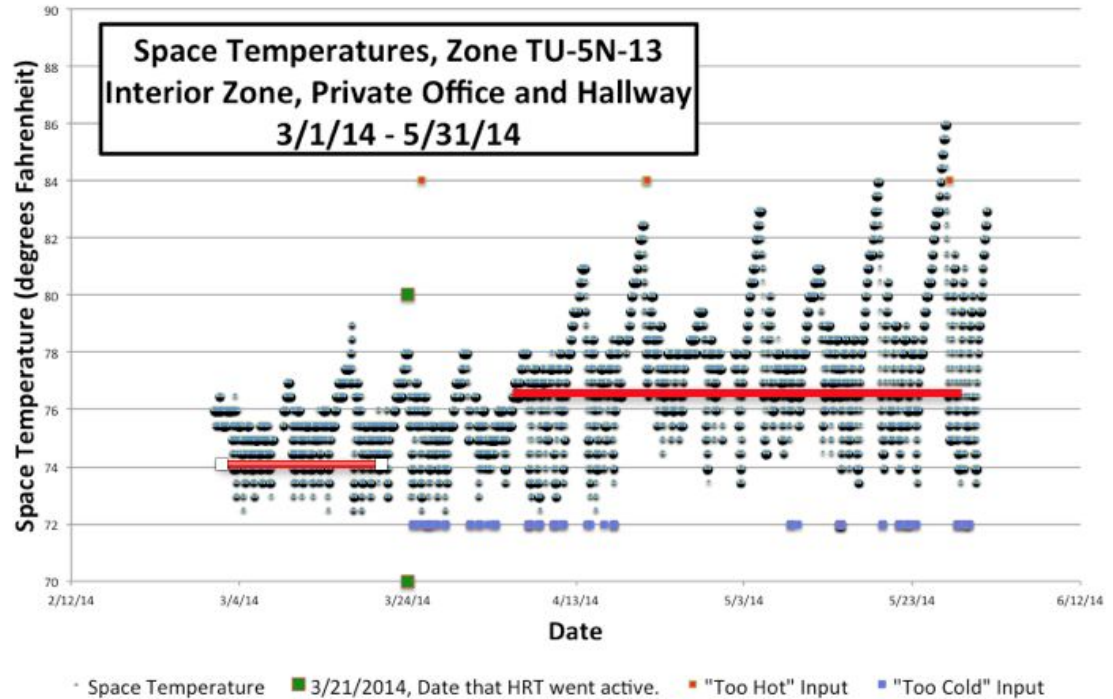


ORNL assessed Socially Driven HVAC at the U.S. Bankruptcy Courthouse, Phoenix, AZ

Technology for test-bed measurement and verification provided by Comfy

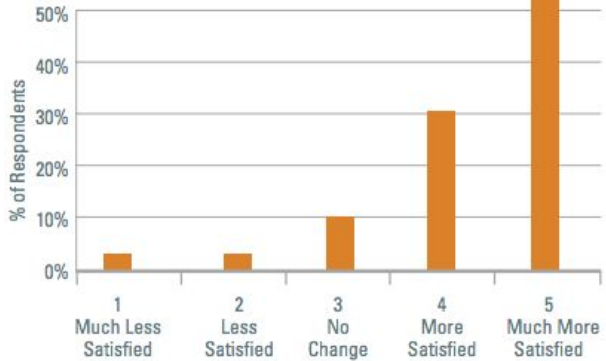
Test Plan

- Insure that technology provided a consistent burst of air in response to occupant input.
- Measure whether technology could adjust space temperatures to an energy-saving setting while maintaining occupant comfort.
- Track occupant comfort.

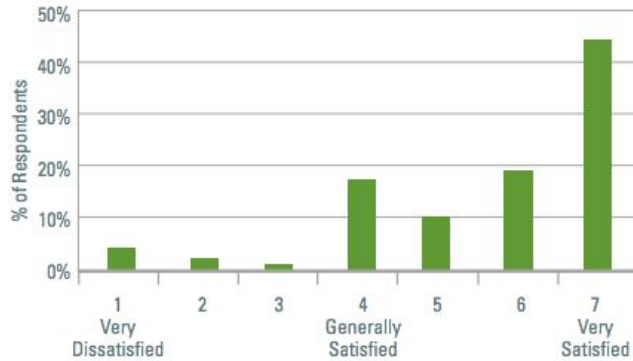


Satisfied Occupants

Occupant Satisfaction : Thermal Comfort



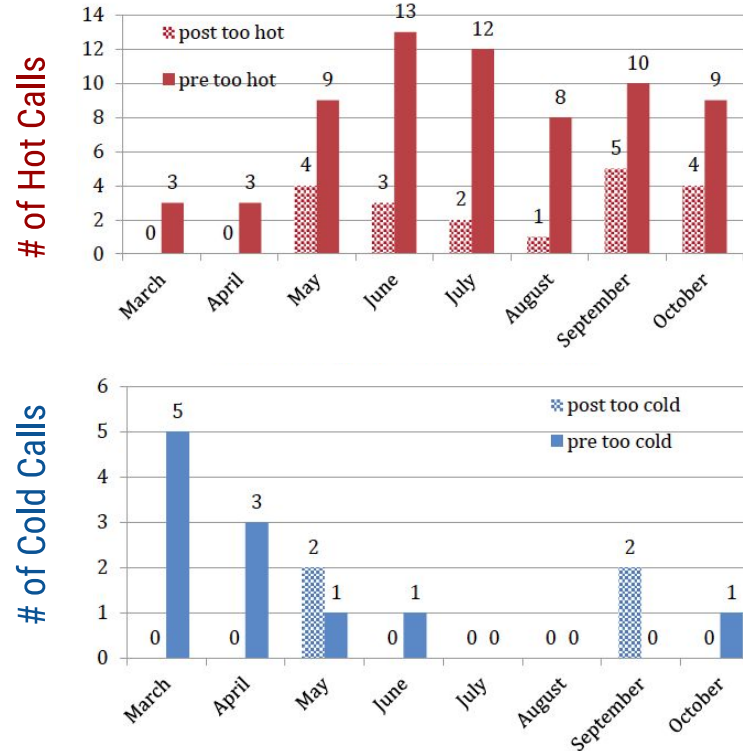
Occupant Satisfaction : Ease of Use



83%
OCCUPANTS
MORE SATISFIED
WITH THERMAL
CONDITIONS

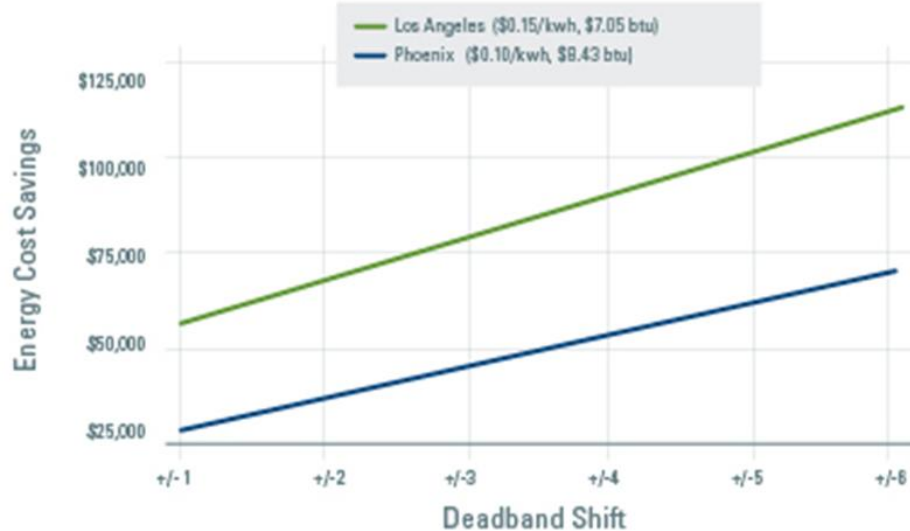
Reduced Hot & Cold Calls

59%
REDUCTION
IN HOT AND
COLD CALLS



Controlled System & Influenced Deadband

Energy Cost Savings for Large Building, 498,500 ft²



20%

**COOLING
ENERGY SAVINGS**

47% HEATING SAVINGS

Over typical GSA facility

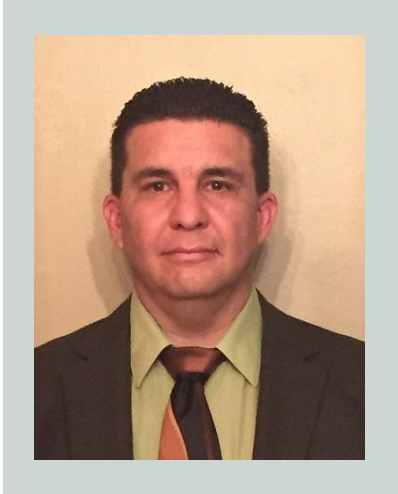
GSA Potential Deployment Opportunity

Location		Large Office - 498,500 ft ² Cost Savings (\$/ft ² /yr)	
CLIMATE ZONE	CITY	2° Shift ¹	4° Shift ²
1A	Miami, FL	\$0.06	\$0.13
2A	Houston, TX	\$0.06	\$0.12
2B	Phoenix, AZ	\$0.07	\$0.13
3A	Atlanta, GA	\$0.08	\$0.15
3B-coast	Los Angeles, CA	\$0.11	\$0.15
3B	Las Vegas, NV	\$0.06	\$0.15
3C	San Francisco, CA	\$0.09	\$0.16
4A	Baltimore, MD	\$0.09	\$0.16
4B	Albuquerque, NM	\$0.05	\$0.10
4C	Seattle, WA	\$0.09	\$0.16
5A	Chicago, IL	\$0.06	\$0.10
5B	Boulder, CO	\$0.06	\$0.10
6A	Minneapolis, MN	\$0.05	\$0.09
6B	Helena, MT	\$0.06	\$0.10
7	Duluth, MN	\$0.06	\$0.10
8	Fairbanks, AK	\$0.09	\$0.12

Prioritize Where Thermal Comfort Is an Issue

- Savings will be greatest in facilities that are only intermittently occupied and have narrow deadbands and high energy costs.
- Modeling estimates cost savings for different locations, office sizes and deadband shift.

On-The-Ground Feedback



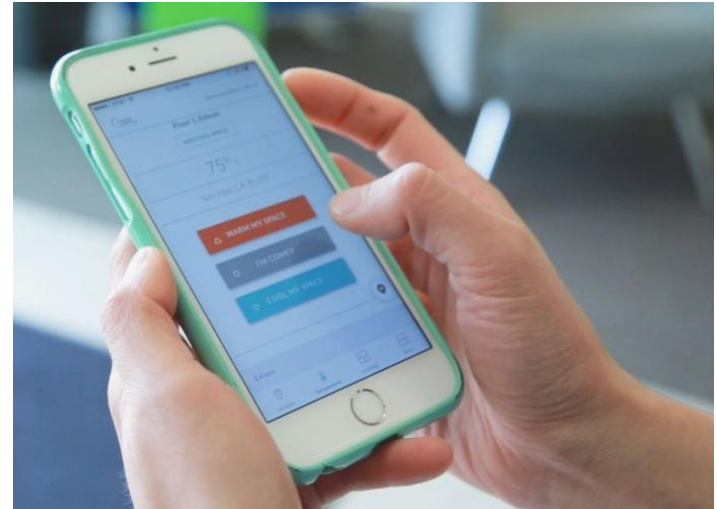
Gabriel Sanchez, R6

Smart Buildings Program Manager

Installation

Biggest Hurdle Was Getting Tenants Signed In to the Correct Location

- Many tenants didn't know their zone; i.e. 7th floor, Room 721, Area B...
- Once signed up, users accessed the application on a web interface or on mobile.

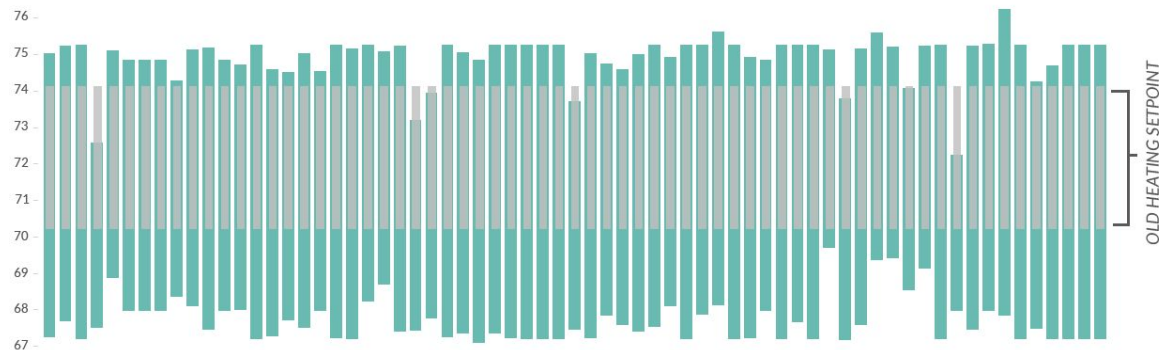


Controls

Two Control Modes

- Learning mode and standard mode. Administrator mode controlled entire zones.
- Technology adjusts setpoints in the background but you can manually adjust upper and lower ends. In one zone with no requests, we went in and raised the setpoint $\frac{1}{2}$ degree. Still no requests, so raised it $\frac{1}{2}$ degree more.

SETPOINTS CHANGE BY ZONE



The Value of Data

- Real data from users showed a wider range of thermal comfort.
- Data also could be used to find problems, in one instance with many requests, we found a broken thermostat.

Weekly Usage & Temperature Report

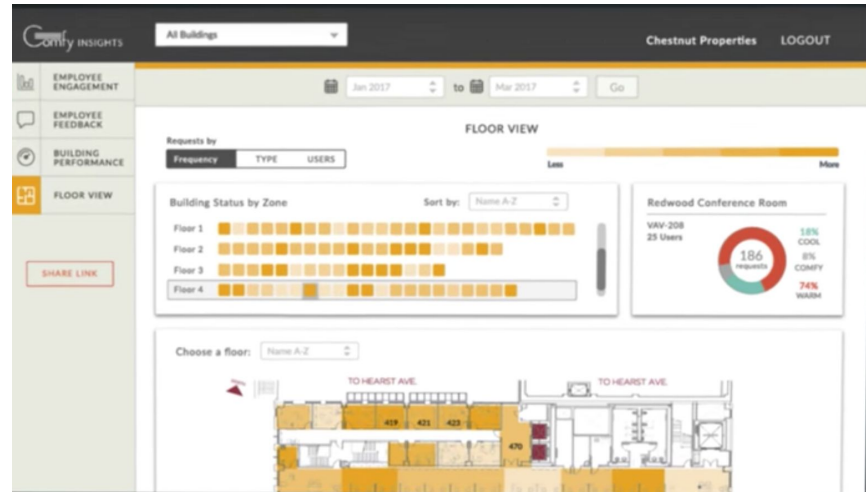
*Only includes zones with at least 1 request. No temperatures recorded for courtrooms, since they contain multiple zones

Zone	# Cool My Space requests	# Warm My Space requests	# I am Comfy requests	Temp Avg when Cool My Space requested	Temp Avg when Warm My Space requested
G603	1	0	0	-	-
TU-1N-10	7	0	0	76.4°F	-
TU-1S-6	7	1	0	74.7°F	73.7°F
TU-1S-7	2	0	0	78.8°F	-
TU-1S-17	0	8	0	-	75.1°F
TU-2N-2	4	0	0	76.8°F	-
TU-2N-8	3	0	0	77.7°F	-
TU-2N-15	11	0	0	76.9°F	-
TU-2N-18	8	2	1	77.7°F	74.6°F
TU-2N-21	11	0	0	74.1°F	-
TU-2S-6	2	1	0	74.8°F	74.1°F
TU-2S-11	164	0	0	76.0°F	-
TU-2S-N4	5	0	0	71.6°F	-
TU-3S-11	1	0	0	76.2°F	-
TU-3S-16	1	0	0	80.4°F	-
TU-4N-8	0	3	0	-	75.0°F
TU-4N-15	24	0	0	76.6°F	-
TU-4N-16	2	0	0	75.8°F	-
TU-4N-17	7	0	0	76.9°F	-
TU-4S-4	1	3	0	73.4°F	73.9°F
TU-4S-5	11	4	0	74.2°F	72.5°F
TU-4S-9	1	0	0	78.2°F	-
TU-4S-16	1	1	0	76.7°F	75.4°F
TU-5N-9	1	0	0	77.8°F	-
TU-5N-10	1	3	0	78.0°F	74.7°F

Group Decision Making

Eliminated False Hot & Cold Calls

- Occupants report “I am Hot/Cold”.
- Everyone in the zone is notified of the request and has a chance to vote.
- The system determines what to do.
- Facility manager does not get involved.



Tenant Satisfaction Improved

Tenant Satisfaction Scores (TSS)*

Average thermal comfort on a scale 1–5

3.2	2014 installed in March
4.3	2015 in place all year
3.0	2016 removed in March
2.8	2017 not in use all year

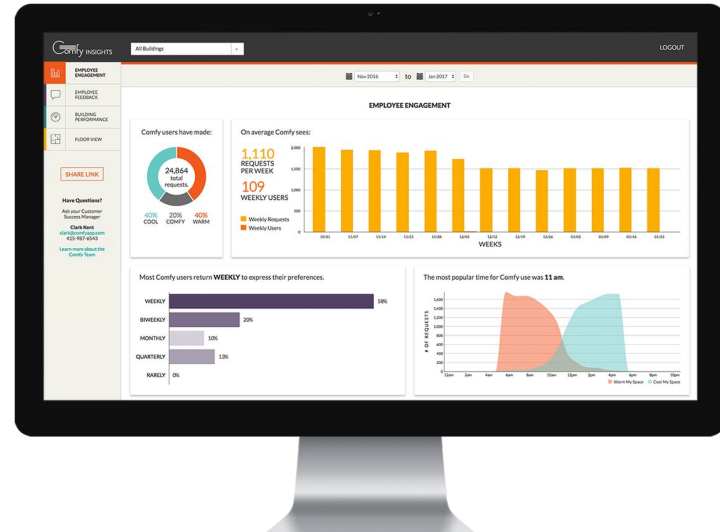


*Surveys conducted in May/June, 5 = highest level of comfort

Cost-Effectiveness

Limitations

- For a building occupied 10-hours, 5-days a week hard to make it cost-effective with energy savings alone.
- Reduction in hot and cold calls could lead to maintenance savings but these are hard for GSA to realize because of fixed O&M contracts.
- GSA tenant agreements may limit ability to change setpoints.



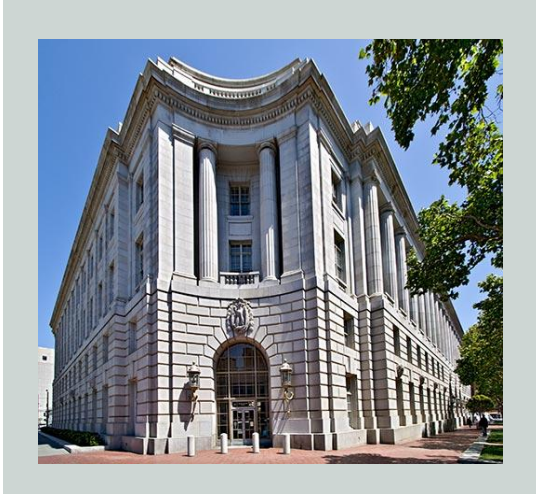
Bottom Line

Tenant Preferences

- Technology could design entire temperature profile of the building based on personal preferences.
- A technology that is geared to the tenant and that I'd like to see in all buildings.



Pacific Rim Experience



Mark Levi, R9

50 United Nations Plaza
Facilities Management Division

Pacific Rim Experience

Challenges of Installing as Part of an ESPC at the LA Courthouse

- Licensing costs were high, pay by the square foot and that can really add up.
- Savings could not be guaranteed.
- IT-Security
 - Comfy decided not to pursue IT scanning and remediation and is focusing on other commercially viable opportunities.
 - Federal-government IT-Security process should be more efficient with more inter-agency cooperation and sharing.

Q & A

Survey and Continuing Education Credit

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Thank you for your participation in GPG Outbriefs.

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Check here to request a certificate for 1 CE unit.

AIA Number

Your answer

First Name and Last Name

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 Socially Driven HVAC Optimization

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

Comments or questions about the webinar or Socially Driven HVAC Optimization.

Your answer

Thank you!



For more information: gsa.gov/GPG

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