

Emerging Technologies

GSA's Proving Ground and Pilot to Portfolio Programs | U.S. General Services Administration

Interagency Sustainability Working Group | May 17, 2018

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white, bold, sans-serif font, set against a dark blue square background.

GSA: Largest Single U.S. Portfolio of Commercial Office Space

8,721

PROPERTIES MANAGED, 377M ft²


1,574

OWNED, 188M ft²

**\$280M annual energy costs
for owned real-estate.**

At 52.2 kBTU/ft²/yr, GSA buildings are
33% more efficient than typical U.S.
commercial buildings.

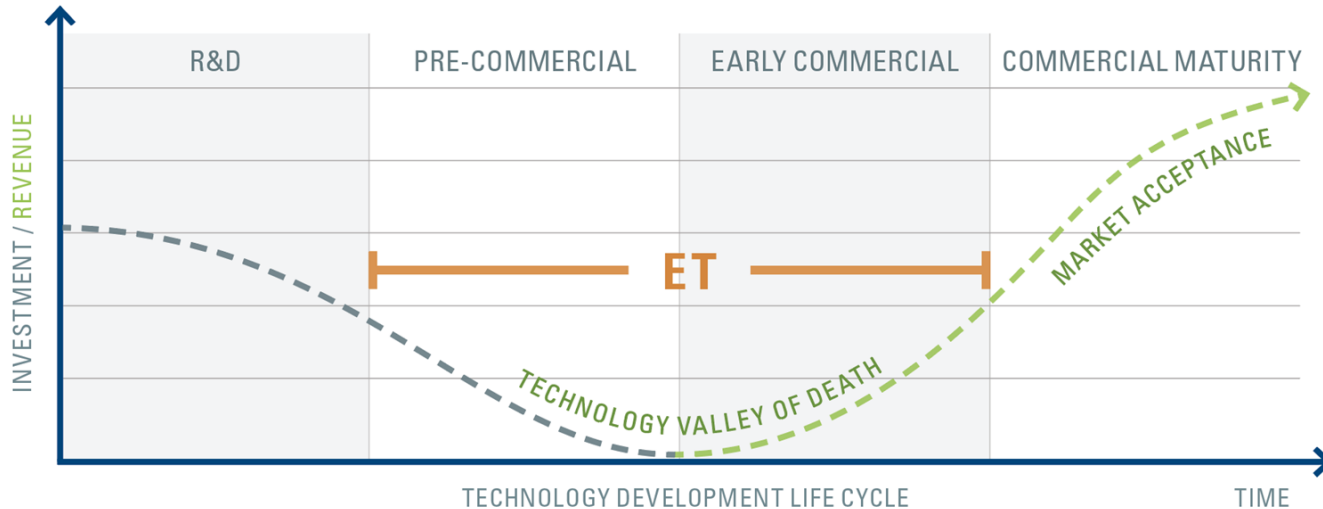




Emerging Technologies' two programs – GSA Proving Ground (GPG) and Pilot to Portfolio (P2P) – enable GSA to make sound investment decisions in next generation building technologies based on their real world performance

Adopting Next Gen Technology: Leading by Example

Emerging Technologies (ET) accelerates market acceptance by objectively assessing innovative building technologies in real-world environments (GPG), and deploying those that deliver (P2P)



GPG Objectives



Identify promising technologies at the edge of commercialization



Pilot technology installations within GSA's real estate portfolio

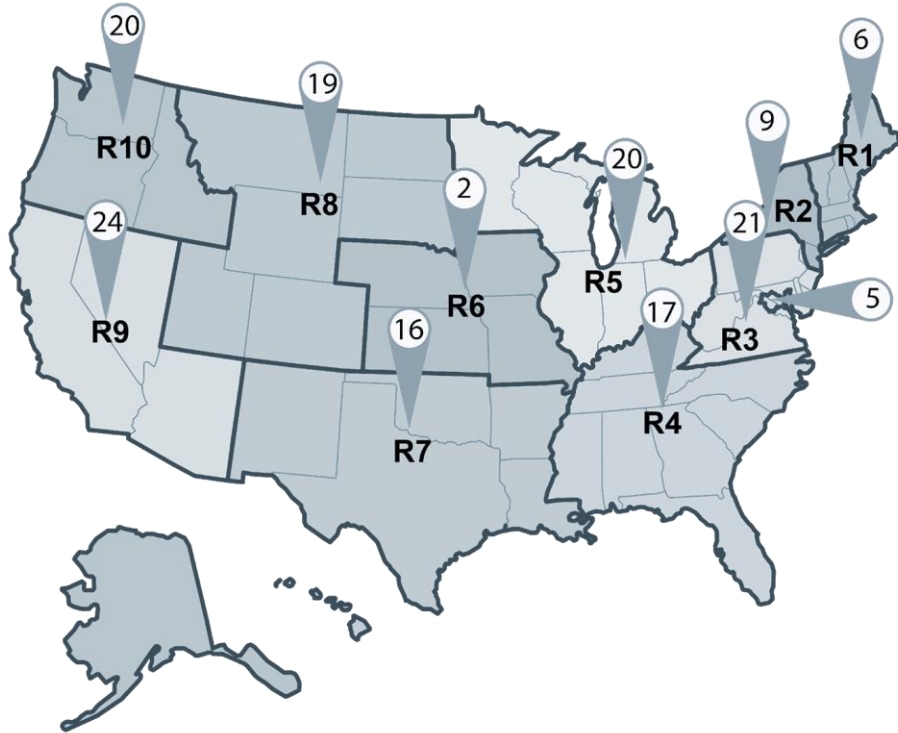


Partner with Department of Energy national laboratories to objectively evaluate real-world performance



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


GPG Test Beds



Test-bed locations
are representative of
broad conditions

Technologies Tested by GPG with Published Results

Building Envelope	HVAC	Lighting	Energy Management	Water	On-Site Renewables
High-R Window Panel Retrofits	Condensing Boilers	Occupant Responsive Lighting	Wireless Sensor Networks	Weather Station for Irrigation Control	Photovoltaics
Thermochromic & Electrochromic Windows	Variable Refrigerant Flow	Integrated Daylighting Systems	Advanced Power Strips	Wireless Soil Moisture Sensors for Irrigation Control	PV Guidance
Vacuum Insulated Panels for Roofing	Variable-Speed Maglev & Direct-drive Screw Chillers	Wireless Advanced Lighting Controls	Control Optimization System for Chiller Plants	Non-Chemical Prevention of Hard Water Scale	Photovoltaic-Thermal System
Solar Control Films	Synchronous & Cogged Fan Belts	LED Fixtures with Integrated Controls	Socially Driven HVAC Optimization		Wood-Pellet-Fired Biomass Boiler
Electrochromic (EC) Windows for LPOEs	Multi-staged Indirect Evaporative Cooler	LED Downlight Lamps for CFL Fixtures			Honeycomb Solar Thermal Collector
EC Windows with Dynamic Controls for General Office Space	Wireless Pneumatic Thermostats	TLED Full Retrofit Kits			
Low-e Window Films	Smart Ceiling Fans				

 Broad Deployment Potential for GSA

 "Top 5" Cost/Benefit for GSA*

* Quantitative Analysis in Process

Technologies Under Assessment

Building Envelope	HVAC	Lighting	Energy Management	Water	On-Site Renewables
Dual Zone Indoor Shades	Drop-In Smart Switched Reluctance Motor	LED Retrofit Kits with ALCs	Adaptive Control for Chilled Water Plants	Non-Chemical Water Treatment Cooling Towers	
	High- efficiency RTU		Circuit-level Energy Monitoring	Chemical-free Water Treatment	
	Smart Circulator Pump		Predictive HVAC Optimization	Monitoring and Partial Water Softening	
	Intelligent Energy Valves for Hydronic Systems		Wireless Sensor and Analytics		
	Smart Air Scrubbers				

2018 DOE/GSA Joint Program: “Beyond Widgets”

Focus: technologies that optimize building components and/or help operators better understand when buildings are not functioning within operational or design parameters



Behind-the-Meter Load
Optimization



Improving Overall Building
Operations and Maintenance

\$175B/_{YR}
**commercial
real-estate
utility bills**



Pilot to Portfolio supports the deployment of proven next generation technologies through process influence, portfolio analysis, project initiation support, and dynamic training

Transitioning Research into Practice

Providing actionable insights guides GSA's investment decisions in next-generation building technologies

63

TECHNOLOGIES
EVALUATED

33

REPORTS
PUBLISHED

20

TECHNOLOGIES
PROVEN FOR GSA

13

TECHNOLOGIES
DEPLOYED

\$7M

ESTIMATED
ANNUAL SAVINGS



Stakeholders: Test-bed Outcomes Publicly Available

OPPORTUNITY
What is the potential benefit to Land Ports of Entry?

PROVIDE DIRECT AN UNDISPERSED VISUAL FEEDBACK AND THE AREA UNDER SURVEILLANCE

TECHNOLOGY
How do electrochromic (EC) windows work?

TRANSITION FROM USING PHOTOSENSITIVE READING

MAV
What are MAV measurement and verification opportunities?

RESULTS
How do electrochromic windows perform in MAV?

GLARE HIGH VISIBLE REDUCTION BELOW PERCEPTIBLE GLARE THRESHOLD WITH HIGH INTERIOR

Daylight Glare Probability (DGP) in Vehicle
Dash with EC windows has much lower DGP

Modeled Perimeter Energy Savings for Range of Climates
Which building energy savings are achievable to be at least 5% of perimeter savings?

Climate	Window	Energy Savings (%)	Energy Savings (\$/yr)	Energy Savings (\$/sq ft)
Miami	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Miami FL	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Phoenix	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Phoenix AZ	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Phoenix AZ	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Phoenix AZ	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01
Phoenix AZ	EC	1.1	1.1	0.01
	EC + SHGC	1.1	1.1	0.01

DEPLOYMENT
Where does MAV measurement and verification opportunities exist?

LAND PORTS
What are the factors when windows affect interior visibility?

ACROSS ALL CLIMATE ZONES
Single office space and custom parking will be to building with solar glazing or window applied film. One is low performance window that is 5% of perimeter area.

Also available for lease and parking building that does not already have a 5% energy savings target.

Overview Infographics

Low-e Applied Film Window Retrofit for Insulation

February 2017

Charlie Curcio
Howdy Gonzalez
Robin Mitchell

General Services Administration
Public Buildings Service

EC WINDOWS AT LAND PORTS OF ENTRY

General Services Administration
Public Buildings Service

Electrochromic Windows Reduce Glare While Preserving Line of Sight

All Land Ports of Entry (LPE), military installations and other facilities where occupants view outdoor activities, security through windows is critical. Land facilities use surveillance cameras to monitor their surroundings, but officers often face vision impairment in direct line of sight. An unobstructed view path between the interior and the outdoors, in sunny conditions, does not exist until the sun is obscured by the window glass. But conventional solutions to control glare, like blind films and window coverings, can obstruct views and inhibit visual security. Electrochromic (EC) windows preserve line of sight and beneficial daylight while controlling glare.

With this technology, windows tint from clear to dark and back again, either automatically or in response to manual controls. To assess EC glass-tinting performance, GSA's GPG program commissioned Lawrence Berkeley National Laboratory (LBNL) to conduct a field study at the Denver LPE of the Tower Number 100 Annex. Researchers found a significant reduction in glare with EC windows, along with high line-of-sight visibility. EC windows are also known to reduce building energy consumption, which is the focus of other completed and ongoing GPG studies.

Technical Report & 4-Page Findings

GPG Program

Secure: https://www.gsa.gov/governmentwide-initiatives/sustainability/gpg-program

Home > Governmentwide Initiatives > Sustainability > GPG Program

GPG Program

Occupants Prefer EC Over Legacy Windows
Implementations that both satisfy occupants and meet competing performance requirements can be challenging and time consuming to develop.
Learn more: EC Window Demonstration for General Office Space >

Outbrief Webinar Series
GPG Outbrief webinars present innovative, cost-effective technology solutions for GSA. Webinars are held once a month or bi-monthly as well as recording slides for past webinars.

Published Findings
GPG has recently completed assessments of the following technologies:

Ongoing Assessments
GPG is assessing technologies in the following areas:

GPG Outbrief 01: Low-Cost Window Retrofits

What is GPG? The real world performance of...

GPG Program | U.S. General Services Administration | March 30, 2017

Website & Webinars

Influencing Internal Processes

GSA processes and guidance support the introduction of next-generation technologies at key lifecycle entry points—end-of-life replacement, retrofits and new construction



Using Analytics to Drive Uptake

Work across GSA databases to identify buildings with aging, inefficient equipment and tenant comfort issues. Leverage Federal buying power by providing decision makers with portfolio-level recommended technologies that solve these problems



Supporting Project Initiation

Provide project and property managers with technology specifications and cybersecurity approval needed to easily select innovative technologies

026 LED Downlight Lamps

Application	Recessed downlight, surface mount
Ballast for 4-pin	Powered by Electronic-ballast
Ballast for 2-pin	Powered by Magnetic ballast

ELECTRICAL

Operating Voltage	120-277V
Power Factor	0.90 at full light output
Total Harmonic Distortion	<20%
Efficacy, lumens per watt	70 at full light output

PHOTOMETRIC PERFORMANCE

Light Output	Minimum 450 lumens
Zonal Lumen Density	>75% of total initial lumens within the 0-60° zone
CCT (Color Temp)	3000K, 3500K, 4000K or as specified by site
CRI	80, R9>0
Lifetime	Minimum 36,000 hours L70

Controls	Look for "dimmable" products before considering daylight harvesting or task tuning. Wired and/or wireless control systems shall not be accessible, networked, or otherwise tied to external systems unless specified by the GSA.
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Warranty	Minimum 5 years
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Qualifications	UL Classified for U.S. and Canada
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Delivering Training

Provide training resources architects, engineers, asset managers and facility managers need to successfully program, engineer, and operate next generation technologies

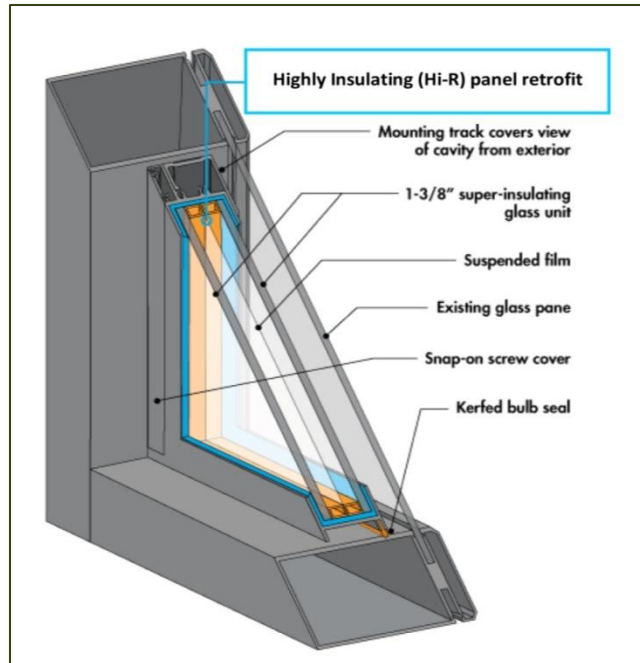


Technology: High-R Low-e Window Panels

Technology Description:

High-R Low-e Window Retrofit Panels – High-performance or “High-R” windows use advanced technology to deliver up to a sevenfold improvement in a window’s thermal performance.

High-R panels are pre-manufactured window units that are installed on top of existing low-performing windows and do not require removing or modifying systems in place. They provide a low-cost alternative (\$25/SF) to costly window replacements.



Manufacturer:
Thermolite Window Systems

Category: Building Envelope

Strategy:
Low-cost window retrofits
Heating/Cooling Load
Reduction through
optimization of building
envelope

Technology Aligned with GSA Needs and Priorities

Technology: High-R Low-e Window Panels

*How much energy
is lost through
inefficient windows
in commercial
buildings?*

23% ENERGY
USED TO HEAT & COOL
BUILDINGS IS LOST
THROUGH INEFFICIENT
WINDOWS*



GSA INVENTORY:

Avg. age = 48 years

Buildings with single-pane windows

particularly in cold climates where they perform poorly and/or in urban areas where acoustical (non-energy) benefit is important

Historical buildings with restrictions on facade interventions

> 470 historic properties

300 listed in the National Register of Historic Places

170 candidates for nomination

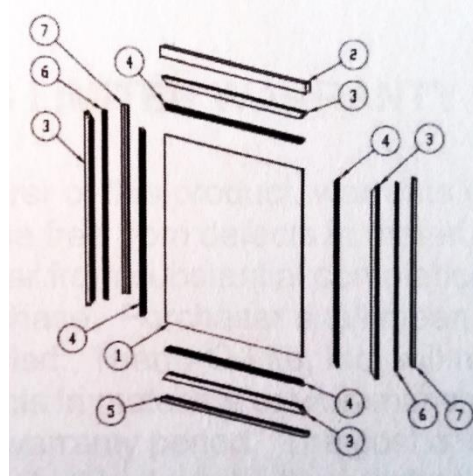
Category: Building Envelope

Strategy:
Low-cost window retrofits

Heating/Cooling Load
Reduction through
optimization of building
envelope

**Technology:
High-R Low-e
Window Panels**

Technology Components:

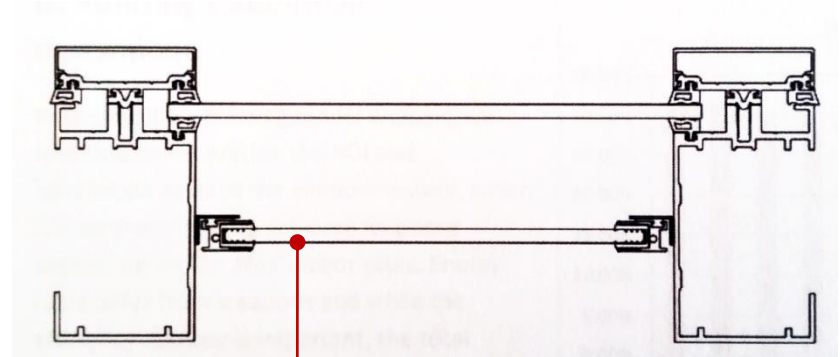


- ① TCL glass
- ② Deep Track
- ③ Sash
- ④ Spline
- ⑤ Shallow Track
- ⑥ Magnet
- ⑦ Steel Angle

Example:

Thermolite RetroWAL Gold Series

- Shallow Track (1 at the bottom part)
- Deep Track (1 at the top part)
- Steel Angle (2 at sides)
- Glass panel with integrated magnetic sash



Interior insulating window panel attached to existing window frame

Category: Building Envelope

Strategy:
Low-cost window retrofits

Heating/Cooling Load
Reduction through
optimization of building
envelope

Technology: High-R Low-e Window Panels

Performance

*How did Window
Panel Retrofits
perform in M&V?*

41%
**HEATING SAVINGS
IN WINTER²**

ESTIMATED SAVINGS
FOR ENTIRE BUILDING
HEATING AND
COOLING: 11%³

**QUICK
INSTALLATION⁴**

IMPROVED VISUAL
AND THERMAL
COMFORT⁵

<9

YEARS

PAYBACK FOR
TRIPLE-PANE;
DOUBLE-PANE
WILL BE SHORTER⁶

Savings Diminish with Triple-Pane Hi-R Window Panel Retrofit

COMFEN results compared to base configuration of single pane with bronze film



Significant energy savings, increased occupant satisfaction, and relatively nonintrusive installation methods make High-R panels a quick and manageable alternative to the full replacement of low-performance windows.

Category: Building Envelope

Strategy:
Low-cost window retrofits

Heating/Cooling Load
Reduction through
optimization of building
envelope

Technology Description

Variable-speed magnetic bearing chiller

The variable-speed magnetic bearing chiller (MBC) is one of GPG's successfully tested next-generation chiller technologies. The MBC or maglev chiller uses magnetic levitation to eliminate heat, noise, and vibration associated with standard chillers. Magnetic levitation chiller compressors improve the energy efficiency of air conditioning systems while minimizing the negative impacts of excess heat, noise, and vibration.



Manufacturer: Daikin
(www.DaikinApplied.com)

Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor

Category: HVAC

Strategy: Next Gen Chillers
Heating/Cooling Load
Reduction through efficient
equipment

Technology Aligned with GSA Needs and Priorities

Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor

*How much energy
is used for space
cooling in U.S.
office buildings?*

10%
OF ENERGY
GOES TO SPACE
COOLING¹



32%
**OF COMMERCIAL
BUILDINGS**
RELY ON CHILLERS
TO PROVIDE THIS
COOLING²

GSA INVENTORY:

80% of buildings >200,000 SF with central plant for heating/cooling using water-cooled chillers of some sort

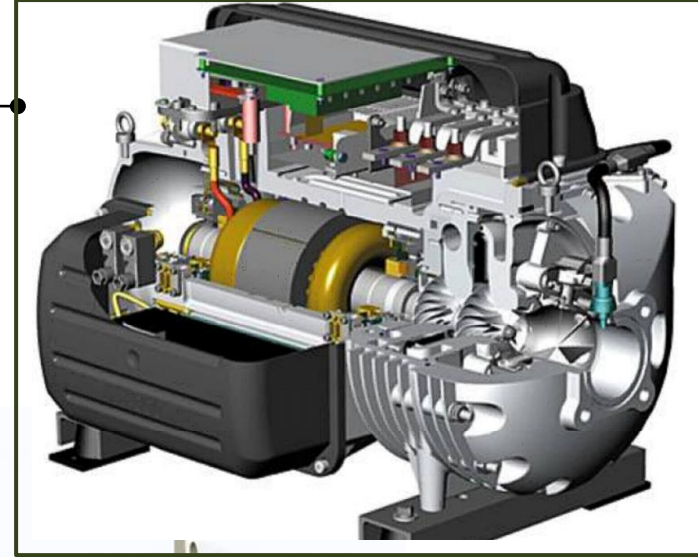
Avg. chiller age = 48 years, resulting in equipment with need for end-of-life replacement

Category: HVAC

Strategy: Next Gen Chillers
Heating/Cooling Load
Reduction through efficient
equipment

Technology Components

Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor



The Compressor



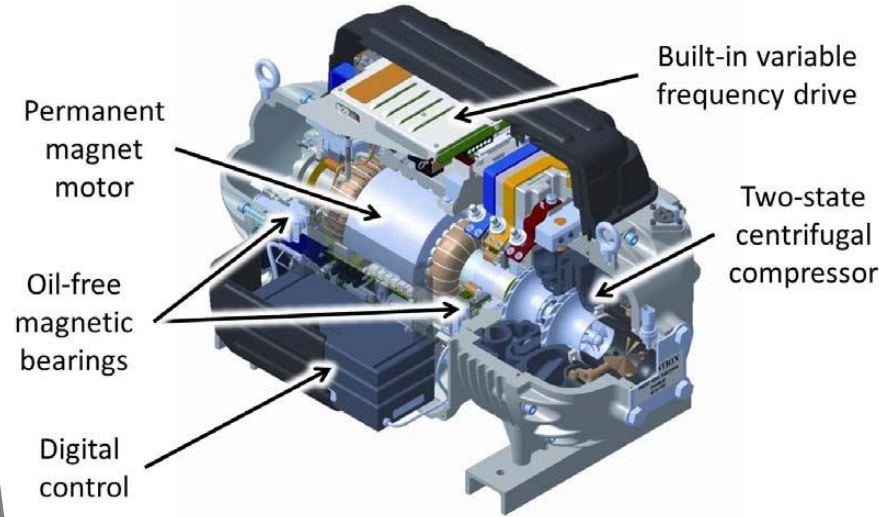
Category: HVAC

Strategy: Next Gen Chillers
Heating/Cooling Load
Reduction through efficient
equipment

Technology: Magnetic Levitation (Maglev) Chiller Compressor

Technology Components

Maglev uses compressors that operate with oil-free bearings. Rather than using conventional lubricants, they operate by levitating the bearings in a magnetic field. These compressors use the centrifugal process to provide compression to the refrigerant and can vary their speeds as the chiller load changes.



Compressor cutaway

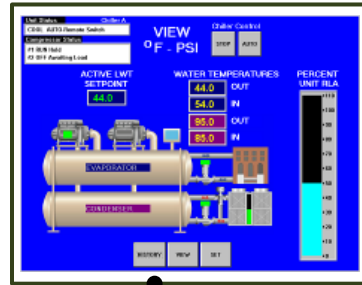


Category: HVAC

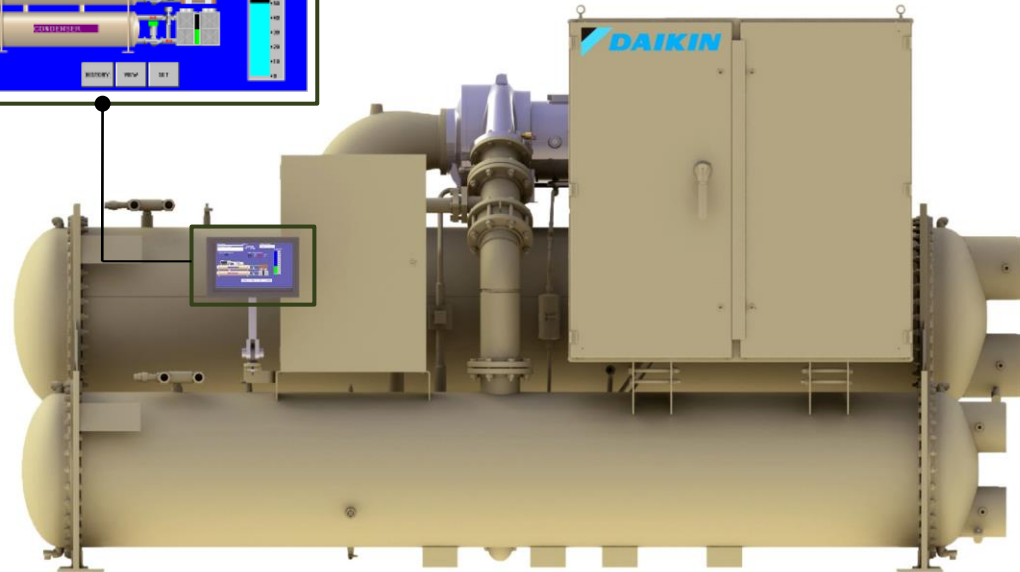
Strategy: Next Gen Chillers
Heating/Cooling Load
Reduction through efficient
equipment

Technology Components

The technology integrates with diagnostic and monitoring systems, thus reducing long- and short-term maintenance needs and having the capability of a key component of control strategies.



Controller operator interface



Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor

Category: HVAC
Strategy: Heating/Cooling
Load Reduction through
efficient equipment

Performance as Evaluated in GSA Test Bed in George Howard Jr. FB, AR

MBC is more efficient in partial rather than full loads, as legacy chillers were operated. Thus running multiple chillers at partial loads yields maximum efficiency.

Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor

How did maglev chillers perform in M&V?

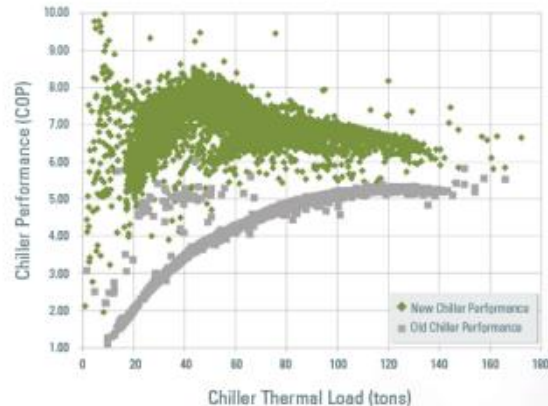
42%
ENERGY SAVINGS
AS COOLING LOADS DECREASE, EFFICIENCY INCREASES³

QUIET PERFORMANCE
ALLOWS CHILLERS TO BE PLACED CLOSER TO OCCUPANT SPACES⁴

<5 YEARS PAYBACK
after normalizing for payment structure & utility costs⁵

Efficiency of Maglev Chiller Increases as Load Is Reduced

Maglev chiller efficiency is highest between 40 to 50 tons (27 to 33% of nominal full load)
Incumbant chiller efficiency continuously decreases as chiller load is reduced

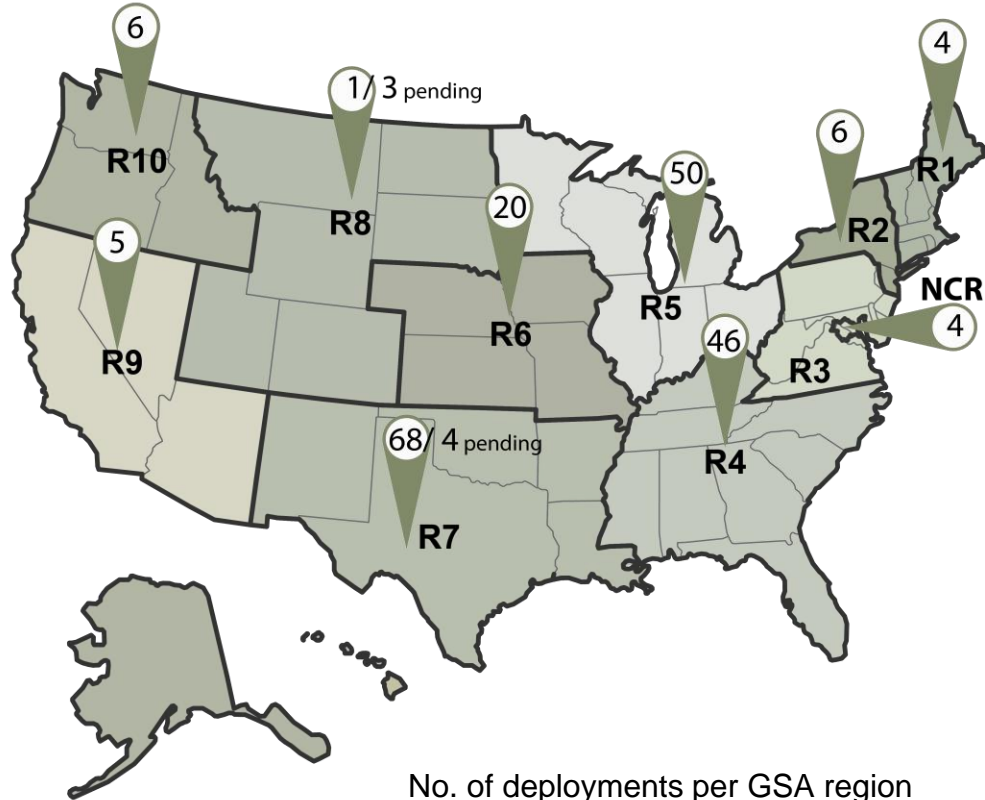


Category: HVAC
Strategy: Heating/Cooling Load Reduction through efficient equipment

Technology:
Magnetic Levitation
(Maglev) Chiller
Compressor

Deployment of Maglev Chillers across GSA Portfolio

The maglev chiller is the technology with the widest deployment across the GSA portfolio, with a total of 210 deployments.



Category: HVAC
Strategy: Heating/Cooling
Load Reduction through
efficient equipment



For more information: gsa.gov/GPG

GSA Opportunity — 15 Technologies with Broad Deployment Potential

Category	Technology	% Saved at Test Beds	Projected Payback (yrs)	Best Suited to
Energy Management	APS for Workstations	26%	2	Deploy broadly.
	Chiller Plant Control Optimization	35% Cooling	5	Chilled water plants with cooling loads > 3 million tons per year.
	Socially Driven HVAC	20% cooling, 47% heating	NA	Facilities where thermal comfort is an issue.
	Wireless Sensor Networks	48% Cooling	2	Data centers.
Lighting	LED Downlight Lamps	40%	3	Spaces where advanced lighting controls are not desired or useful.
	TLED Full Retrofit Kits	30%	5	Fixtures where lenses/sockets are in good condition and ALC is useful.
	LEDs with Integrated Controls	60%	9	Retrofits with EUI > 3.25 kWh/ft ² /yr and utility rates > \$0.10 kWh.
Building Envelope	EC Windows for LPOEs	9%	NA	Facilities where window glare compromises mission-critical visibility.
	Hi-R Low-E Window Panels	41%	7	Cold climates; single-pane windows, locations with outside noise issues
	Low-E Film	29% perimeter HVAC	2-6	All climate zones. Most cost-effective for single-pane clear windows.
HVAC	Condensing Boilers	14%	7	End-of-life replacement. Life-cycle cost effective when 3 -5 % more efficient than high-efficiency boilers.
	Fan Belts	2 - 20%	1-4	VAV Fans, retrofit with synchronous drive belts. CV Fans, replace at end-of-life with cogged V-belts.
	Magnetic Bearing Chiller (MBC)	42%	5	End-of-life replacement.
	Variable Speed Screw Chiller	11% compared to MBC	3	End-of-life replacement.
	Wireless Pneumatic Thermostats	20% cooling, 43% heating	6	Facilities with pneumatic control.