


GPG Outbrief 01

# Low-Cost Window Retrofits

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



The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

# Presenters

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**Kevin Powell**

Program Manager  
GPG



**Michael Lowell**

Low-e Project Manager  
GPG



**Howdy Goudey**

Scientific Engineer  
Lawrence Berkeley  
National Laboratory



**Daniel Wang**

Facility Manager  
Hi-R Panel Test-Bed  
R8, Provo, UT, GSA



**Aaron Rock**

Facility Manager  
Low-E Film Test-Bed  
R8, Ogden, UT, GSA



**Richard Kuhlman**

Facility Manager  
Low-E Film Test-Bed  
R7, Dallas, TX, GSA

# Low-Cost Window Retrofits Agenda

- ❑ Hi-R Low-e Window Panels (~20 minutes)
- ❑ Low-e Window Film (~20 minutes)
- ❑ Q & A (~30 minutes, submit through the chat window)

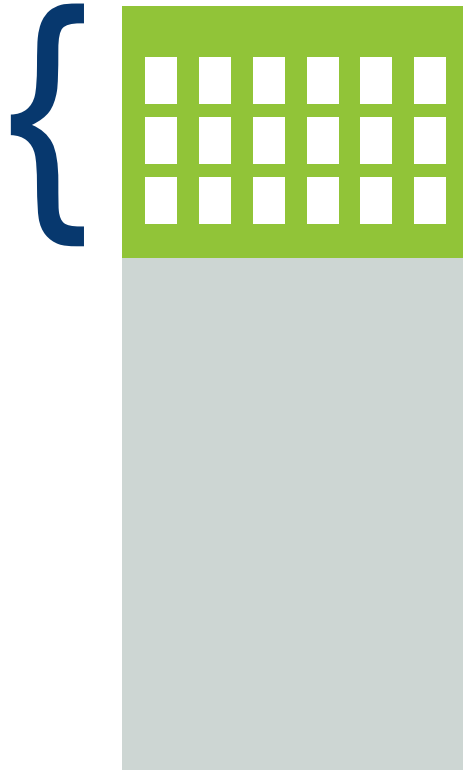
# Opportunity

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**34%**

HVAC energy in  
commercial buildings  
is lost to windows

**1.5%** of total U.S.  
energy consumption



GPG-007

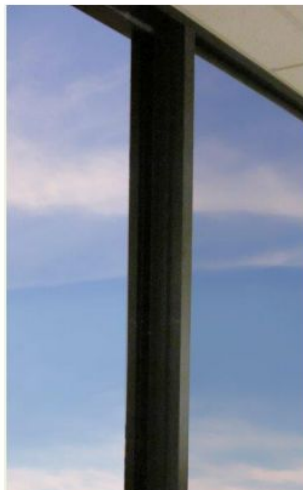
# Hi-R Low-E Window Panels

GSA Public Buildings Service



GPG-007 | OCTOBER 2013

## HIGHLY INSULATING WINDOW PANELS



### Hi-R Panel Retrofits Provide Significant Energy Savings for Low Investment

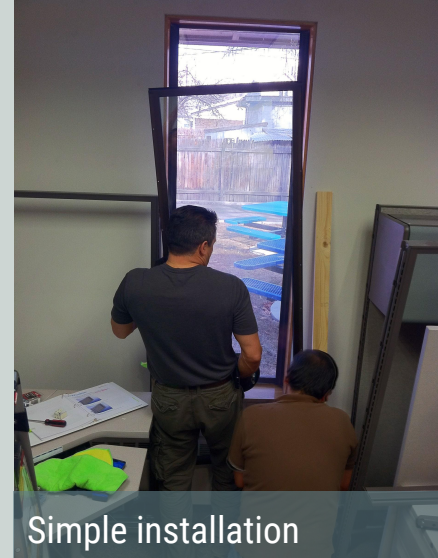
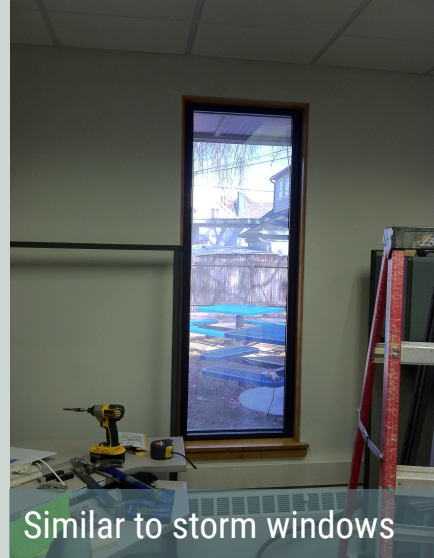
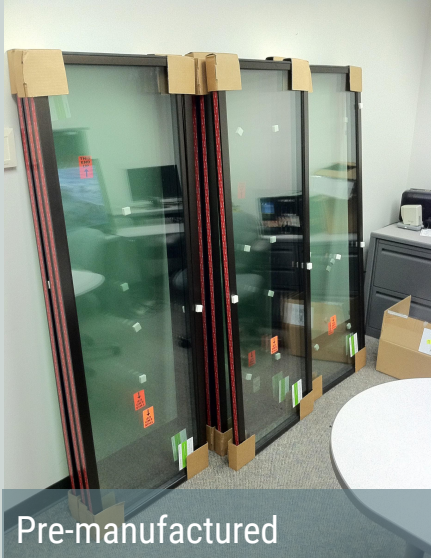
In a recent assessment, GSA's Green Proving Ground (GPG) program achieved a 41% reduction in winter energy use at a Provo, Utah federal office building by retrofitting 21 single-pane windows with triple-pane highly insulating window panels (Hi-R panels). Hi-R panels are pre-manufactured units designed to improve the insulating power of low-performing windows, without the need for major renovations or costly modifications to existing buildings. Hi-R panels use low emissivity coating and single-, double- and triple-pane configurations to build upon the concept behind residential storm windows, providing greater thermal performance with a long-lasting, simple application. These framed units can easily be installed on the interior side of existing windows, improving their performance at minimal cost with little or no disruption to building occupants. Findings from this study support the consideration of Hi-R panel retrofits as a low-cost option for achieving significant savings in heating and cooling commercial buildings, particularly those located in cold climates.



# GPG-007. Hi-R Low-E Window Panels

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Improves Thermal Performance



# Measurement & Verification - GPG-007. Hi-R Low-E Window Panels

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Provo, Utah 6,400 square foot single-story office building monitored 3 months pre-retrofit, 5 months post-retrofit

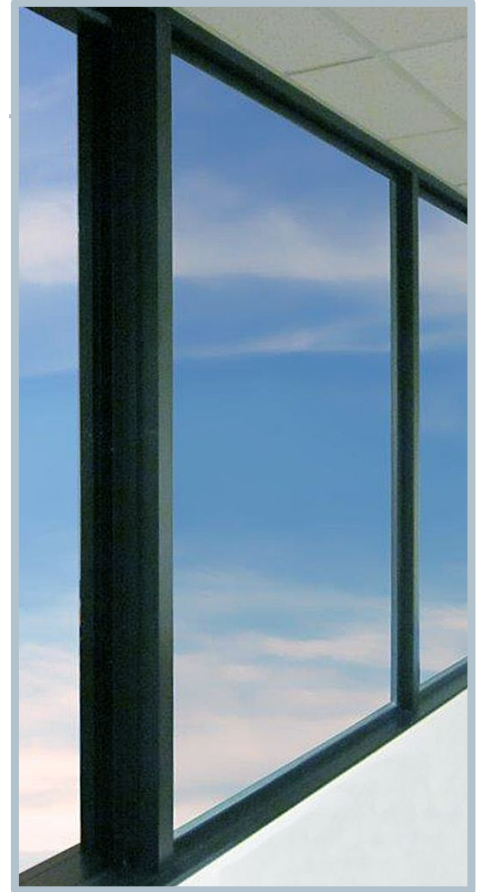




## GPG-007. Hi-R Window Panels

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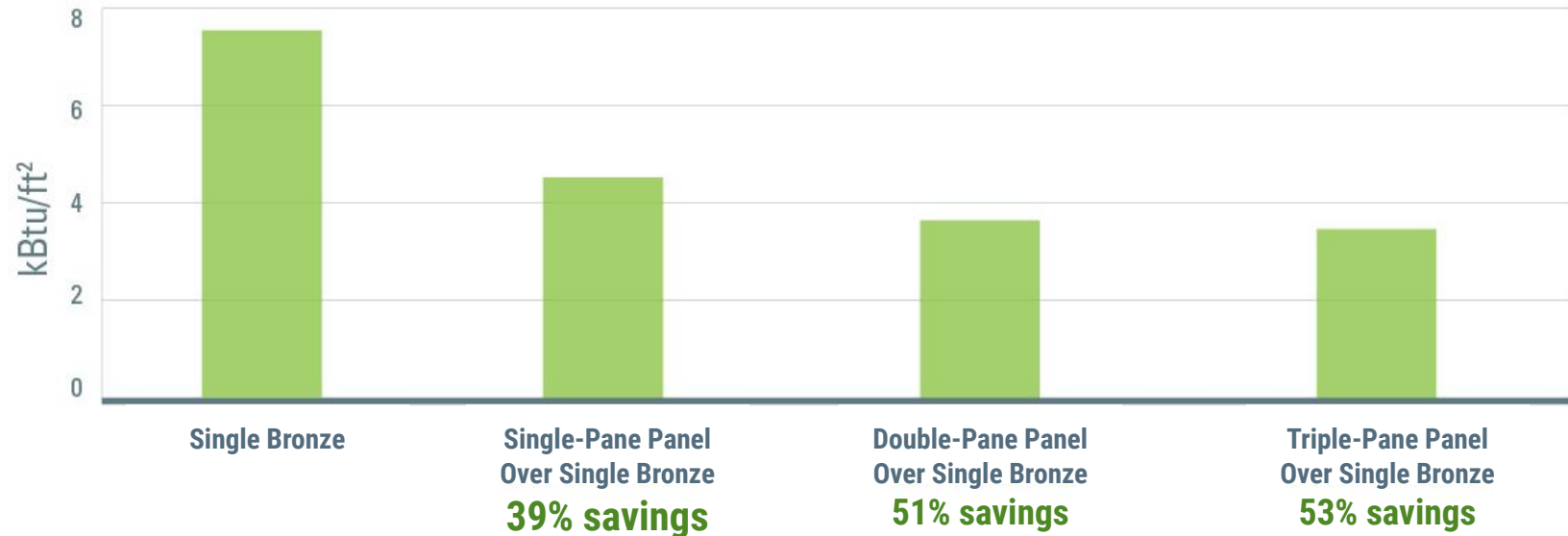
- **Energy Savings**
  - 41% HVAC energy savings
  - 11% whole-building savings estimated
- **Occupant Satisfaction**
  - Quick installation and improved visual and thermal comfort
- **Cost-Effectiveness**
  - < 9 year payback for triple-pane, double-pane will be shorter



## GPG-007. Hi-R Low-E Window Panels

### Savings Diminish with Triple-Pane Hi-R Low-e Window Panel Retrofit

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



# Hi-R Window Panels Guidelines

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## Condensation Sensitivity

Condensation sensitivity is a potential challenge in Hi-R panels. The dry climate in Provo, Utah and the absence of a building humidification system made this test case a poor gauge of potential weaknesses caused by condensation. Window panel retrofits have since been installed by GSA in more humid climates with no apparent signs of condensation.

# Additional GSA Deployments Hi-R Low-e Window Panels

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R2: 26 Federal Plaza\*

R9: Foley Courthouse

R9: Cliffton Young Federal Building\*

NCR: New Carrollton Federal Building\*

NCR: Silver Springs Metro Center\*

NCR: William Jefferson Clinton Complex\*

NCR: Veteran Affairs\*

\*Deployed through ESPCs

# Facility Manager Feedback Hi-R Low-E Window Panels

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## Daniel Wang—Provo, Utah

- Thermal comfort, occupants really aware of less air-infiltration
- Ease of installation, had to move cubicles, but didn't have to empty offices



# Facility Manager Feedback Hi-R Low-E Window Panels

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- Small building, big gain  
Compared energy usage from the winter before and saw huge decrease



- Still performing well after 4 years



GPG-032

# Low-E Window Film

GSA Public Buildings Service



GPG-032 | FEBRUARY 2017

## LOW-EMISSION WINDOW FILM



### Low-E Film Amplifies Efficiency by Combining Solar Control & Thermal Insulation

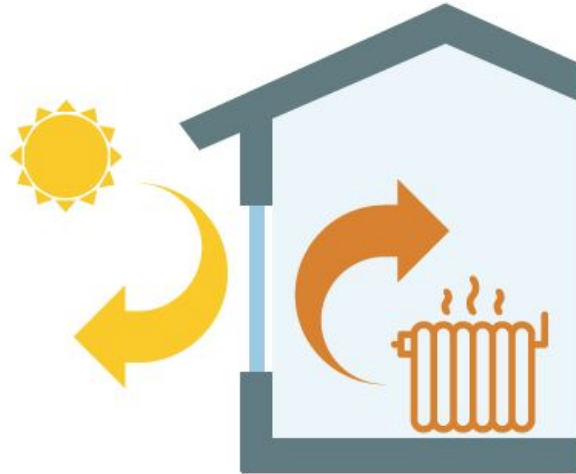
Conventional applied solar control window film reduces solar heat gain and decreases the use of cooling energy, but in cold weather it fails to take full advantage of the sun's warmth, offsetting summer energy savings with increased winter energy use. A new kind of applied window film combines the solar control functions of standard film with the insulating power of a low-emissivity (low-e) coating, which, until now, has been available only as part of a factory-produced unit. Adding insulation, which improves efficiency in all seasons, compensates for diminished solar heat gain in the colder months. Researchers from Lawrence Berkeley National Laboratory (LBNL) assessed the new film at two GSA locations: the Hansen Federal Building in Ogden, Utah, and the Cabell Federal Building in Dallas, Texas. A total of seven climates and four base windows were also studied in computer simulations. Compared to clear, single-pane glass windows, a version of the film with a visual transmittance of 35% averaged 29% HVAC savings in perimeter building zones. Savings were found across climate zones, including cold and moderate ones.

## GPG-032. Low-E Window Film

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### Reduces Solar Heat Gain and Insulates

Selectively absorbs and reflects heat. Blocks direct solar heat to reduce summer cooling demand. Improves window insulation to reduce summer and winter energy use and improve occupant comfort.



# Measurement & Verification - Low-E Window Film

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Hansen Federal Building, Ogden, Utah



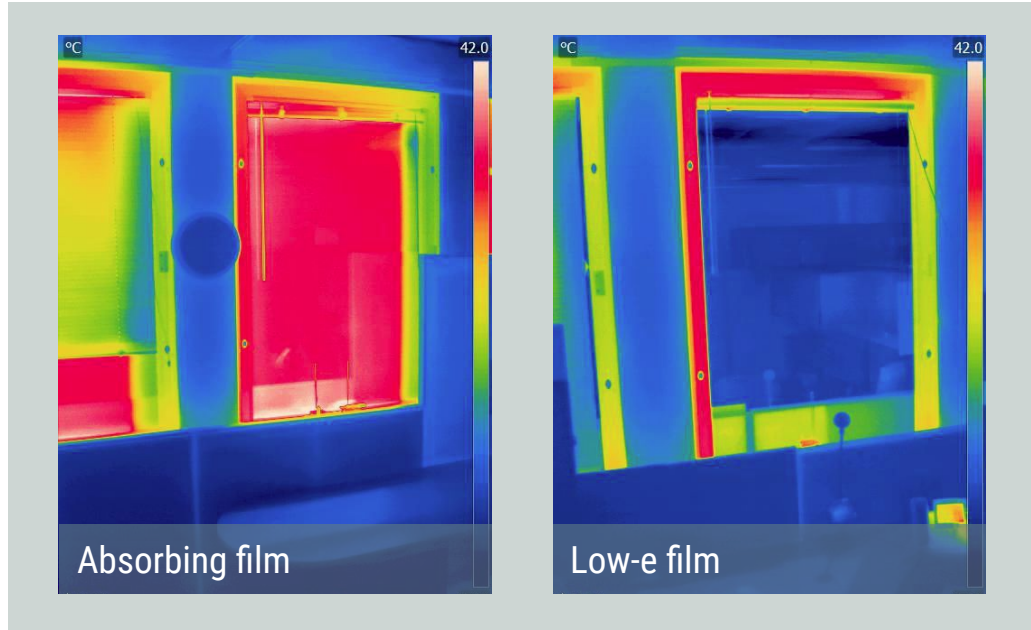
Cabell Federal Building, Dallas, Texas



# Absorbing vs. Low-E Window Film

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Infrared images comparing radiant energy from window during warm conditions



**Improved Thermal Comfort**  
Occupants are not exposed to thermal radiation from warm (or cold) glass.

## GPG-032. Low-Emissivity Window Film

### Modeled Perimeter Energy Savings for Range of Climates

Whole building energy savings is estimated to be at least 1/3 of perimeter savings

Location		Single Clear Glazing to VT35 Film			Single Bronze Glazing to VT35 Film		
CLIMATE ZONE	CITY	HEATING kBtu/ft2/yr	COOLING kBtu/ft2/yr	TOTAL %	HEATING kBtu/ft2/yr	COOLING kBtu/ft2/yr	TOTAL %
1A	Miami, FL	0.01	12.16	33%	0.03	8.08	25%
2A	Dallas, TX	0.47	10.94	33%	1.52	7.12	26%
2B	Phoenix, AZ	0.20	15.24	38%	0.45	10.40	30%
4A	Washington, D.C.	0.51	6.40	26%	3.24	3.74	23%
5A	Chicago, IL	1.97	5.66	24%	5.79	3.23	22%
5B	Ogden, UT	1.45	7.13	30%	4.97	4.12	27%
6A	Minneapolis, MN	2.97	5.45	22%	7.51	3.06	21%
<b>AVERAGE PERIMETER SAVINGS</b>		<b>1.08</b>	<b>9.00</b>	<b>29%</b>	<b>3.36</b>	<b>5.68</b>	<b>25%</b>

## GPG-032. Low-Emissivity Window Film

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- **Energy Savings**  
29% average perimeter heating and cooling energy savings when compared to single-pane clear windows. Whole building energy savings is estimated to be at least 1/3 of perimeter savings.
- **Occupant Satisfaction**  
Improved thermal comfort and glare reduction.
- **Cost-Effectiveness**  
Assuming the film is applied to clear, single-pane glass with installed costs of \$7.75/ft<sup>2</sup>, payback is between 2-6 years.





# Low-E Window Film Guidelines

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## Site Analysis

In some cases, where daylight harvesting is as valuable as solar heat gain control, VT50 low-e film may be more appropriate than VT35.

## Test Application

If appearance is a concern, consider different visible transmissions and conduct a trial application.

# Deployment Opportunity for Low-Cost Window Retrofits

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- **Hi-R Low-E Window Panels**

Cold climates. Single glazing. Single- or double-layer panels recommended as triple-pane offers diminishing returns.

- **Low-E Window Film**

Effective across all climate zones. Fastest payback will be in buildings with clear, single glazing, or buildings with applied film nearing the end of its (~15 year) service life.



# Facility Manager Feedback Low-E Film

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## Aaron Rock–Ogden, Utah

- Where people sit next to the window, especially during the summer, they notice a big difference.
- Pleasing to look out of compared to old window film. Like looking out of a nice pair of sunglasses.
- Compare 4th and 5th floor in the afternoons on the West side. Notice a couple degree difference. Noticeable on the south side. Some people on the North missed the daylighting.

# Facility Manager Feedback Low-E Film

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## Richard Kuhlman—Dallas, Texas

- Heat factor improved.
- Visual effect is good, modest tinting but very positive.
- Potential to save a lot of energy. 1.3 million sq. feet of space.
- Good retrofit.

Q & A

# Upcoming GPG Outbriefs - Thursdays, 12 PM ET

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April 27      Wireless Pneumatic Thermostats

June 8        Next-Generation Chillers

## Webinar Recordings

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

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





For more information: [gsa.gov/GPG](https://gsa.gov/GPG)

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