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**Renovating Historic Facilities:  
Using the National Building Museum  
as a Template to Cost Effectively  
Green Historic Facilities**

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# Historic Preservation and Energy Efficiency

- Agencies must meet Federal requirements for renewable energy, energy efficiency, water efficiency, and greenhouse gases
  - <http://www.femp.energy.gov/regulations/regulations.html>
- While historic buildings are often considered “off limits” for energy projects, they **ARE NOT** exempt from energy legislation
  - Most requirements do not include historic preservation as a reason for exemption
- Balancing energy projects with the National Historic Preservation Act (NHPA) of 1966 can be delicate
- Many Federal buildings are currently listed on the National Registry of Historic Places
  - NPS is known for historic buildings
  - Approx 25% of GSA buildings
  - Approx 30% of DOD buildings



# National Historic Preservation Act

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- Federal agencies shall assume responsibility for the preservation of historic properties owned or controlled by such agency
- Section 106: Agencies must consider the effect of any undertaking on Federal buildings eligible for the National Register (or already registered) before approving Federal funds or licenses
  - Advisory Council on Historic Preservation shall be afforded a reasonable opportunity to comment with regard to such undertaking
  - Council may promulgate rules and regulations as necessary to govern Section 106 implementation
  - Agencies may seek advice and assistance from the Council on the application of Section 106 to specific undertakings



Lighting upgrades at the Washington Monument improve available lighting and energy efficiency



# **NATIONAL BUILDING MUSEUM**

**STRATEGIC SUSTAINABILITY/ENERGY**

**EFFICIENCY RENOVATION**

# Background

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**The National Building Museum is located at 5<sup>th</sup> and F street , Washington DC.**

- 147,460 ft<sup>2</sup> historically significant structure
- 165 full time occupants
- Mixture of office and gallery space

# Background

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## NREL provided investment grade assessment of NBM (May 18, 2009)

- Energy efficiency, water conservation, renewable energy assessment
- Fourteen projects were accepted for funding (*Total Funding \$3,426,692*)



# Energy Use and Utility Data

Utility	Annual Consumption	Utility Rates(*)	Annual Cost of Service	Utility/Service Provider
Electricity (kWh)	3,545,906	\$0.12/kWh	\$469,263	PEPCO
Purchased Steam (MMBtu)	7,453	\$41/MMBtu	\$305,986	GSA - Central Steam Plant
Water (Gallons)	-	-	-	-

- Site Energy Use Intensity (EUI) 143.2 kBtu/ft<sup>2</sup>
  - 5% reduction from FY 2006 -2008
- Total GHG CO<sub>2</sub> Equivalent 2,709 Metric tons

# ECM - Replace the 160 Ton Chiller with a High Efficiency Variable Speed Centrifugal or Frictionless Chiller

**Current Condition.** The gallery area cooling system is served by a 15 year old 160-ton Dunham-Bush water-cooled chiller.

**Recommended Action.** Replace the current 160-ton Dunham-Bush water-cooled chiller with a high efficiency centrifugal or frictionless chiller.

<b>Electricity Savings</b>	292,035 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$35,267/yr
<b>Implementation Costs</b>	\$260,000
<b>Simple Payback</b>	7.37 years



## ECM - Manage OA Intake More Efficiently (Install Modulating Damper Actuators on AHU's)

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**Current Condition.** The outside air (OA) dampers for air handling units (AHU's) 7-11 are currently tied into the AHU motor starters and are either fully open or fully closed. AHU's 7, 8, and 9 serve large conference rooms and AHU's 10 and 11 serve the gallery space.

**Recommended Action.** Install modulating damper actuators on the AHU air intake to control the amount of OA brought into the facility.

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<b>Electricity Savings</b>	38,479 kWh/yr
<b>Purchased Steam Savings</b>	535 MMBtu/yr
<b>Cost Savings</b>	\$25,557/yr
<b>Implementation Costs</b>	\$28,600
<b>Simple Payback</b>	1.1 years

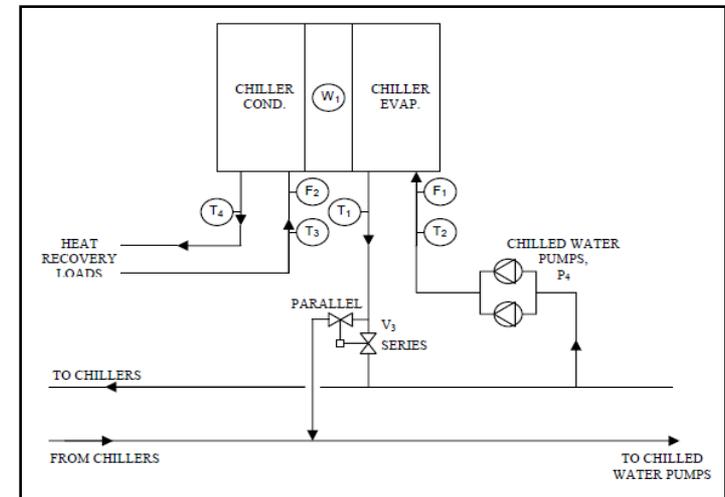


# ECM - Install a Heat Recovery Chiller

**Current Condition.** Steam is currently purchased from a GSA owned steam plant. Steam provides heat to the HVAC system through a hot water converter.

**Recommended Action.** Install a heat recovery chiller to provide hot water for the HVAC system and supplementary cooling to the primary chilled water loop.

<b>Electricity Savings</b>	- 437,289 kWh/yr
<b>Purchased Steam Savings</b>	2,682 MMBtu/yr
<b>Cost Savings</b>	\$ 55,356 /yr
<b>Implementation Costs</b>	\$ 150,000
<b>Simple Payback</b>	2.7 years



## ECM - Install More Efficient Humidifying Systems

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**Current Condition.** The NBM currently satisfies the humidity requirements of the gallery with purchased steam from the central plant.

**Recommended Action.** Replace the steam humidification system with a low energy system such as ultrasonic humidification or high-pressure cold water fogging system.

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<b>Electricity Savings</b>	0 kWh/yr
<b>Purchased Steam Savings</b>	796 MMBtu/yr
<b>Cost Savings</b>	\$ 26,576 /yr
<b>Implementation Costs</b>	\$270,000
<b>Simple Payback</b>	10.2 years



# ECM – Install Low Ballast Factor Ballasts in all T8 Lighting Systems

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**Current Condition.** Office areas are currently illuminated with T8 lamps and electronic ballasts. These systems generally operate with an efficacy of 80 lumens/watt and have 0.88 ballast factors (BF).

**Recommended Action.** Replace the existing electronic ballast with a program start ballast with a rated ballast factor determined by the A/E firm. Based on spot illuminance measurements it is assumed that ballast factors between 0.7 – 0.77 will be acceptable

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<b>Electricity Savings</b>	35,000 kWh/yr
<b>Purchased Steam Savings</b>	-10 MMBtu/yr
<b>Cost Savings</b>	\$ 3,443 /yr
<b>Implementation Costs</b>	\$ 64,284
<b>Simple Payback</b>	18.7 years



# ECM - Retrofit halogen lamps in gallery with LED Spot Lamps

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**Current Condition.** Halogen spot lamps are currently used in most of the gallery spaces. These lights are used because of the beneficial color rendering required for exhibits and the spectral distribution of the lamp

**Recommended Action.** Retrofit the current halogen spotlights with similar color temperature LED spot lamps and remove the current lighting filters. The NREL team identified 390 halogen spot lights in the gallery spaces which relates to a total connected load of 23.4 kW and a total usage of 2,496 hours/year.

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<b>Electricity Savings</b>	50,725 kWh/yr
<b>Purchased Steam Savings</b>	-52 MMBtu/yr
<b>Cost Savings</b>	\$5,531 yr
<b>Implementation Costs</b>	\$ 66,306
<b>Simple Payback</b>	11.31 years



## ECM - Install Occupancy Sensors in the Library and Executive Offices on the 3rd and 4th Floor

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**Current Condition.** There are no occupancy sensors in the 4<sup>th</sup> floor library (room 425), executive office (room 431) or 30 perimeter offices on the third floor.

**Recommended Action.** Install a passive electronic sensor to automatically activate and deactivate the 4<sup>th</sup> floor library, 3<sup>rd</sup> floor perimeter offices and 4<sup>th</sup> floor executive office lighting circuits based on occupancy.

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<b>Electricity Savings</b>	9,591 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$1,127/yr
<b>Implementation Costs</b>	\$10,608
<b>Simple Payback</b>	9.41 years

## ECM - Install Dimming Ballasts and Daylighting Controls in the Fourth Floor Office Space

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**Current Condition.** The office space on the 4<sup>th</sup> floor has significant day-lighting potential, but have no day-lighting controls. The 4<sup>th</sup> floor office spaces were found to be overlit and were observed to have significant day-light provided by skylights.

**Recommended Action.** Install dimming ballasts and daylighting controls around the sky-lights on the fourth floor.

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<b>Electricity Savings</b>	78,726 kWh/yr
<b>Purchased Steam Savings</b>	-48 MMBtu/yr
<b>Cost Savings</b>	\$6,794/yr
<b>Implementation Costs</b>	\$112,554
<b>Simple Payback</b>	16.6 years

## **ECM - Retrofit T-12 Exterior Canopy Lighting with T-8 Lighting Fixtures**

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**Current Condition.** T-12 lamps with magnetic ballasts were observed in the exterior canopy at the East entrance loading dock area.

**Recommended Action.** Replace T-12 lamps and magnetic ballasts with T-8 lamps and electronic ballasts

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<b>Electricity Savings</b>	673 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$79/yr
<b>Implementation Costs</b>	\$394
<b>Simple Payback</b>	5.0 years

## ECM - Install High Efficiency Motors on Gallery AHU's

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**Current Condition.** NREL assessment team identified 13 of 53 AHUS that are older inefficient motors.

**Recommended Action.** Replace the 13 inefficient gallery AHU motors with NEMA premium efficiency motors.

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<b>Electricity Savings</b>	10,179 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$1,230/yr
<b>Implementation Costs</b>	\$8,416
<b>Simple Payback</b>	6.8 years

## ECM - Install VFD's on Secondary Chilled Water Pumps for the Gallery Chillers

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**Current Condition.** The secondary chilled water coils on the 53 gallery AHU's are 2 way control valves. The chilled water supply pumps that supply chilled water to the chilled water coils are constant volume pumps.

**Recommended Action.** Install VFDs on each 25 HP pump. The site will need to purchase and install two 25 hp VFDs. They will also need to add 2 new control points to the DDC system.

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<b>Electricity Savings</b>	66,512 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$8,035/yr
<b>Implementation Costs</b>	\$15,860
<b>Simple Payback</b>	2.0 years

## ECM - Install VFD's on the Main Hot Water Pumps

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**Current Condition.** The hot water heating coils on the main AHUs don't currently have any type of control valve. Of the main 11 AHUs 1, 2, 4, and 5 don't have heating coils and are for cooling only.

**Recommended Action.** Install variable frequency drives VFDs on both hot water pumps and install 2 way control valves on each AHU. The contractor shall install a 50 hp VFD and a 40 hp VFD.

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<b>Electricity Savings</b>	54,725 kWh/yr
<b>Purchased Steam Savings</b>	0 MMBtu/yr
<b>Cost Savings</b>	\$6,611/yr
<b>Implementation Costs</b>	\$46,833
<b>Simple Payback</b>	7.1 years

# ECM - Install Low Flow Fixtures (Toilets, Urinals, Faucets)

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## Recommended Action.

- Replace all of the Kohler valves and or toilets with standard low consumption toilets. The standard low consumption toilet shall have a flow rating of 1.6 gpf or less.
- Replace all of the Kohler valves and urinals with low consumption urinals.
- Replace the current faucets with low flow faucets with a flow rate equal to or less than 0.5 GPM.

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<b>Water Savings</b>	768,192 gallons/yr
<b>Electricity Savings</b>	510 kWh/yr
<b>Cost Savings</b>	\$5,824/yr
<b>Implementation Costs</b>	\$88,433
<b>Simple Payback</b>	15 years

# Combined Savings

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- Site Energy Use Intensity (EUI) 110.8 kBtu/ft<sup>2</sup>
  - 23% reduction from FY 2008 baseline

## Projects that trigger Historic Preservation Review

- Double Paned Windows
- Revolving Door
- 3<sup>rd</sup> Floor daylighting
- Exterior Façade Infiltration
- Solar Hot Water and PV

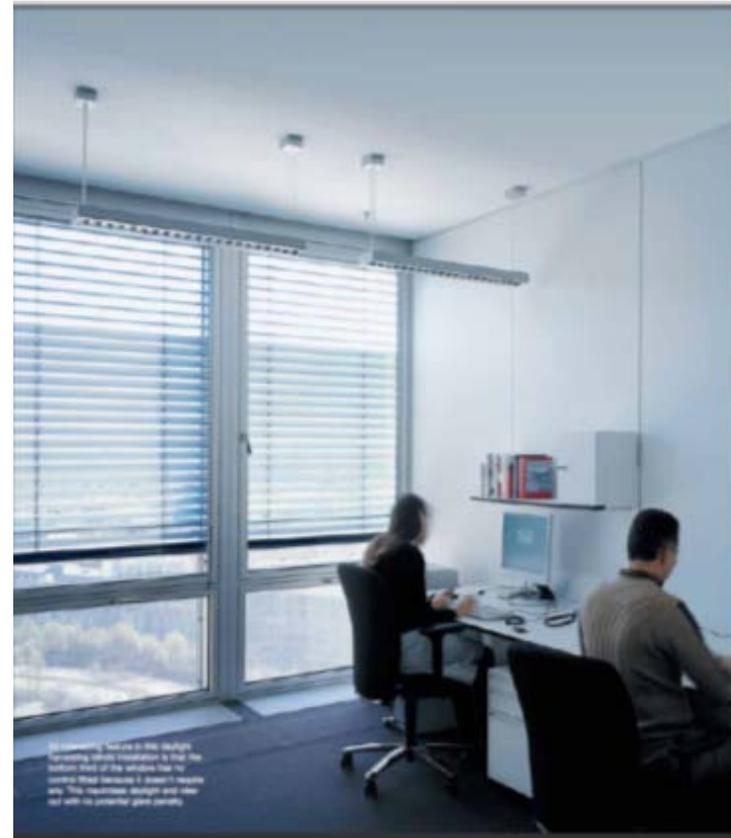
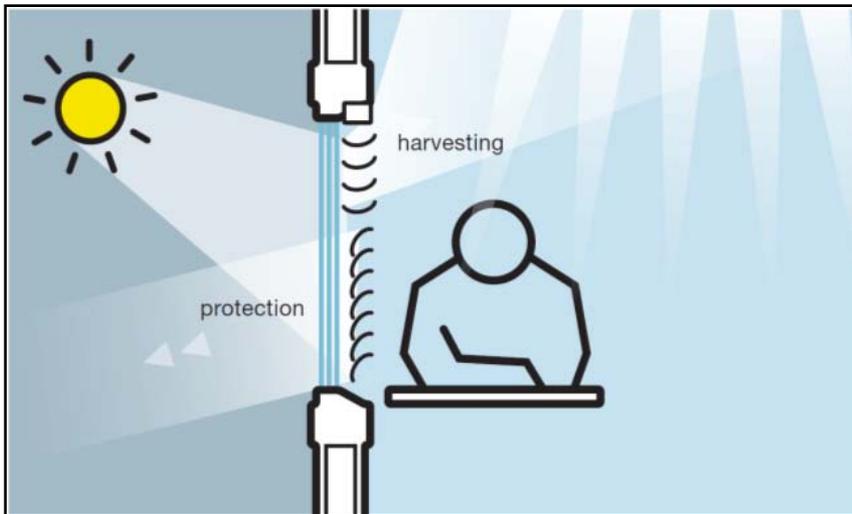


# Daylighting Strategies

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- Design Goals
  - Provide ample natural light on the workplane
  - Create uniformity of light in the space
  - Control direct sun and glare
  - Maintain a view and connection to the outdoors
  - Allow realizable energy savings
- Design Strategies
  - Daylighting Blinds
  - Lightshelves
  - Optical Louvers

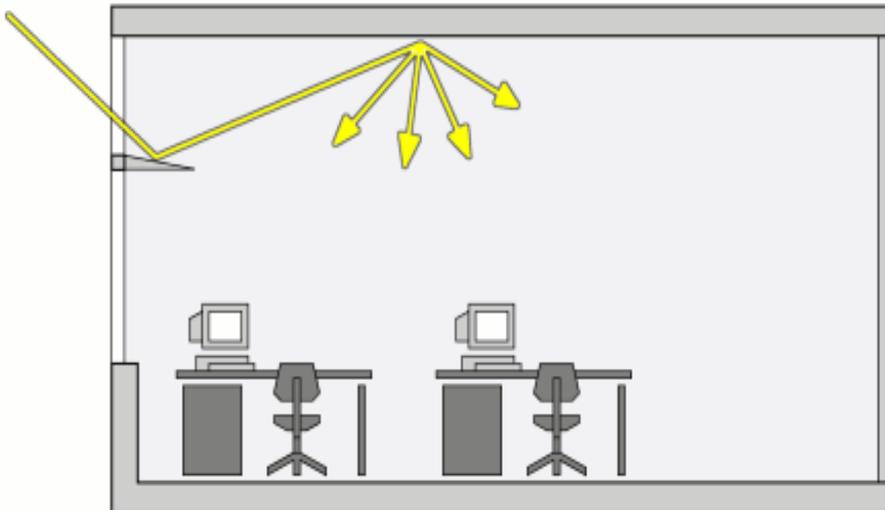
# Daylighting Blinds



<http://www.zumtobel.com>

# Lightshelves

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# Optical Louvers

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<http://www.lightlouver.com/>

# Department of Interior Building

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- The Main Interior Building is located at 1848 C Street NW, Washington DC.
  - Constructed in 1936, it was hailed as a model of architectural and decorative craftsmanship which included the progressive air conditioning systems.
  - Seven story office building
  - Over 1 million square foot building





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# DOI BLAST/STORM WINDOWS

Blast windows were installed on 5,000 windows



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# **DOI INTERIOR INSULATION**

Interior Insulation was added through the facility modernization



# DOI GREEN ROOF

Green roof project pilot in DC

# Thank you!

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