



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

Federal Energy Management Program

Sustainable Design

Presented By

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Overview

- Sustainable Design Definition
- Federal Requirements Summary
- Sustainable Design Considerations
- Design Tools
- Performance Measurement

What is Sustainable Development?

Classic Definition:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

Brundtland Commission



- Across Time
- Across Space

What is Sustainable Building Design?

- Integrated design that considers its overall impact on development and the following:
 - Site Planning
 - Water Use
 - Energy Use
 - Materials Selection
 - Indoor Environmental Quality
 - Construction Management



Federal Requirements Summary

- Energy Policy Act of 2005 (EPAAct 2005)
- Energy Independence and Security Act of 2007 (EISA 2007)
- Executive Order 13423 – Strengthening Federal Environment, Energy, and Transportation Management
- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding
 - EPA's Comprehensive Procurement Guidelines (CPG)
<http://www.epa.gov/cpg/products.htm>
 - Federal Biobased Products Preferred Procurement Program (FB4P)
<http://www.biopreferred.gov/Default.aspx?SMSESSION=NO>



EPAct 2005

- Section 109 – Federal Building Performance Standards
 - Sustainable design principles are applied to siting, design, and construction of all new and replacement buildings, when life-cycle cost-effective.

EISA 2007

- Section 433
 - New Federal buildings and Federal buildings undergoing major renovations shall apply sustainable design principles to siting, design, and construction.
 - A certification system and level for green buildings will be identified.
 - U.S. Green Building Council Leadership for Energy and Environmental Design (LEED) Silver level identified by General Services Administration on April 25, 2008
- Section 436
 - Establish an Office of Federal High-Performance Green Buildings

Executive Order 13423

- New construction and major renovation of Federal buildings comply with the *Guiding Principles*, and
- At least 15 percent of the existing Federal capital asset building inventory of the agency as of the end of Fiscal Year 2015 incorporates the sustainable practices in the *Guiding Principles*.

Federal Leadership in High Performance and Sustainable Buildings MOU

Federal Leadership in High Performance & Sustainable Buildings Guiding Principles

- *(aka Guiding Principles)*

- Employ Integrated Design Principles
 - Integrated Design
 - Commissioning

- Optimize Energy Performance
 - Energy Efficiency
 - Measurement and Verification



Guiding Principles, continued

- **Protect and Conserve Water**
 - Indoor Water
 - Outdoor Water
- **Enhance Indoor Environmental Quality**
 - Ventilation and Thermal Comfort
 - Moisture Control
 - Daylighting
 - Low-Emitting Materials
 - Protect Indoor Air Quality during Construction

Guiding Principles, continued

- Reduce Environmental Impact of Materials
 - Recycled Content
 - *EPA's Comprehensive Procurement Guidelines (CPG)*
<http://www.epa.gov/cpg/products.htm>
 - Biobased Content
 - *Federal Biobased Products Preferred Procurement Program (FB4P)*
<http://www.biopreferred.gov/Default.aspx?SMSESSION=NO>
 - Construction Waste
 - Ozone Depleting Compounds

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Design Considerations

- Site Planning
 - Site selection and building orientation
 - Stormwater management
 - Occupant transportation impacts
 - Heat Island Effect
 - Light pollution



U.S EPA Region 7 Science and Technology Center

<http://femp.buildinggreen.com/>

Design Considerations

- Water Use
 - Indoor
 - Outdoor
 - Wastewater



Social Security Administration Child Care Center

Design Considerations

- Energy Use
 - Performance
 - Renewables
 - Commissioning



NREL Science and Technology Facility

Design Considerations

- Building Materials
 - Sustainably managed wood products
 - Rapidly renewable resources
 - Recycled content
 - Recyclability
 - Reusability
 - Manufacturing environmental impact
 - Global warming potential
 - Packaging
 - Aesthetics



Design Considerations

- Building Materials, *continued*
 - Minimize quantity of materials
 - Durability
 - Flexibility
 - Maintainability
 - Use of resources during operation and maintenance of building
 - Low emitting materials
 - Regionally available
 - Salvaged materials



Design Considerations

- Indoor Environmental Quality

- Thermal comfort
- Daylight and views
- Low-emitting materials



*Naval Base Kitsap-Bremerton
Bachelor Enlisted Quarters Building*

- Construction Management

- Installation matches design intent and specifications

Types of Tools

- Design strategy
 - Specifications
 - Product selection
- Specific material selection
 - Paint
 - Carpet
 - Adhesives
 - Wood
- Impact evaluation
- Rating systems

Resources for Sustainable Design Specification Wording

- EPA Federal Green Construction Guide for Specifiers

<http://www.wbdg.org/design/greenspec.php>



- Whole Building Design Guide Unified Facility Guide Specifications <http://www.wbdg.org>



- Building Green's GreenSpec Directory

<http://www.buildinggreen.com/guidespecs/index.cfm>

- EPA's Research Triangle Park Specifications

<http://www.epa.gov/rtp/campus/environmental/specs.htm>

Product Selection Guides

- GSA Environmental Products and Services Guide
[http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/2003_4_e_psg_optB\(final%20web%20version2\)_R2OP1-z_0Z5RDZ-i34K-pR.pdf](http://www.gsa.gov/gsa/cm_attachments/GSA_DOCUMENT/2003_4_e_psg_optB(final%20web%20version2)_R2OP1-z_0Z5RDZ-i34K-pR.pdf)
- Energy Star <http://www.energystar.gov/>
- WaterSense <http://www.epa.gov/watersense/>

- The Green Building Advisor
<http://www.nwbuildnet.com/stores/ss/green/gba/index.html>
- Architectural Record – Green Product Guide
<http://archrecord.construction.com/products/green/>

Material Specific Tools

- The Master Painters Institute™ (MPI) Green Performance™ Standard
 - Paint
- GreenSeal – Choose Green Reports
 - In-depth environmental impact reports on over 15 different construction materials/products ranging from lighting to particle board
- Carpet and Rug Institute (CRI) – Green Label Plus
 - Carpet and adhesives
- Forest Stewardship Council
 - Certified wood



Impact Evaluation

- Energy Star Portfolio Manager
<http://www.energystar.gov/>
- Building for Environmental Economic Sustainability (BEES 3.0)
http://www.bfrel.nist.gov/oe/software/bees/please/bees_please.html
- Cradle 2 Cradle <http://www.mbdc.com/c2c/>
- Pharos <http://www.pharoslens.net/>

Rating Systems

- U.S. Green Building Council's Leadership for Energy and Environmental Design (LEED)

<http://www.usgbc.org>



- Others

- Laboratories for the 21st Century (Labs21)
<http://www.labs21century.gov/>
- Building Research Establishments Environmental Assessment Method (BREEAM) <http://www.breeam.org/>
- Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)
<http://www.ibec.or.jp/CASBEE/english/index.htm>
- GBTool <http://greenbuilding.ca/gbc2k/gbtool/gbtool-main.htm>
- Green Globes <http://www.thegbi.org/gbi/>



Leadership in Energy and Environmental Design

A leading-edge system
for certifying the
greenest performing
buildings in the world

LEED® Facts
Building size 12,500 square ft
Type of building
LEED for Core & Shell Development
Certification awarded July 27, 2006

Platinum	49*
Sustainable Sites	13/15
Water Efficiency	5/5
Energy & Atmosphere	12/15
Materials & Resources	6/9
Indoor Environmental Quality	10/13
Innovation & Design	3/5

*Out of a possible 62 points

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Sample LEED Scorecard

Project Name:
Project Address:

HPSB Maybe N/A

Certified: 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 points

0 0

Sustainable Sites

14 Points

Y			Prereq 1	Construction Activity Pollution Prevention	Required
			Credit 1	Site Selection *	1
			Credit 2	Development Density & Community Connectivity	1
			Credit 3	Brownfield Redevelopment	1
			Credit 4.1	Alternative Transportation , Public Transportation Access	1
			Credit 4.2	Alternative Transportation , Bicycle Storage & Changing Rooms	1
			Credit 4.3	Alternative Transportation , Low-Emitting & Fuel-Efficient Vehicles	1
			Credit 4.4	Alternative Transportation , Parking Capacity	1
			Credit 5.1	Site Development , Protect or Restore Habitat	1
			Credit 5.2	Site Development , Maximize Open Space	1
			Credit 6.1	Stormwater Design , Quantity Control	1
			Credit 6.2	Stormwater Design , Quality Control	1
			Credit 7.1	Heat Island Effect , Non-Roof	1
			Credit 7.2	Heat Island Effect , Roof	1
			Credit 8	Light Pollution Reduction	1

Yes No

0 0

Water Efficiency

5 Points

			Credit 1.1	Water Efficient Landscaping , Reduce by 50%	1
			Credit 1.2	Water Efficient Landscaping , No Potable Use or No Irrigation	1
			Credit 2	Innovative Wastewater Technologies	1
			Credit 3.1	Water Use Reduction , 20% Reduction	1
			Credit 3.2	Water Use Reduction , 30% Reduction	1



Which tools to use?

- Determine if a resource/tool is applicable
 - Is it a fit for the building function/type?
 - Is it a match for the geographic region?
 - Does it match the organization or community needs?
 - Does the level of innovation match the organization's willingness to take risk?
- Check the validity of a resource/tool
 - Who is the sponsor?
 - Is similar information provided on more than one site?
 - Is the information up-to-date?

First Cost Comparisons

Table S-1. Summary of First Costs and Annual Cost Savings of Sustainable Features in the Prototype Building Analysis

Feature	Change First Cost	Change Annual Cost	Explanation
Energy-efficiency measures	+\$38,000	-\$4,300	Results of energy simulation models showed that a 37% reduction in annual energy costs could be achieved by a combination of energy-efficiency measures at a total first-cost increase of about 1.6% of the building cost. The simple payback was estimated to be 8.7 years. See Section 2.2.
Commissioning	+\$4,200	-\$1,300	Commissioning costs about 2% of the heating, ventilation and air conditioning plus control system cost. It can yield a benefit on the order of 10% of annual energy costs, for a payback period of about 3.2 years. See Section 2.2.
Water-savings measures	-\$590	-\$330	No-water urinals can have lower first costs than their traditional counterparts because less piping is required, thus lowering first costs for the entire package of water-savings measures. All of the water-savings technologies analyzed have favorable economics, with payback periods ranging from 0.3 to 2.8 years. See Section 2.3.
Sustainable landscaping and stormwater management	+\$5,600	-\$3,600	Landscaping using natural grasses and wildflowers instead of traditional turf, and a sustainable stormwater management system using porous-surface parking lot paving instead of asphalt, have payback periods of 0.8 and 5.6 years, respectively. See Section 2.4.
Subtotal ii	+\$47,000	-\$9,500	5-year payback
Raised floor system and moveable walls	Negligible iii	-\$35,000	A raised floor system and moveable wall partitions instead of traditional systems would decrease churn costs significantly with very little additional first costs. See Section 2.5.
Sustainable materials	-\$51,000	N.A.	Use of various sustainable materials (concrete with slag content, recycled carpet, low-emitting paint, and certified wood doors) reduced the prototype building's first cost by up to \$2.60/ft ² , lowering the building's cost by about 2%.iv See Section 2.1.
Societal cost reduction of air pollution reduction	v	-\$2,000	Annual reductions in emissions from improved energy performance were estimated to be 0.016 tons of SO ₂ , 0.08 tons of NO _x , and 10.7 tons of CO ₂ , which might be valued as high as \$1090 for SO ₂ , \$800 for NO _x , and \$107 for CO ₂ . By including the sum of these societal cost reductions in the payback calculation for the energy measures, the simple payback period would decrease from 8.7 to 6.0 years. See Section 2.8.1.
Total	-\$3,800	-\$47,000	

i Values were rounded to two significant digits. ii The costs for features included in the subtotal are more certain than those for the features in the rows below. iii Lower cost of air distribution systems, electrical receptacles and other equipment usually offsets the higher cost of the raised floor itself. iv Sometimes the costs of sustainable materials are higher than traditional ones, so the cost reduction for sustainable materials shown in this table should be viewed as less certain than the other values. v The cost is included in energy-efficient measures.

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Energy Use Comparisons

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- U.S. Department of Energy. 2003. *The Business Case for Sustainable Design in Federal Facilities*. Interagency Sustainability Working Group, Federal Energy Management Program, Washington, DC. http://www.eere.energy.gov/femp/technologies/sustainable_federalfacilities.cfm
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Figure 2-1. Energy-Efficiency Measures Examined in the Prototype Building Analysis

Table 2-1. Prototype Building Analysis: Energy-Efficiency Features
Reduce Annual Energy Costs by 37%

	Base-Case Building Annual Energy Cost	Sustainable Building Annual Energy Cost	Percent Reduction
Lighting	\$6,100	\$3,190	47.7
Cooling	\$1,800	\$1,310	27.1
Heating	\$1,800	\$1,280	28.9
Other	\$2,130	\$1,700	20.1
Total	\$11,800	\$7,490	36.7



Water Use Comparison

Table WE3.1-2

20% Water Use Reduction – 0.5 gpm Faucets (Office Building)

Flush Fixture	Daily Uses	Flowrate [GPF]	Duration [flush]	Auto Controls N/A	Occupants	Water Use [gal]
Conventional Water Closet						
Male	1	1.6	1	--	550	880
Female	3	1.6	1	--	550	2,640
Conventional Urinal						
Male	2	1.0	1	--	550	1,100
Female	0	1.0	1	--	550	0
Flow Fixture	Daily Uses	Flowrate [GPM]	Duration [sec]	Auto Controls [% savings]	Occupants	Water Use [gal]
Ultra-Low Flow Lavatory	3	0.5	15	--	1,100	413
Shower	0.05	2.5	300	--	1,100	688
Pantry Sink	0.75	2.5	15	--	1,100	516
Total Daily Volume [gal]						6,236
Annual Work Days						260
Annual Volume [gal]						1,621,263
Annual Graywater or Stormwater Reuse [gal]						0
TOTAL ANNUAL VOLUME [gal]						1,621,263
Water Use Reduction (compared to Baseline)						21%

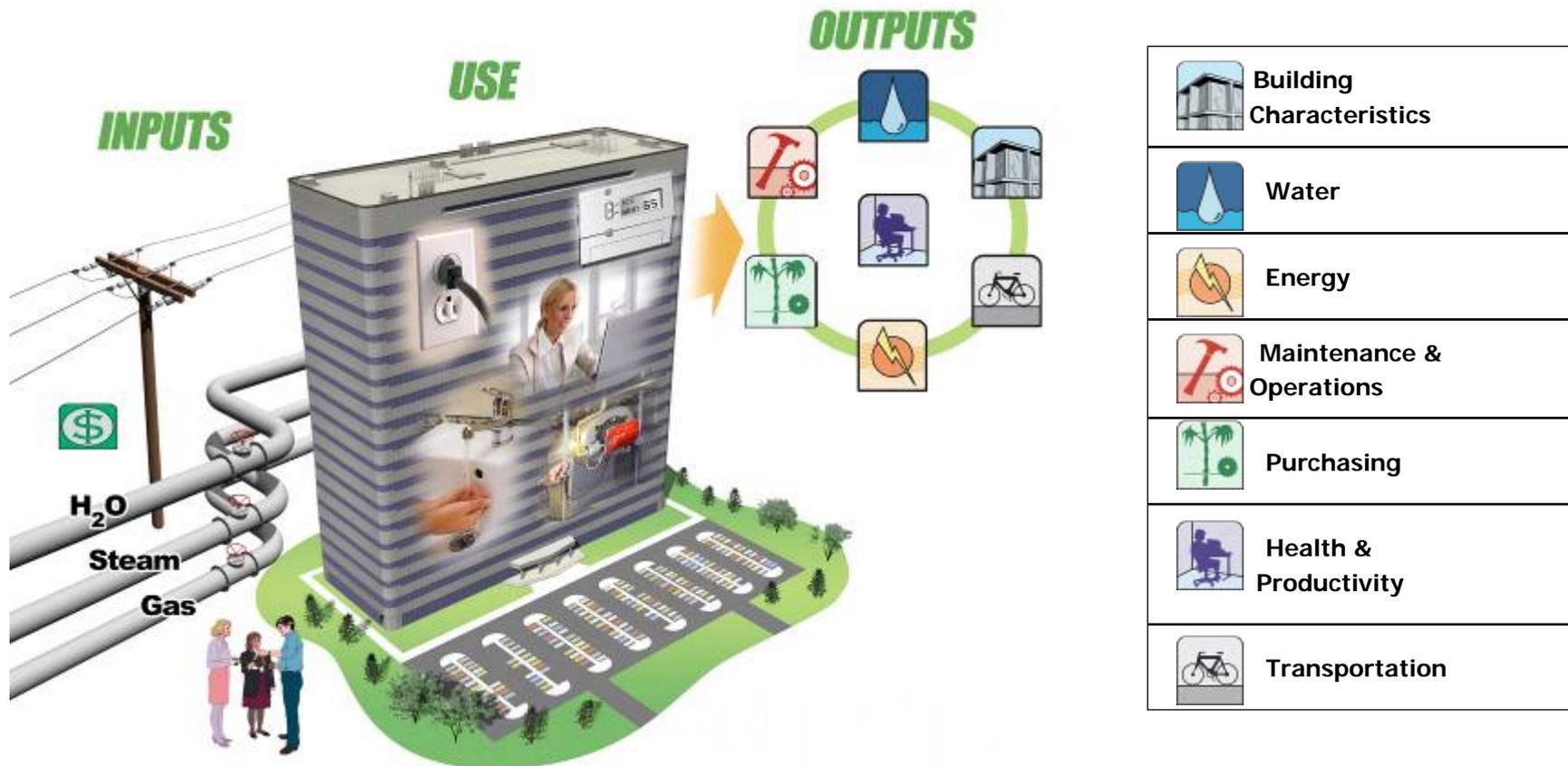
- Federal Water Use Indices**
http://www1.eere.energy.gov/femp/water/water_useindices.html
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Importance of Occupants

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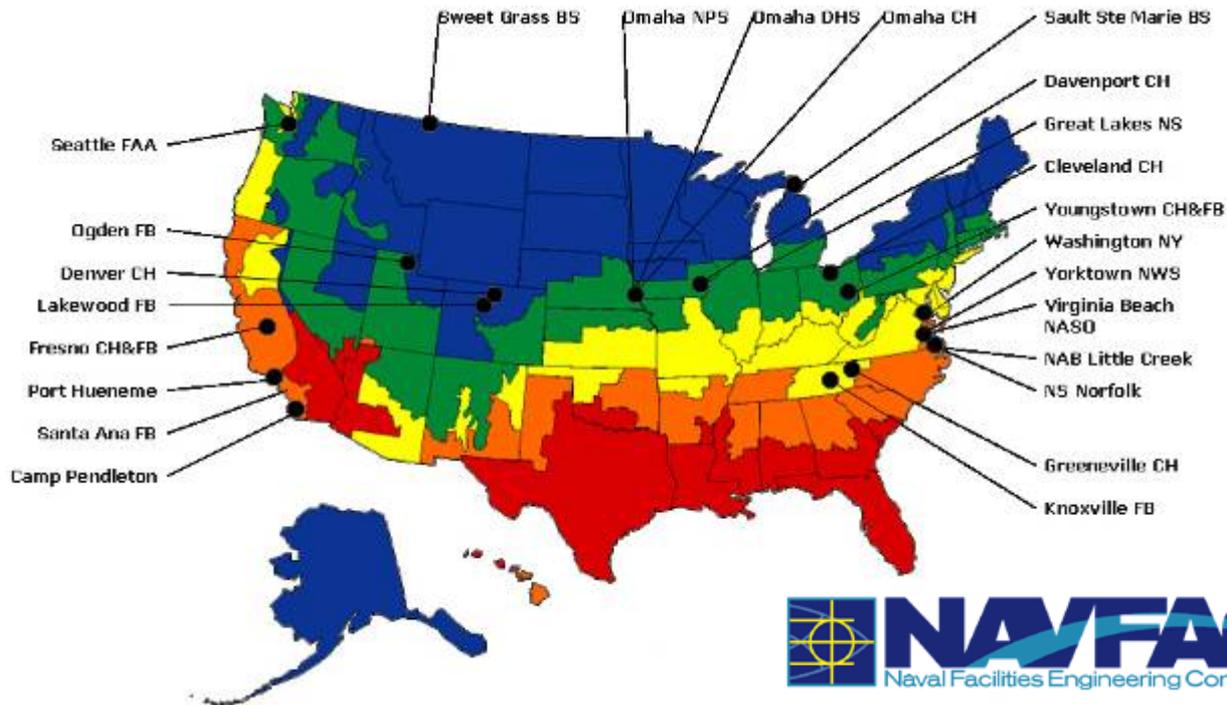
What is Whole Building Performance Measurement?



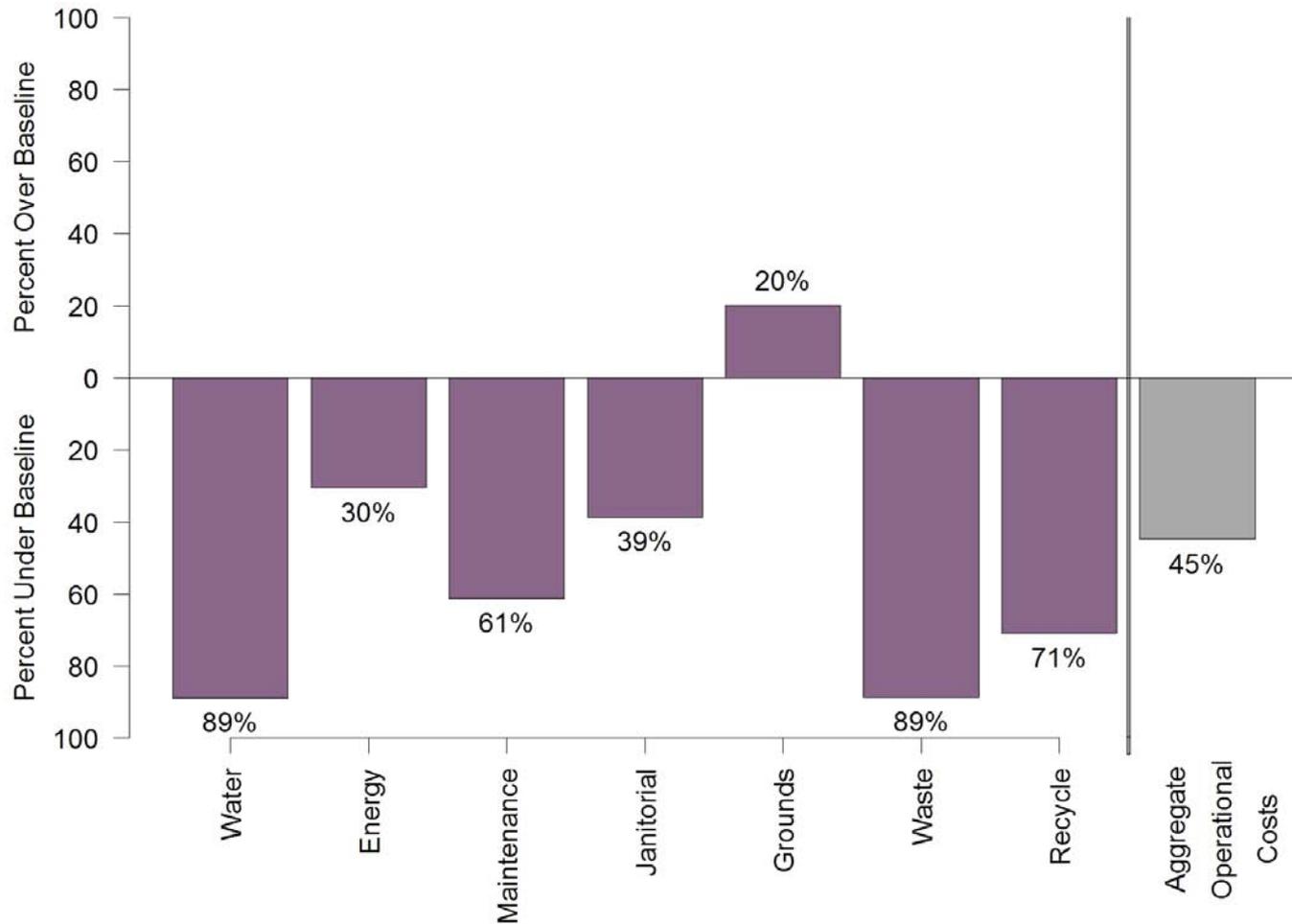
Whole-Building Performance Measurement involves measuring, not estimating or modeling, actual building related performance.

What the government is doing?

- Side-by-side comparisons of green and typically designed buildings
- Green portfolio compared to industry & internal standards
- Designing and constructing green buildings with WBPM integrated into design, compared to typical buildings



Whole Building Performance



Whole Building Performance

- Findings to date:
 - Sustainably designed buildings perform better than industry baselines
 - Design emphasis on a performance target equates to better performance
 - Consistent data collection allows for more accurate performance measurement analysis
 - Site specific data can inform building managers on building's performance

Comments or Questions?

Sustainable Development

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

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- Across Time
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