



Tracking LEED Performance Metrics
at
Old Dominion University's
Engineering & Computational Sciences
Research Laboratory

Bryna Cosgriff Dunn, LEED® ap
Moseley Architects

Greening Virginia Universities and Colleges
September 26, 2006
Harrisonburg, VA

Agenda

- Project Overview
- Energy Performance Benchmarks
- Water Performance Benchmark
- Post Occupancy Survey
- Lessons Learned

HIGH PERFORMANCE

Engineering & Computational Sciences Laboratory

- 21,300 Students @ ODU
- Carnegie Research Extensive University
- Forbes' Cyber University
- Top Programs
 - Modeling & Simulation
 - Oceanography
 - Nuclear Physics
 - Engineering Management



Budget: \$11,820,000

Bid: \$ 10,522,000



Photo Credit: Steve Maylone

HIGH PERFORMANCE

Energy costs are a big concern!

Utility Costs (FY05)

Electric	\$2,586,473
Natural Gas	663,233
Oil	26,698
Water/Sewer	<u>311,817</u>
Total	\$3,588,221
Utility Costs/GSF	\$1.35/GSF

Design Goals for E&CS project

- Construct Flagship for Energy/Water Conservation
- Improve Indoor Environmental Quality
- Use Recycled Materials/Construction Waste Mgmt.
- Create Test Site - Pending Energy Deregulation
- Build 1st LEED Engineering Lab (HE) in USA
- Build 1st *LEED* (HE) Facility in Va

HIGH PERFORMANCE

WHY LEED?

Validation imbedded in process


Demonstrates environmental stewardship

Example for Virginia higher education

Benchmark performance

Build support for the future

HIGH PERFORMANCE

 LEED <small>LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN</small>		Engineering & Computational Sciences Building Old Dominion University, LEED® Project # 0102 LEED Version 2 Certification Level: CERTIFIED August 25, 2004																																																																																																																				
30 Points Achieved		Possible Points: 69																																																																																																																				
<small>Certified: 26 to 32 points Silver: 33 to 38 points Gold: 39 to 51 points Platinum: 52 or more points</small>																																																																																																																						
5 Sustainable Sites Possible Points: 14		7 Materials & Resources Possible Points: 13																																																																																																																				
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HIGH PERFORMANCE

Our Site



HIGH PERFORMANCE

Restoration of Open Space



HIGH PERFORMANCE

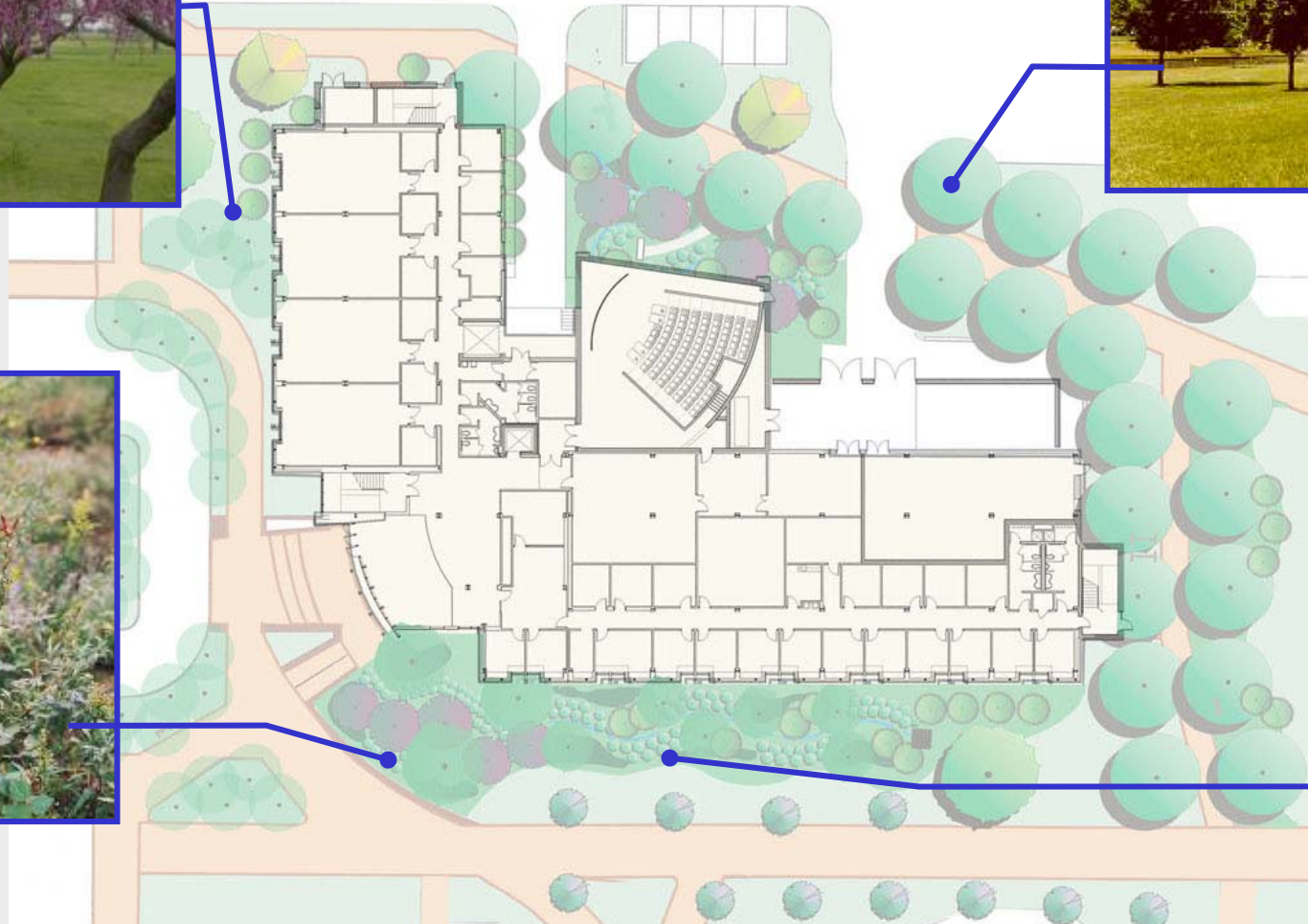
Water Efficient Landscaping



Red Bud



Saw
Tooth
Oak



Cardinal
Flower



Day Lily

Minimize Energy Consumption

- State of Virginia Building Code required meeting ASHRAE 90.1-1989
- The Engineering and Computational Sciences Building was designed according to ASHRAE 90.1-1999
- Modeled Energy Improvement = **21%**

Architectural Strategies to Minimize Energy Consumption

- Building Orientation
- Daylighting and Sunscreens
- Low-e glazing
- Rigid board insulation as exterior wall sheathing
- Increased insulation in roof (R-38)

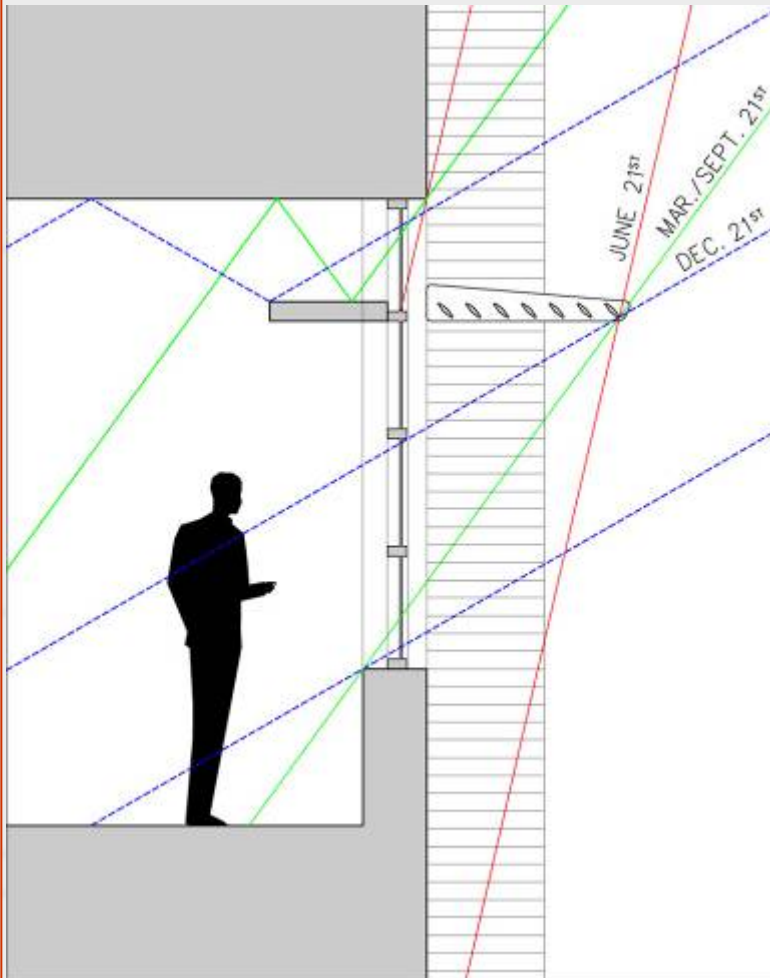
HIGH PERFORMANCE

Shading & Lighting: Solar Shading Screens



Photo credit: Steve Maylone

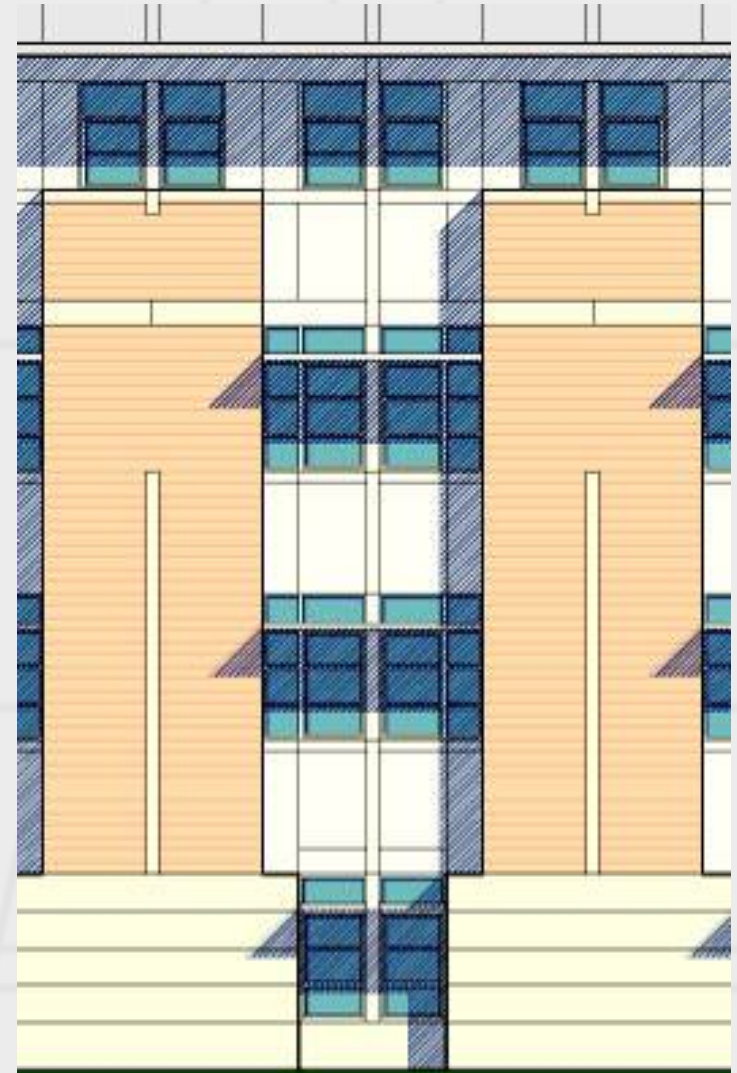
Shading & Lighting: Solar Shading Screens



TYPICAL LAB BAY - SECTION

**INTERIOR
LIGHT
SHELVES**
Maximize
natural
daylighting

**EXTERIOR
WINDOW
SHADING**
Minimize
heat gain
during
cooling
season



TYPICAL LAB BAY - SOUTH ELEVATION

Shading & Lighting: Solar Shading Screens



South Facing Solar Shading Screens

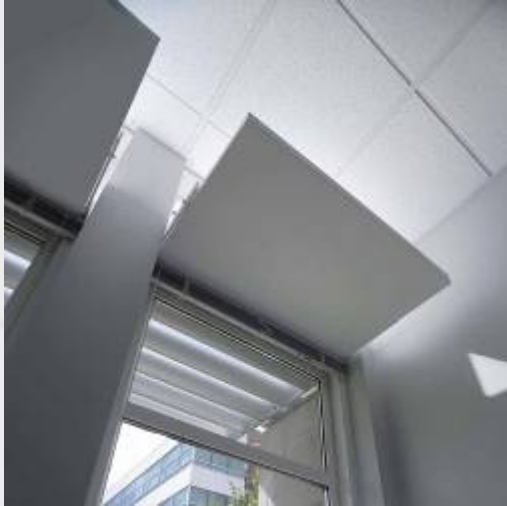


West Facing Solar Shading Screens



View of Roof Top Daylight Monitor

Shading & Lighting: Solar Shading Screens



Light Shelves in Faculty Offices



Shading & Lighting: Solar Shading Screens



4th Floor OCCS Office incorporating Natural Top Lighting

Mechanical Strategies

to

Minimize Energy Consumption

- Energy recovery devices (“heat wheels”) at air-handling units
- Multiple zones per floor
- Demonstration geothermal system for auditorium
- Occupancy sensors for lighting
- Carbon dioxide monitors

HIGH PERFORMANCE

Minimize Energy Consumption



4th Floor University Data Center



Demonstration/Visualization Auditorium incorporating Geothermal System

Measurement & Verification Plan

To ensure that energy savings are actually realized at this facility, a long-term monitoring and verification infrastructure has been established to monitor the following:

- Lighting systems and controls
- Constant and variable motor loads
- Variable frequency drive operation
- Chiller efficiency at variable loads
- Cooling load
- Air and water economizer and heat recovery cycles
- Boiler efficiencies
- Building specific process energy efficiency systems
- Indoor water risers and outdoor irrigation systems

Construction Indoor Air Quality (IAQ) Management

- Material and equipment protection
- Source control
- Pathway interruption
- Housekeeping during construction
- Scheduling of materials installation
- Testing of IAQ after construction

HIGH PERFORMANCE

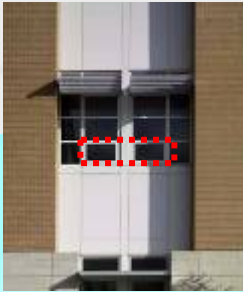
Low Emitting Materials

- **Adhesives** –met the VOC limits of the South Coast Air Quality Management District Rule #1168
- **Sealants** –met the Bay Area Air Resources Board Regulation 8 Rule 51
- **Paints** –met the VOC and chemical component limits of the applicable Green Seal standard
- **Carpets** –met the Carpet and Rug Institute Green Label Indoor Air Quality Test Program
- **Composite Wood Products** –contained no added urea-formaldehyde resins

HIGH PERFORMANCE

Operable Windows

One operable window and one lighting control zone per every 200 square feet for all perimeter spaces



HIGH PERFORMANCE

Energy Performance Benchmarks

ASHRAE BASE CASE

LEED DESIGN CASE

ODU Campus Energy Use

LABS 21 Data

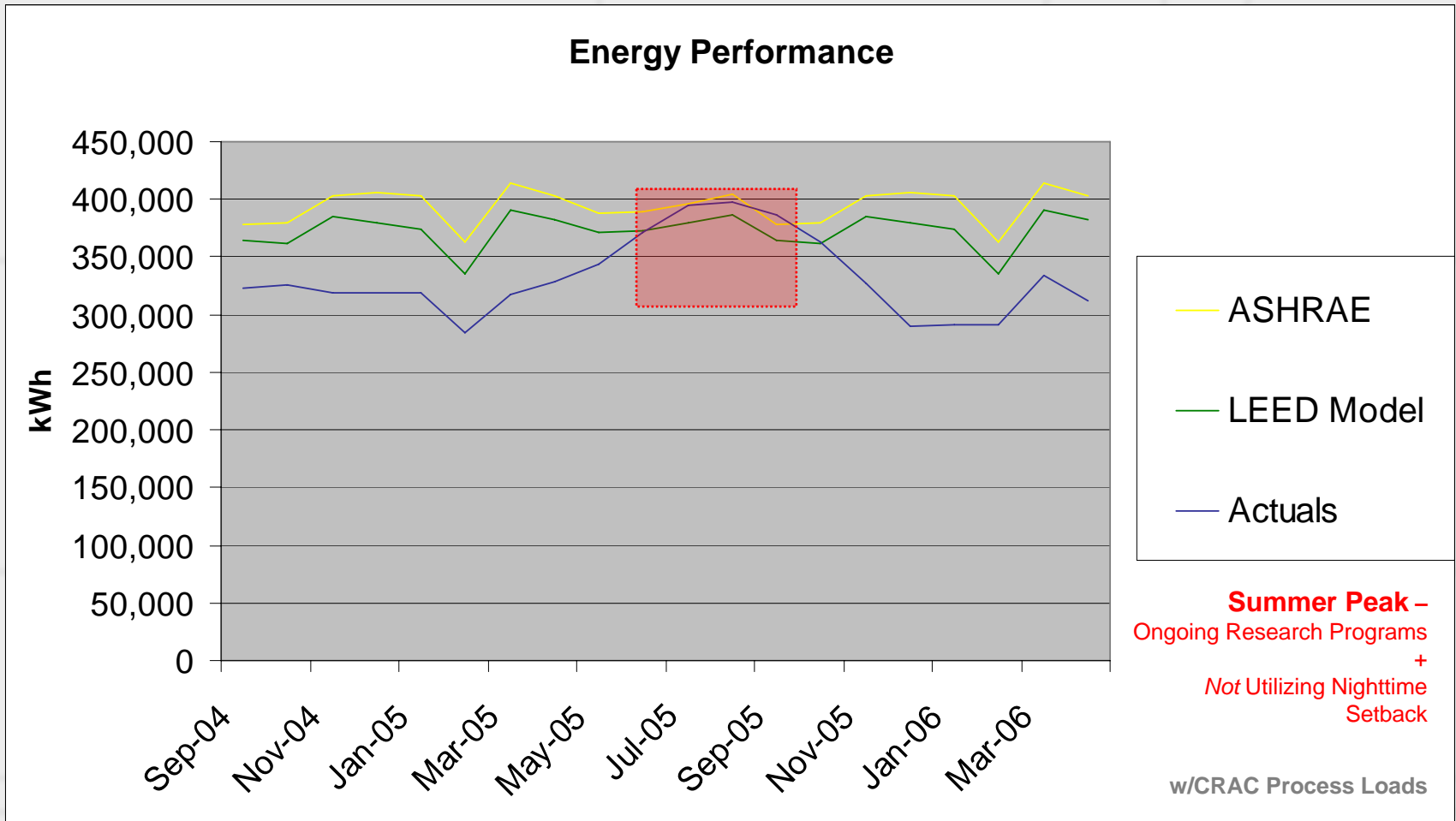
Occupant IEQ Survey (CBE)

Benchmarking Ground Rules

- CRAC/Data Center Process Loads Extracted (per LEED criteria) from:
 - ASHRAE Base Case
 - LEED Design Case
 - Actual Building Performance
- Actual Performance Does Not Take Advantage of Nighttime Setback Savings
 - Initial Year of Operation/Addressing Warranty Issues

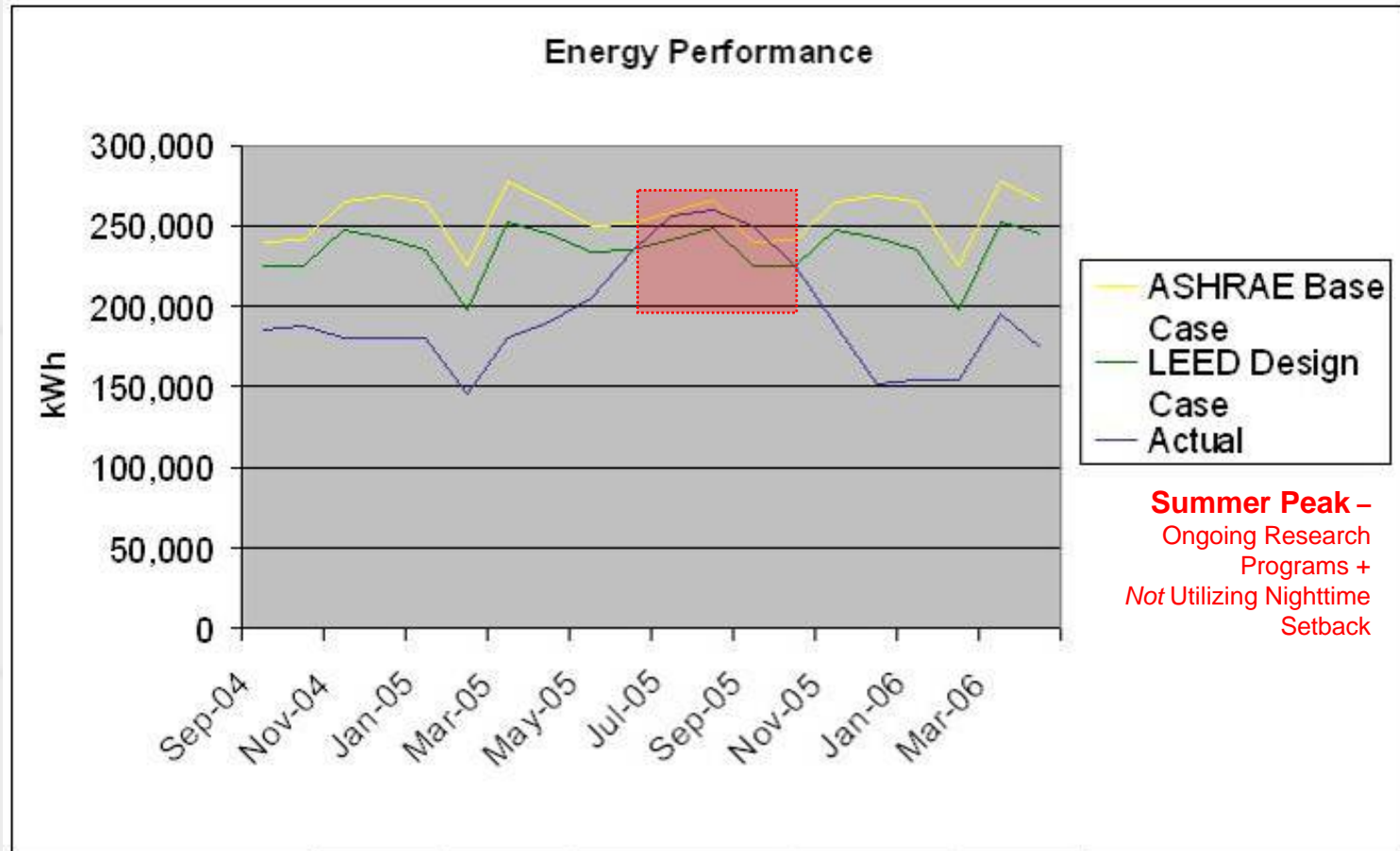
HIGH PERFORMANCE

Benchmark: Models versus Actual



HIGH PERFORMANCE

Benchmark: Models versus Actual



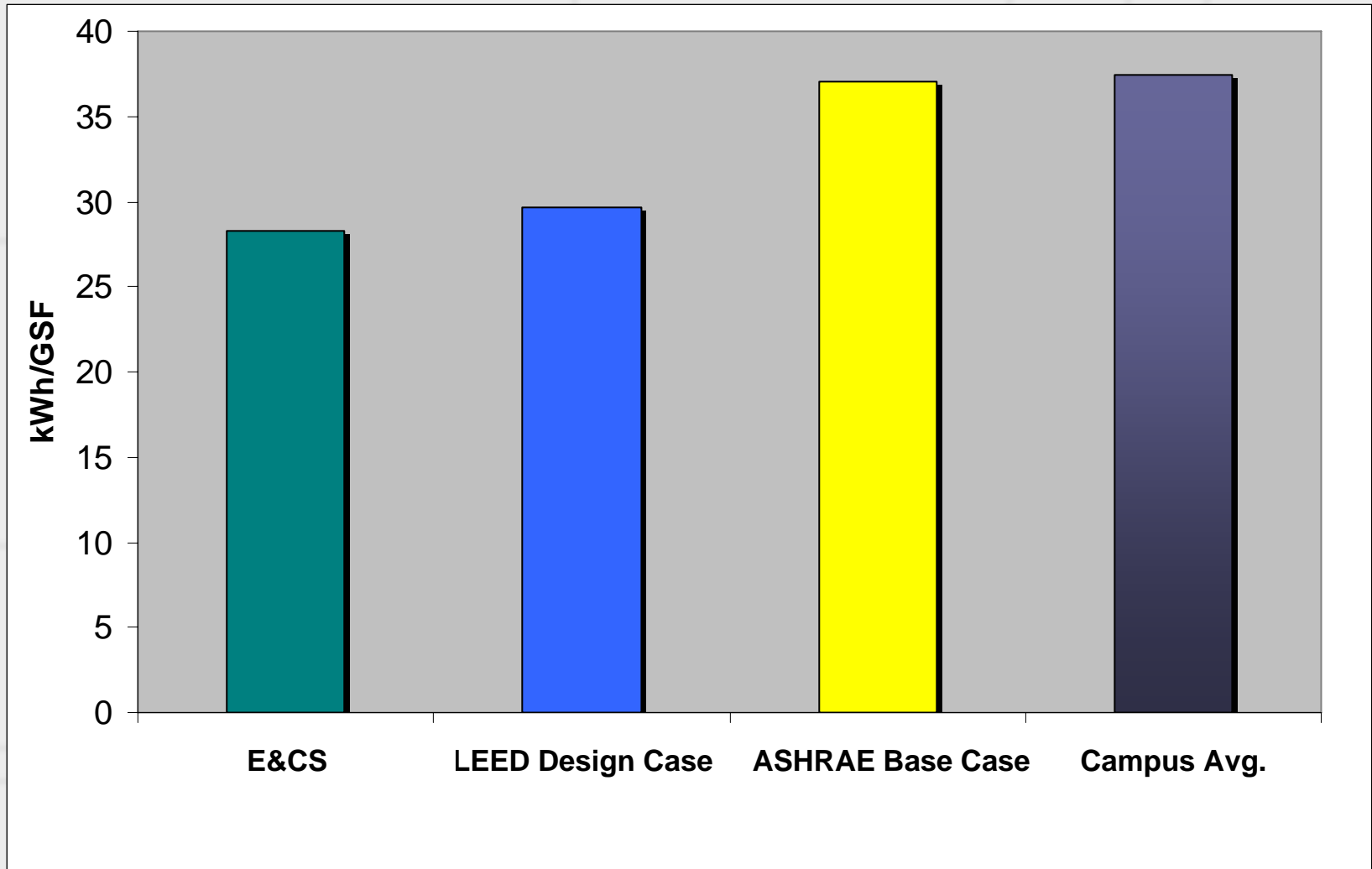
	Annual	*PV
Savings	30,550.03	\$454,506.00
PV - Present Value - 20 year discounted savings		
* Assuming 6% cost of capital and 3% escalation in energy costs		

w/o CRAC Process Loads

Out Performing LEED Base-case Model

1. Energy recovery devices (“heat wheels”) at air-handling units
2. Multiple zones per floor
3. Demonstration geothermal system for auditorium
4. Occupancy sensors for lighting
5. Carbon dioxide monitors

Benchmark: Actual versus Campus Energy Use



HIGH PERFORMANCE

Benchmark: LABS21

*Labs21 is a
voluntary
partnership
program
dedicated to
improving the
environmental
performance of
U.S. laboratories.*

[Carnegie Mellon University](#)

Cornell University

[Duke University](#)

Fred Hutchinson Cancer Research Center

[Harvard University](#)

North Carolina A&T State University

[Northern Arizona University](#)

Sierra Nevada College

[Sonoma State University](#)

Stanford University

[University of California-Davis](#)

[University of California-Merced](#)

[University of Colorado at Boulder](#)

[University of Hawaii](#)

[University of North Carolina-Asheville](#)

[University of Rochester](#)

Wright State University

<http://www.labs21century.gov/>

LABS 21

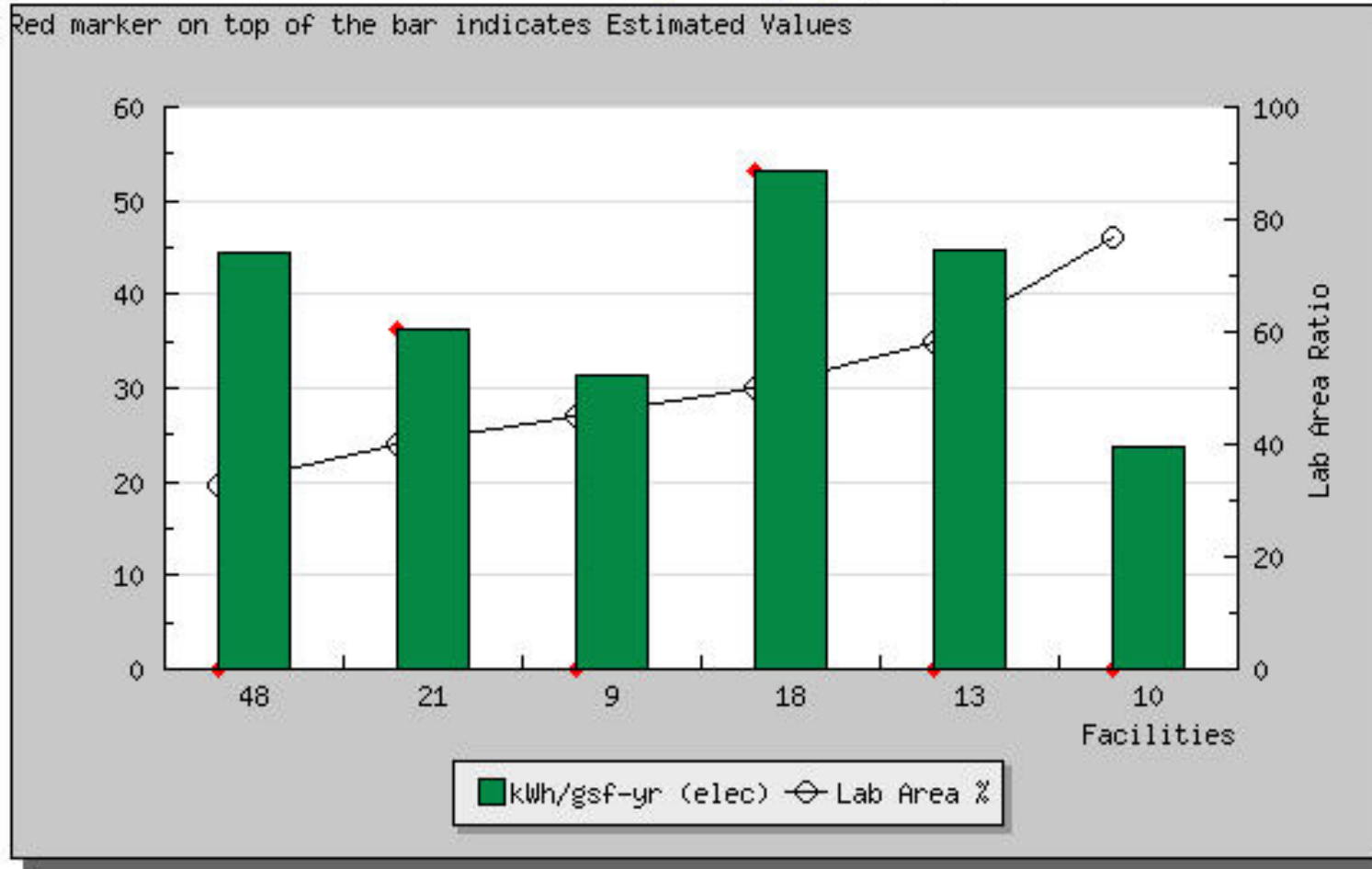
Energy Benchmark Data Table Region 4

Facility	Total Electric Use(kWh)	Gross Area (sq. ft.)	kWh/gsf-yr (elec)	Lab Area Ratio	Occupancy Hours	Climate
48	1832216	41233	44.44	0.33	12	4A
21	2406379	66500	36.19	0.4	1	4A
9	2020000	64228	31.45	0.45	12	4A
18	18300000	344000	53.2	0.5	10	4A
13	48959000	1091680	44.85	0.58	12	4A
10	3600000	151467	23.77	0.77	14	4A

LABS 21

Zone 4 Laboratories

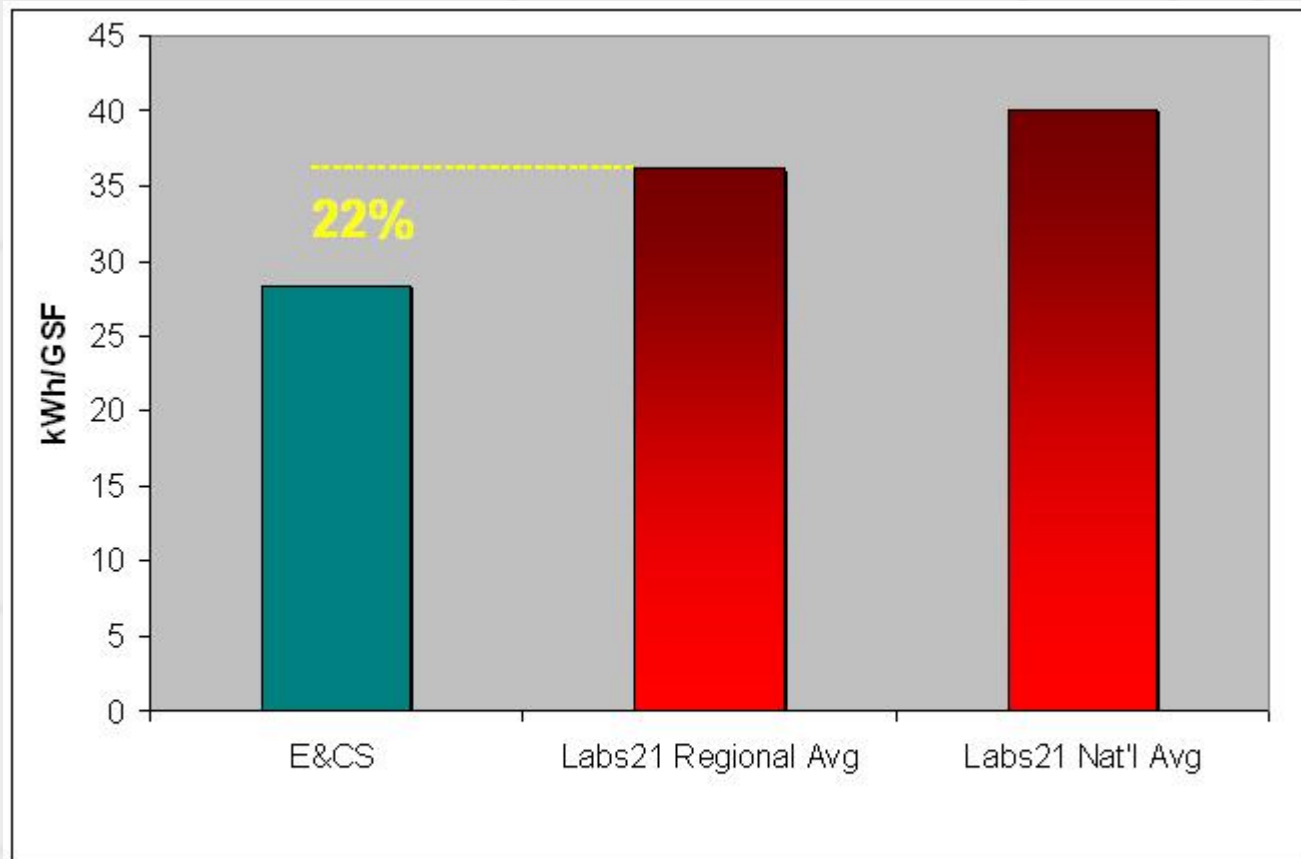
Total Building kWh/gsf-yr (elec)



HIGH PERFORMANCE

LABS 21

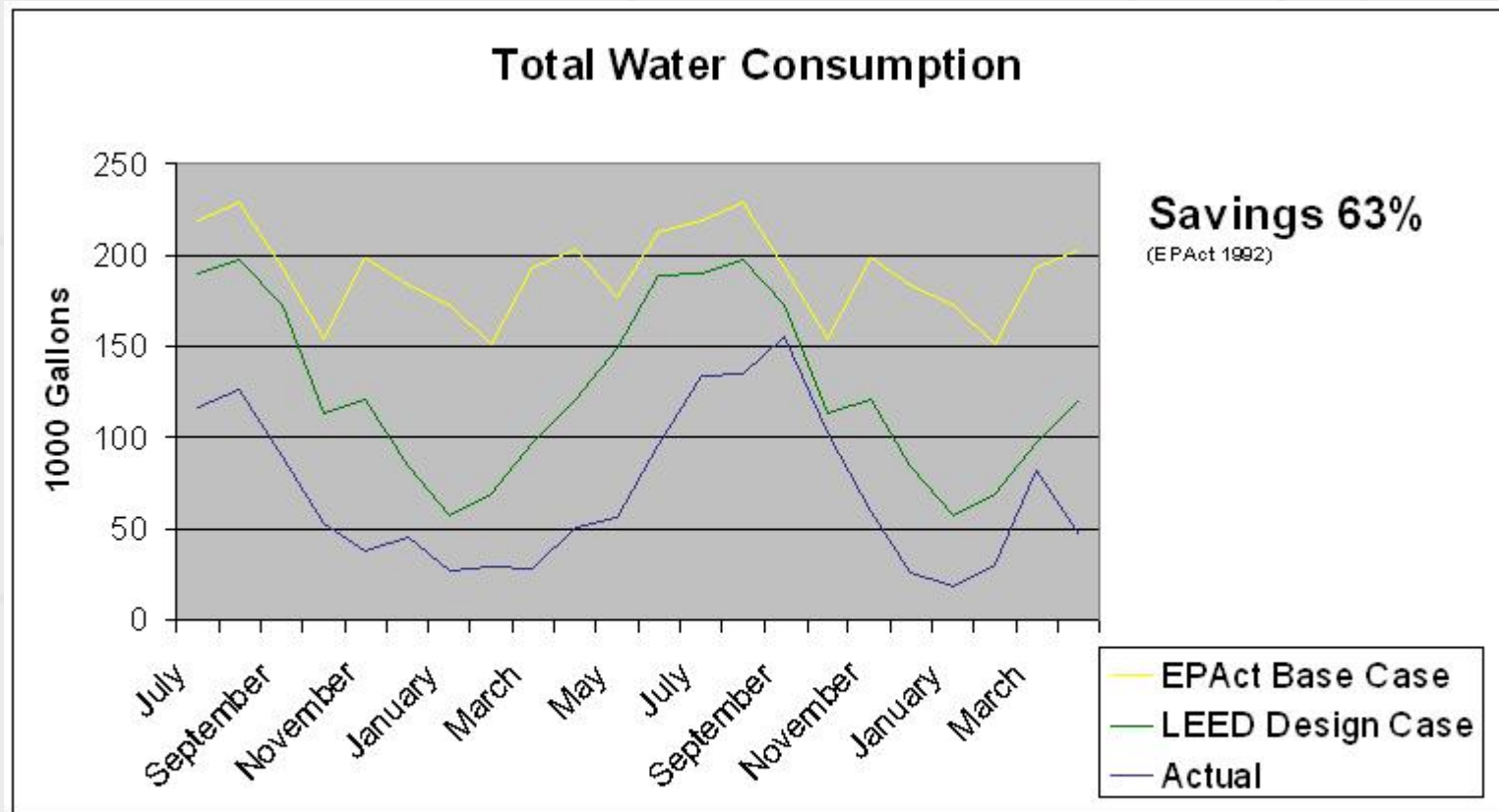
**Zone 4 & National Laboratories*



	Annual	*PV
Savings	\$ 30,508.62	\$453,883.00
PV - Present Value - 20 year discounted savings		
* Assuming 6% cost of capital and 3% escalation in energy costs		

HIGH PERFORMANCE

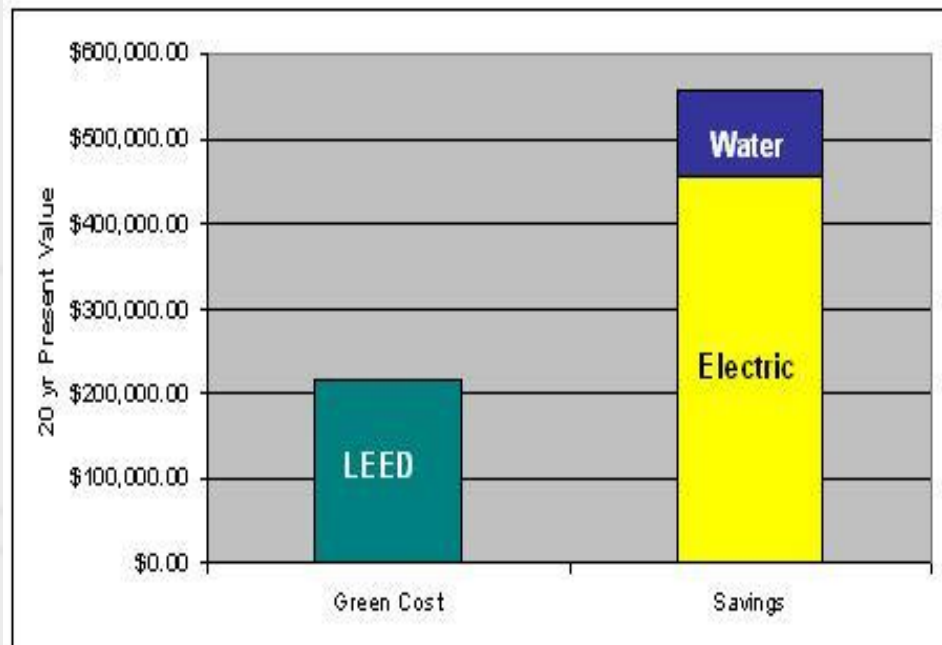
Benchmark: Water consumption



	Annual	*PV
Savings	\$8,865.31	\$101,684.29
PV - Present Value - 20 year discounted savings		
* Assuming 6% cost of capital		

PERFORMANCE VS. LEED PREMIUM

- Positive bid environment in 2003
- Project \$1.0 M +/- under budget
- No quantifiable bid premium for LEED Basic Certification Level



Capital E Report December 2005 - 1.5% - 2.5%
Davis Langdon Report July 2004, 0% - 3%

Occupant Satisfaction Data Collection



CENTER FOR THE BUILT ENVIRONMENT

<http://www.cbe.berkeley.edu/research/survey.htm>

OBJECTIVE

Study the performance of green and LEED-certified buildings in comparison to conventional buildings, in terms of occupant satisfaction with indoor environmental quality (IEQ).

BACKGROUND

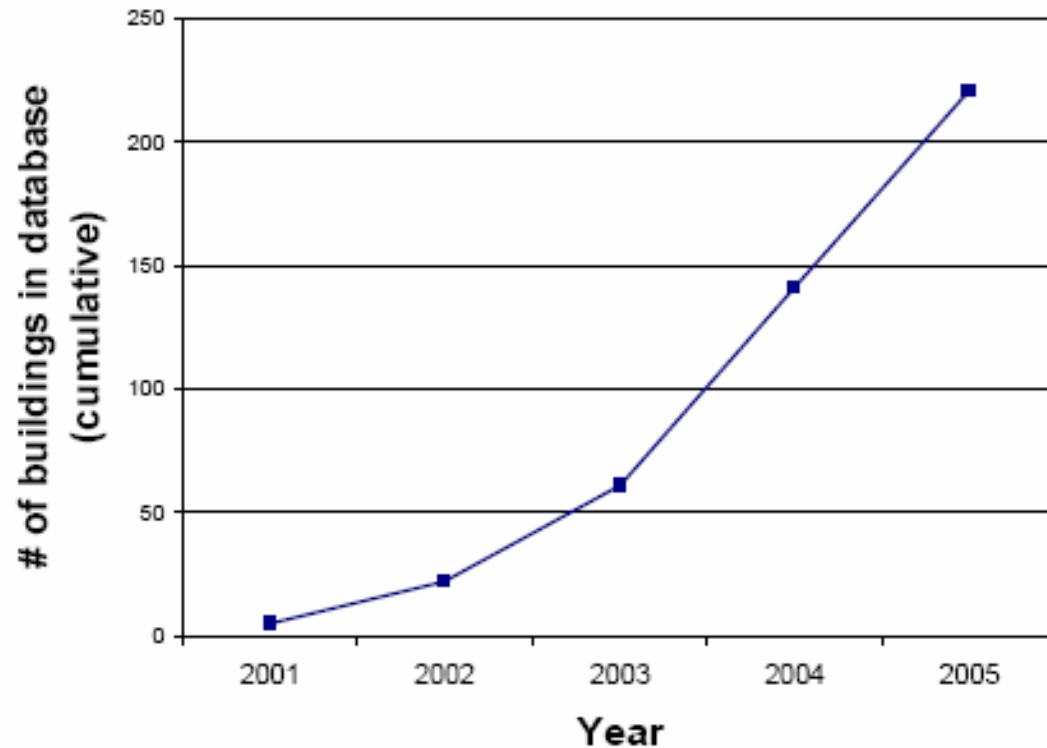
This database contains survey responses from over 200 buildings and 35,000 individual occupants, making it a useful measure for studying building performance. The survey consists of a set of core questions to assess occupant satisfaction with four main IEQ factors in the workspace—thermal comfort, lighting, air quality, and acoustics. The survey relies directly on occupants to obtain feedback about how they feel about their IEQ conditions in their space, and how it affects their effectiveness.

HIGH PERFORMANCE

About the CBE database

Survey database growth

To date: 210+ buildings, more than 34,000 respondents



CENTER FOR THE BUILT ENVIRONMENT GreenBuild 2005

Who are our occupants?

Worked in building 1-2 years	91%
Worked in present workspace more than 1 year	93%
Spend more than 30 hours/week in personal workspace	73%
Aged 31-50	52%
Aged 50+	36%
Gender: Male	70%
Gender: Female	30%

What work do our occupants do?

Administrative Support	4%
Technical	32%
Professional	34%
Managerial/Supervisory	19%
Other	9%

What departments are our respondents in?

Aerospace	4%
VMASC	4%
Computer Science	21%
Math and Statistics	25%
Facilities and Maintenance	12%
Communication/Computing Svcs	35%

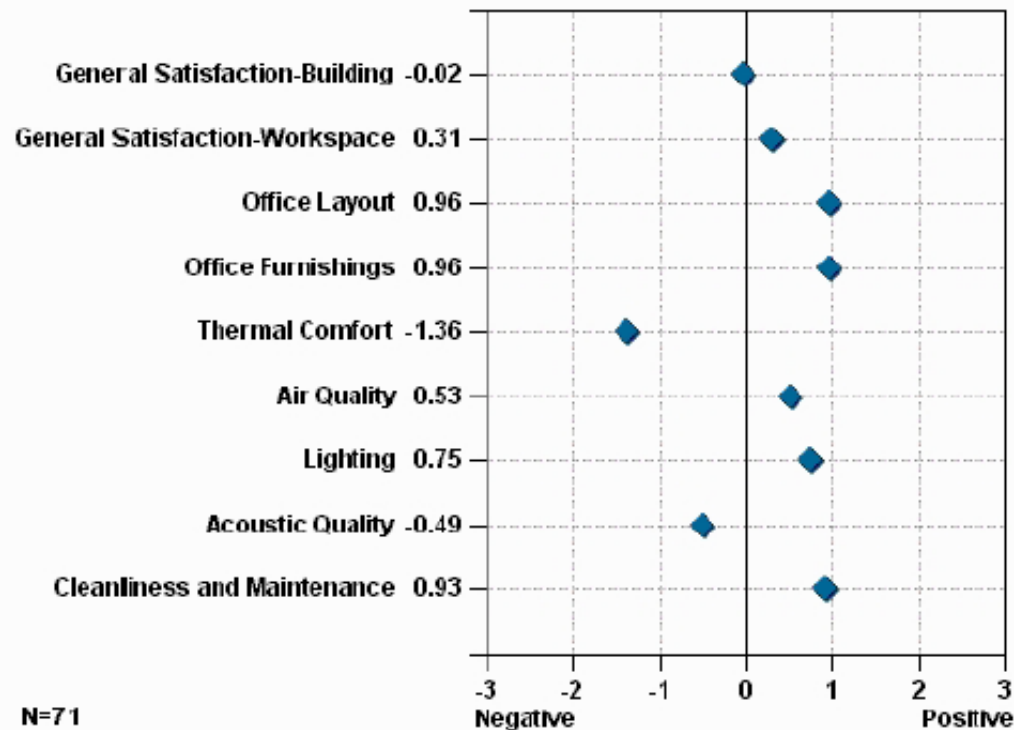
HIGH PERFORMANCE

Benchmark: Occupant Satisfaction

ODU Engineering and Comp. Sciences Building

Survey dates: 2/13/2006 — 2/24/2006 (inclusive)
Response rate: 53% (135 letters distributed, 71 valid responses)

Average Scale Scores by Category



LESSONS LEARNED

- Understand potentials/limitations of construction delivery method
- Establish construction schedule duration to accommodate commissioning/IAQ testing
- M&V infrastructure is a powerful tool for improving building energy performance
 - ✓ Ensure programming of performance reports is complete before project close-out
 - ✓ Incorporate nighttime setback mode
 - ✓ Submeter large isolated uses like the CRAC load
 - ✓ Use actual consumption as new base line to monitor future building energy performance

LESSONS LEARNED

- Post Occupancy Survey has identified several technical issues for follow up
 - ✓ Occupancy Sensors
 - ✓ OCCS Open Office Acoustics Issues
 - ✓ Data Center/Computer Science Server Room CRAC Units
- Target LEED points that are compatible w/programmatic use
- 2nd Occupancy Survey is critical to understand building performance

Virginia Resources



National Capital Region Chapter

cmerlino@sebesta.com

<http://www.usgbc-ncr.org>



James River Green Building Council

jamesriverchapter@jrgbc.org

<http://www.jrgbc.org>



Southwest Virginia Chapter

sharlyn@smithlewis.net

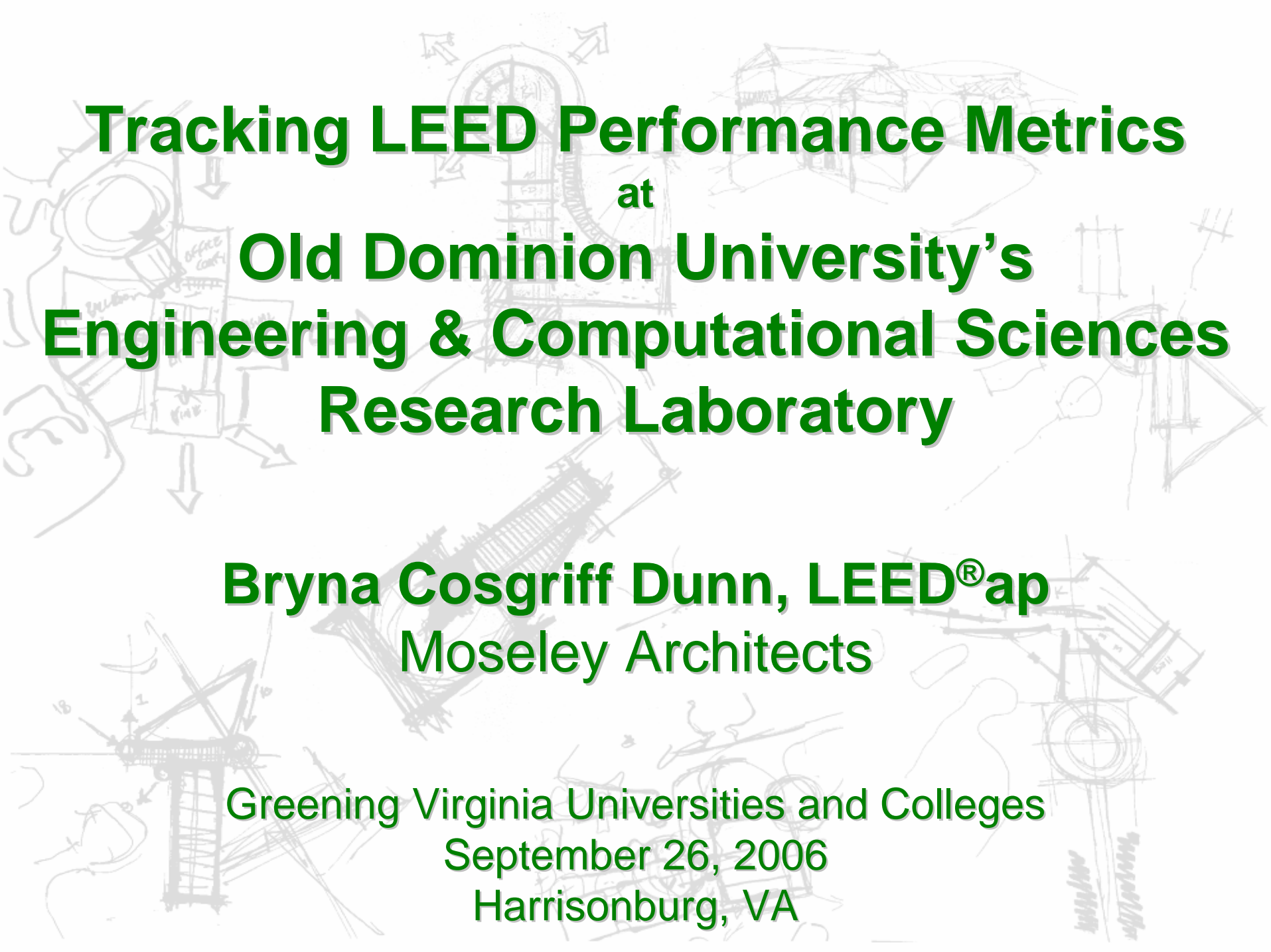
<http://www.usgbc.org/chapters/southwestvirginia/>



Virginia Sustainable Building Network

vsbn@vsbn.org

<http://www.vsbn.org>



Tracking LEED Performance Metrics
at
Old Dominion University's
Engineering & Computational Sciences
Research Laboratory

Bryna Cosgriff Dunn, LEED® ap
Moseley Architects

Greening Virginia Universities and Colleges
September 26, 2006
Harrisonburg, VA