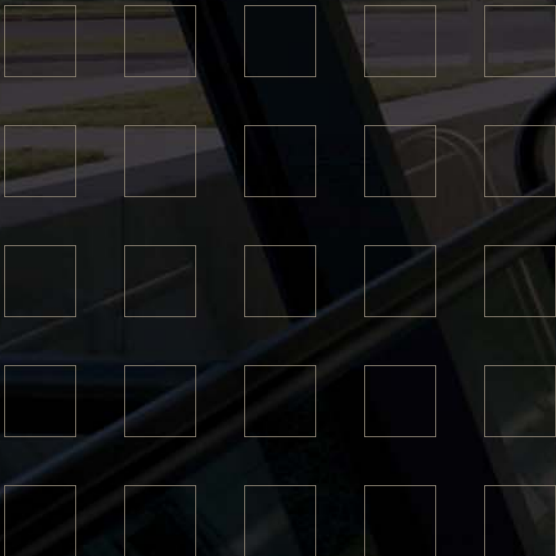


Science Gazing: Sustainable Solutions for High Performance Laboratories



**David Gibney
Western Regional Director
HDR Sustainable Design Solutions**



HDR

About HDR

- Founded in 1917
- 7,500+ employees
- Employee owned
- Over 120 offices
- Architecture
- Engineering
- Design-Build
- Public-Private Partnering



HDR Corporate HQ Office, Omaha, NE

About HDR Sustainable Design Solutions

- First A/E firm to join USGBC - 1994
- Sustainable Design Solutions Team
 - USGBC Board of Directors
 - National LEED-EB Committee
 - Codes Committee
- 228 LEED Accredited Professionals
- 60+ LEED Registered Projects
 - 2 Platinum Certified Buildings

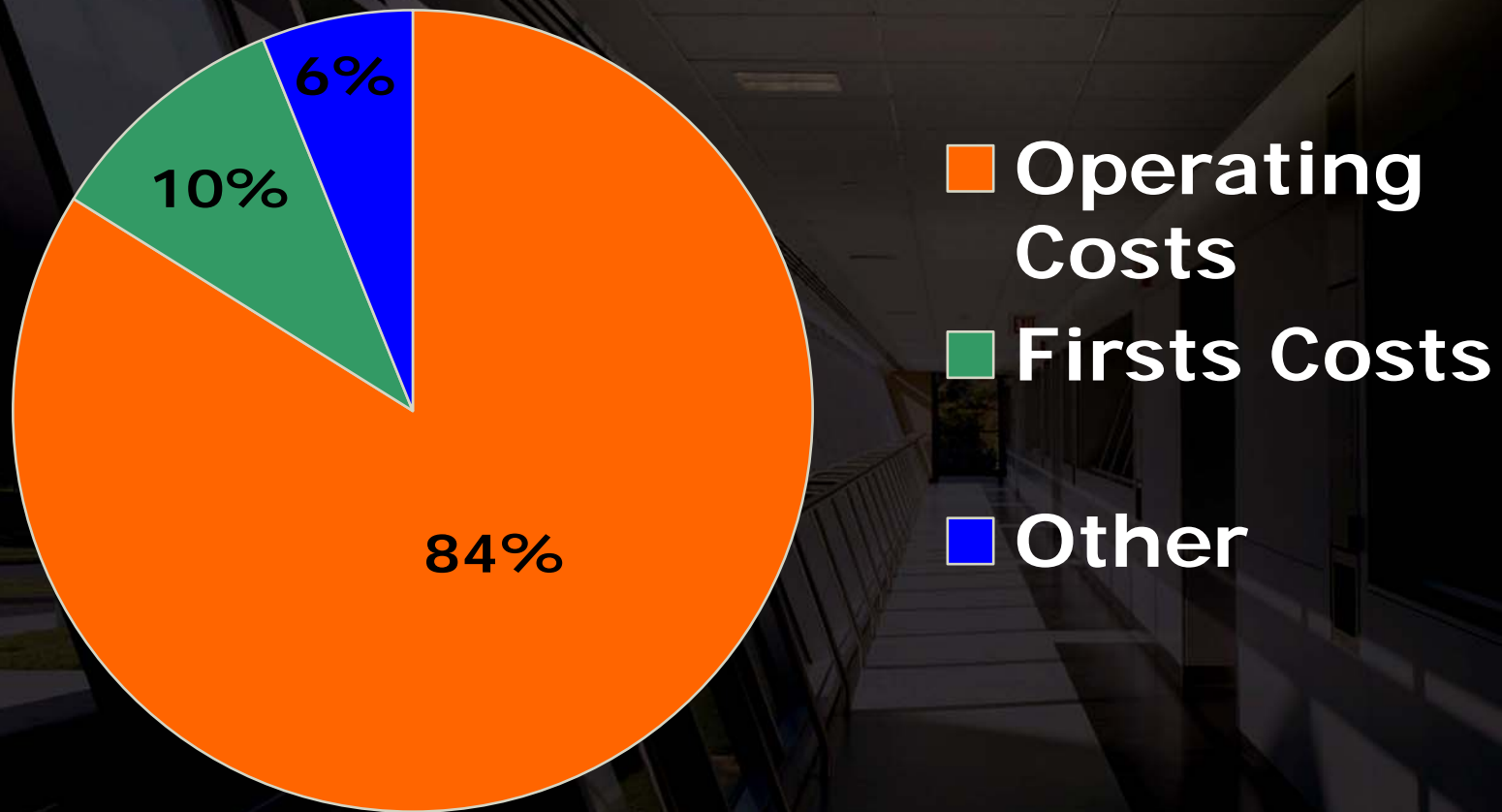


Sustainability is not:



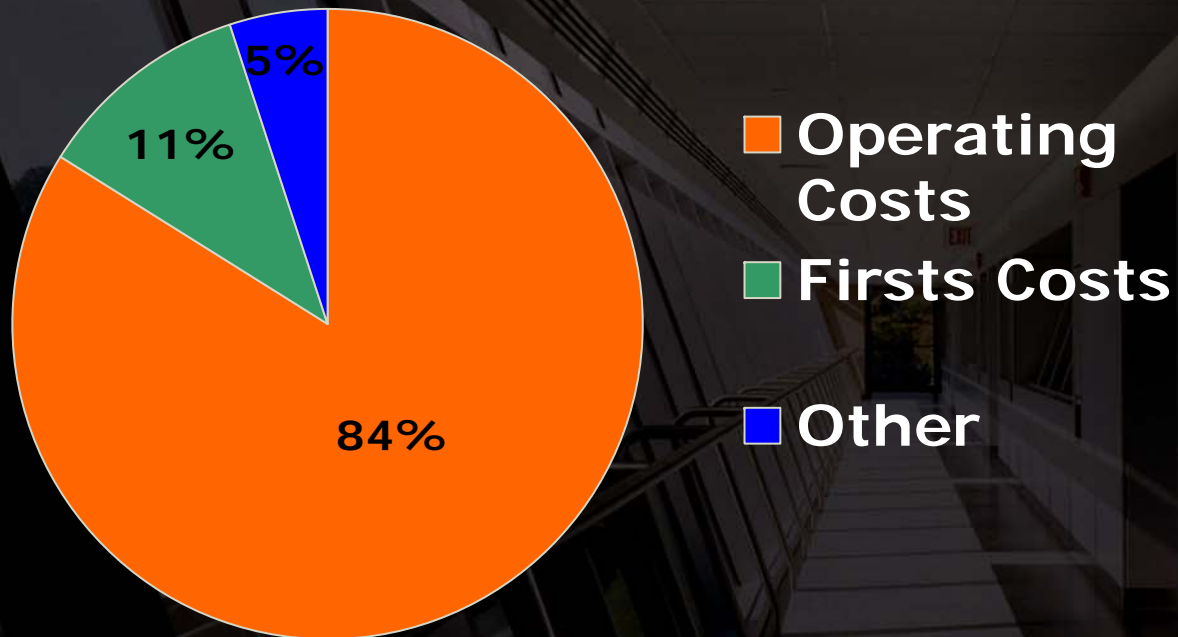
- Political
- Limiting
- Just about the environment

BUILDING OWNERSHIP \$\$



Source: Center for the Built Environment, 2005

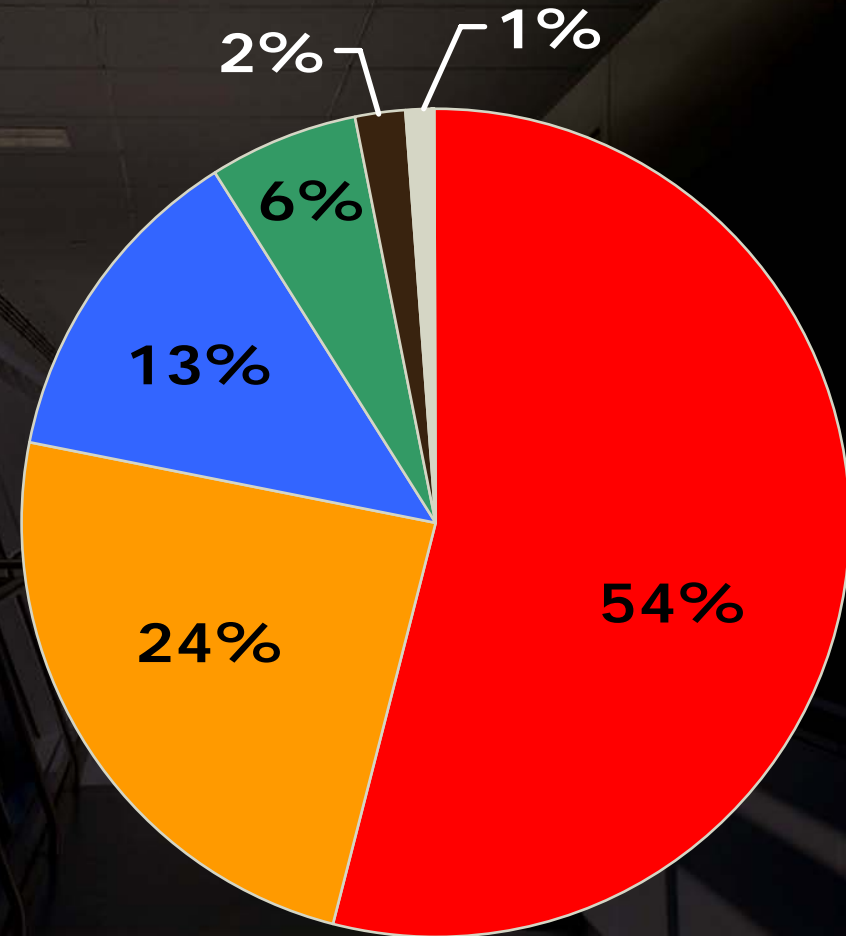
BUILDING OWNERSHIP \$\$



Source: Center for the Built Environment, 2005

BUSINESS OWNERSHIP \$\$

- Salary
- Benefits
- Technology
- Lease/Loan
- O & M
- Churn



Source: Center for the Built Environment, 2005

BUSINESS OWNERSHIP \$\$



Productivity!

BUSINESS OWNERSHIP \$\$



Sustainable Design – Enhancing the Lab

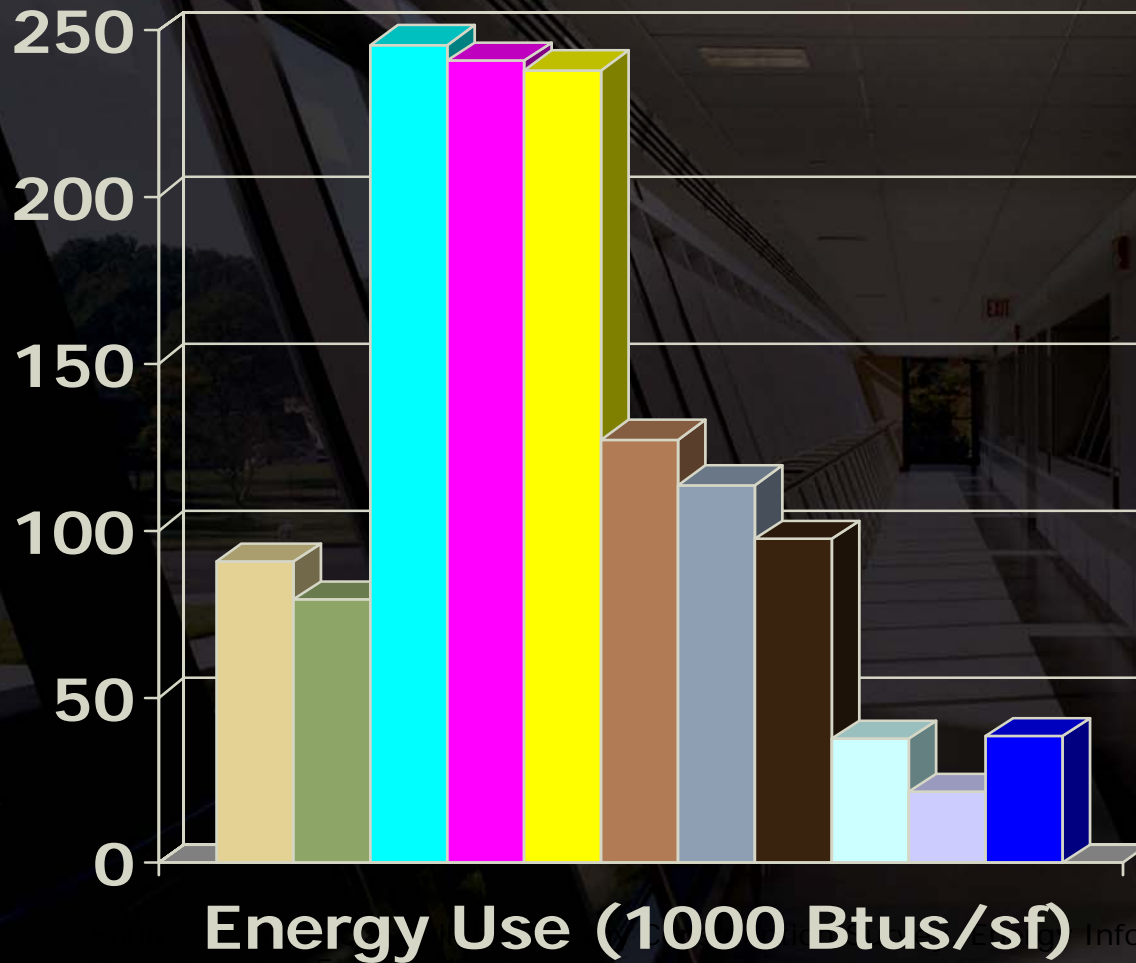
- Recruiting
- Staff retention
- Staff performance
- Reduced absenteeism
- Reduced sick days



Why labs?



Energy Intensive Buildings



- Commercial
- Education
- Food Service
- Healthcare
- Laboratories
- Lodging
- Public Assembly
- Office
- Religious
- Vacant
- Warehouse

“Thirsty” Buildings

- Domestic purposes
- Irrigation
- Process
- HVAC



Energy & Water - Interconnected



Rule #1: Not all labs are created equal!

Lab Types

Chemical Sciences

Physical Sciences

Nanoscale Research

Biology

Forensics

Some Special Considerations...

Hazardous collection & disposal

Power supply

Vibration, temperature, humidity

Containment

Security

Rule #1: Not all labs are created equal!

Forensics Labs – How They Are Different...

- **Not a Research Lab**
- **Security is Paramount**
- **Evidence Flow & Security**
- **Contamination Control**
- **Specialized Rooms**
 - Firing Range
 - Evidence Storage
 - Vehicle Examination
 - Evidence Examination



Rule #2: Support the Facility mission!

Sustainability must not create conflicts with the facility mission.

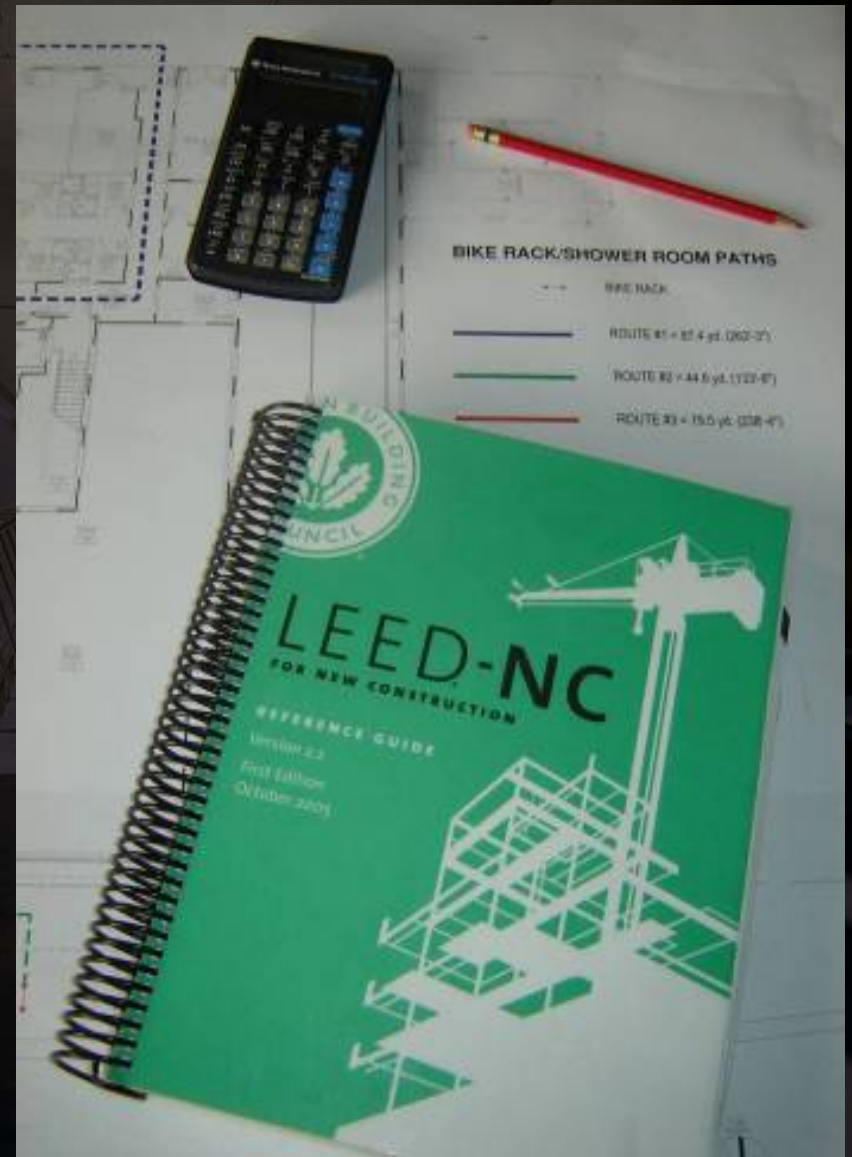
Sustainability can often *enhance* the mission.



SS Credit 8, *Light Pollution Reduction*



This thing called LEED...



LEED for New Construction, Version 2.2

LEED Category	Credits Offered	Prerequisites
Sustainable Sites	14	1
Water Efficiency	5	0
Energy & Atmosphere	17	3
Materials & Resources	15	1
Indoor Environmental Quality	16	2
Innovation in Design	5	0
TOTAL	69	7

Four levels of LEED-NC certification:



Platinum Rating 52 - 69 points



Gold Rating 39 - 51 points



Silver Rating 33 - 38 points



Certified Rating 26 - 32 points

20% increase

10% increase

10% increase

Beyond LEED...

- Net-Zero Energy?
- Living Building??
- Restorative???



CASCADIA
REGION GREEN BUILDING COUNCIL



**labs for the
21st century**



Best Practices for Creating High Performance Healing Environments™



HDR

LEED Integration...

- Sustainable Design Charrette?
- LEED Workshop?
- LEED Scorecard Review?



LEED Scorecard

40 21 8 **LEED SCORE REVIEW Updated 09-23-08** ASU Interdisciplinary Science & Technology Bldg. #4 Possible Points 69

Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points

10 3 1 Sustainable Sites Possible Points 14

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

4 1 Water Efficiency Possible Points 5

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

10 7 Energy & Atmosphere Possible Points 17

Y	?	N			
Y			Prereq 1	Fundamental Commissioning of the Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
4	6		Credit 1.1-10	Optimize Energy Performance , 10.5% - 42%	10
3			Credit 2.1	On-Site Renewable Energy , 2.5% / 7.5% / 12.5%	3
1			Credit 3	Enhanced Commissioning	1
1			Credit 4	Enhanced Refrigerant Management	1
1			Credit 5	Measurement & Verification	1
	1		Credit 6	Green Power	1

4 3 6 Materials & Resources Possible Points 13

Y	?	N			
Y			Prereq 1	Storage & Collection of Recyclables	
		1	Credit 1.1	Building Reuse , Maintain 75% of Existing Walls, Floors & Roof	1
		1	Credit 1.2	Building Reuse , Maintain 95% of Existing Walls, Floor & Roof	1
		1	Credit 1.3	Building Reuse , Maintain 50% of Interior Non-structural Elements	1
2			Credit 2.1-2	Construction Waste Management , Divert 50% / 75% from Disposal	2
		2	Credit 3.1-2	Material Reuse , 5% / 10%	2
1	1		Credit 4.1-2	Recycled Content , 10% / 20% (post-consumer + 1/2 pre-consumer)	2
1	1		Credit 5.1-2	Local/Regional Materials , 10% / 20% Extracted, Processed & Manufactured Locally	2
		1	Credit 6	Rapidly Renewable Materials	1
	1		Credit 7	Certified Wood	1

7 7 1 Indoor Environmental Quality Possible Points 15

Y	?	N			
Y			Prereq 1	Minimum IAQ Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outside Air Delivery Monitoring	1
	1		Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan , During Construction	1
	1		Credit 3.2	Construction IAQ Management Plan , Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials , Adhesives & Sealants	1
1			Credit 4.2	Low-Emitting Materials , Paints & Coatings	1
1			Credit 4.3	Low-Emitting Materials , Carpet Systems	1
1			Credit 4.4	Low-Emitting Materials , Composite Wood & Agrifiber Products	1
	1		Credit 5	Indoor Chemical & Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems , Lighting	1
	1		Credit 6.2	Controllability of Systems , Thermal Comfort	1
	1		Credit 7.1	Thermal Comfort , Design	1
	1		Credit 7.2	Thermal Comfort , Verification	1
	1		Credit 8.1	Daylight & Views , Daylight 75% of Spaces	1
		1	Credit 8.2	Daylight & Views , Views for 90% of Spaces	1

5 Innovation & Design Process Possible Points 5

Y	?	N			
1			Credit 1.1	Innovation in Design : Green Public and Staff Education Program	1
1			Credit 1.2	Innovation in Design : Green Cleaning and Integrated Pest Management Program	1
1			Credit 1.3	Innovation in Design : TBD	1
1			Credit 1.4	Innovation in Design : TBD	1
1			Credit 2	LEED™ Accredited Professional	1

Cost of LEED???

- Varies dramatically
- Each project is unique
- LEED is evolving



Budgeting for LEED



???

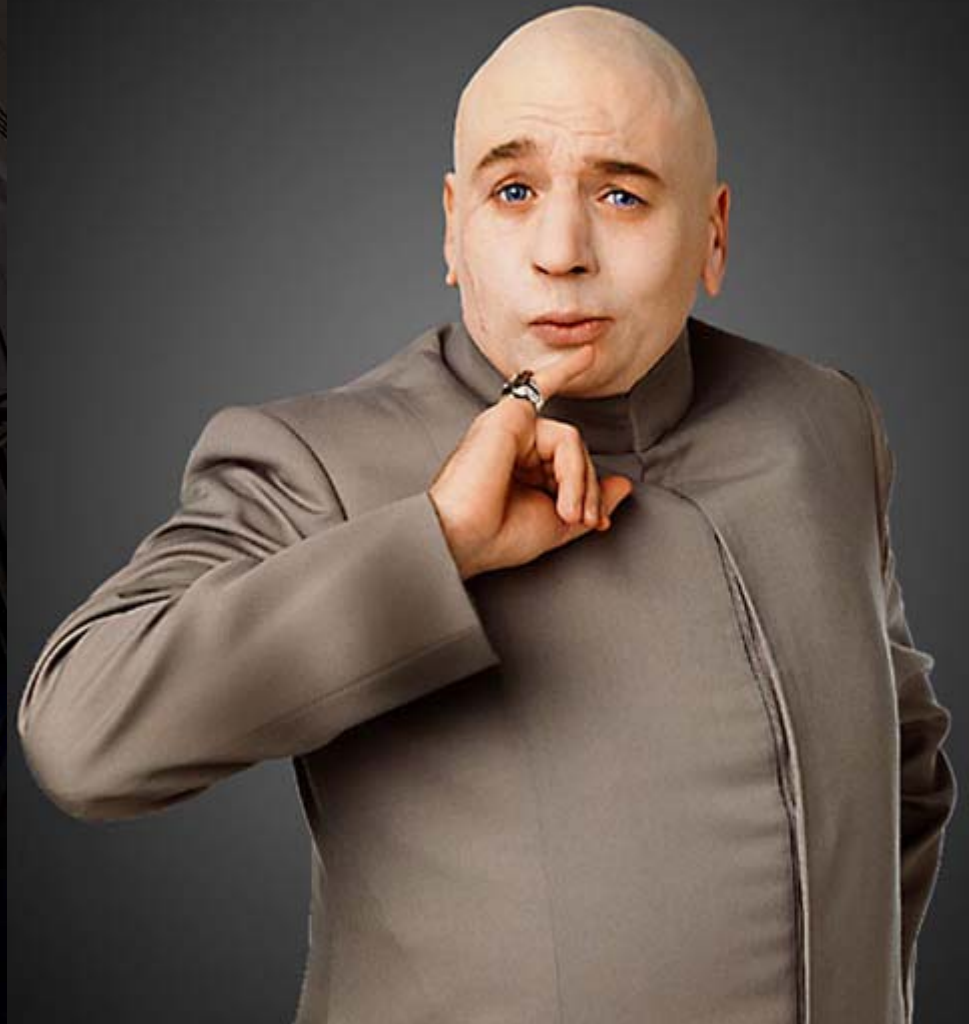
Budgeting for LEED



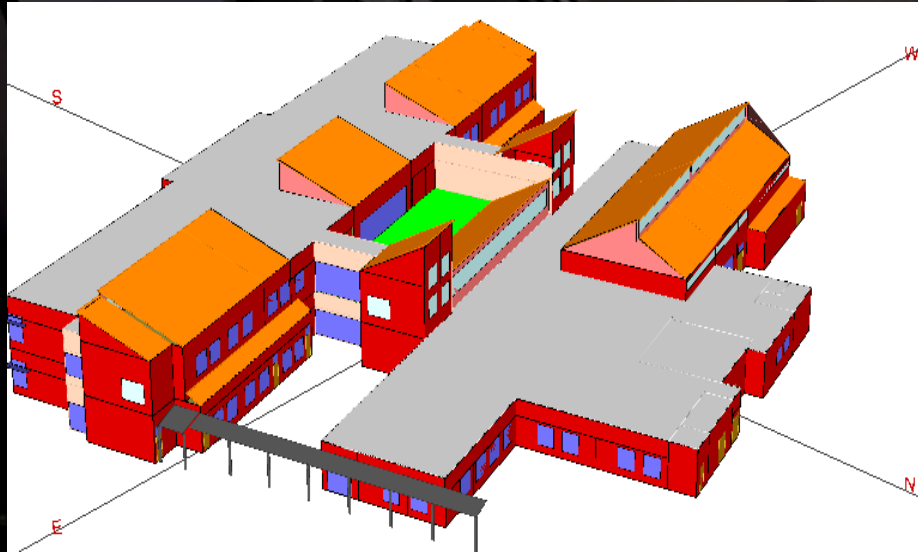
1. Most costs can be safely estimated and controlled through the process.
2. Don't forget exclusions & assumptions!
3. Take as much time as needed.
4. Start early!

LEED Added Costs – on Average

0.5% to 5% of
construction cost.

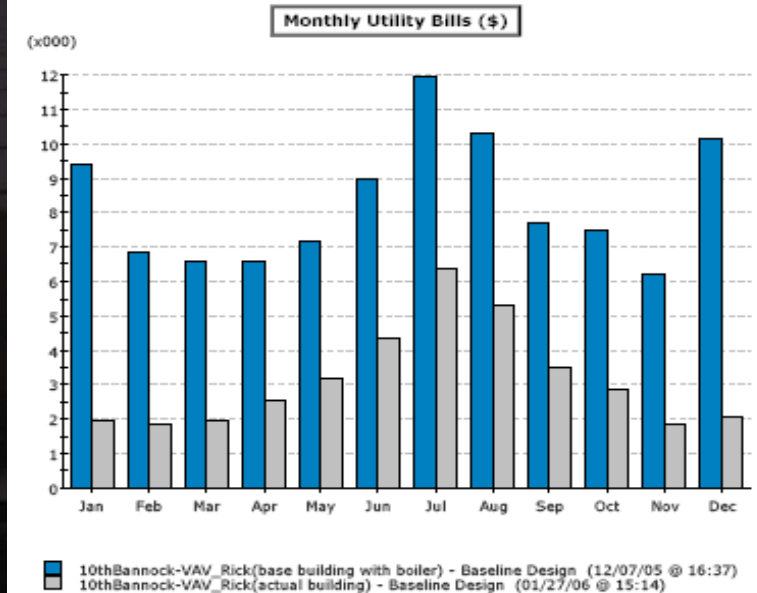


“LEED” Services

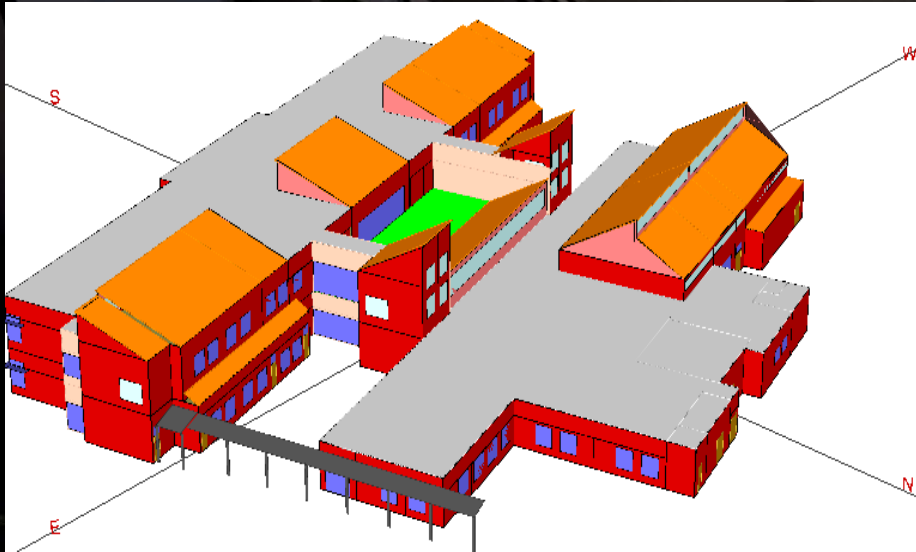


There are very few “LEED Services”.

- EA C.1 - Energy Modeling
- EA C.3 – Commissioning

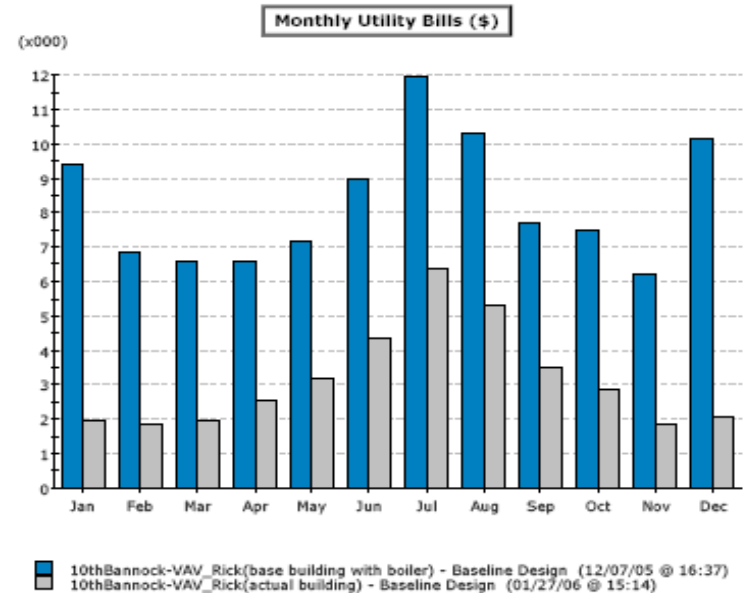


“LEED” Services



- EA C.1 – Energy Modeling
- EA C.3 – Commissioning

NOT “LEED Services”.



About Energy Modeling...

- Be sure energy modeling fees (who pays and how much) for are clearly stated in contracts.
- Energy modeling is a design tool. Use it as such!
- Look for \$\$\$ assistance in paying for energy modeling.
- Do it regardless of LEED!



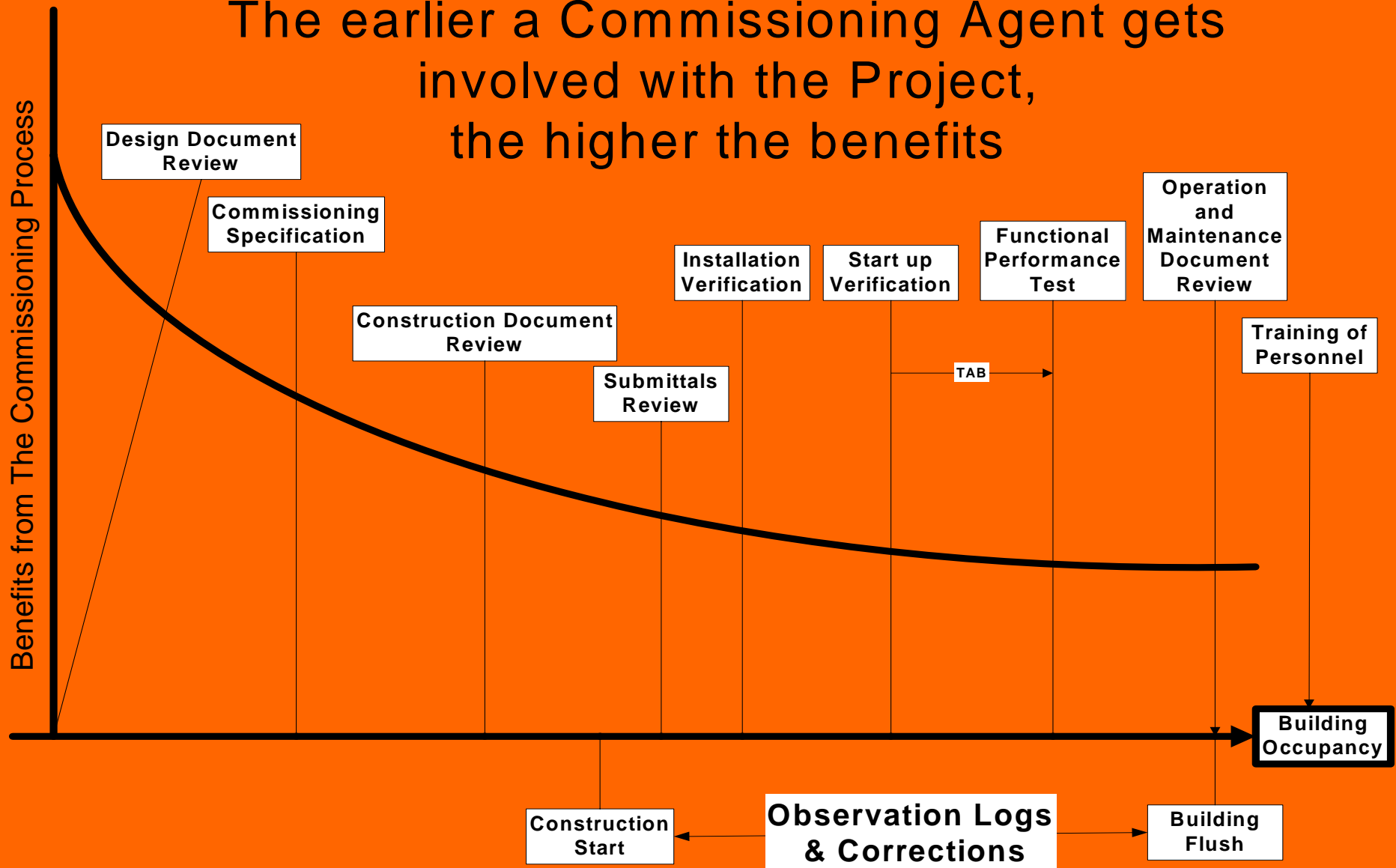
About Commissioning...

- Define scope of systems to be commissioned.
- Include careful Cx schedule & deliverables
- Get several quotes.
- Do it regardless of LEED!
- Get Cx Agent Involved Early in the Project!



About Commissioning...

The earlier a Commissioning Agent gets involved with the Project, the higher the benefits



Measurement & Verification Plan



More than a LEED Credit Point!

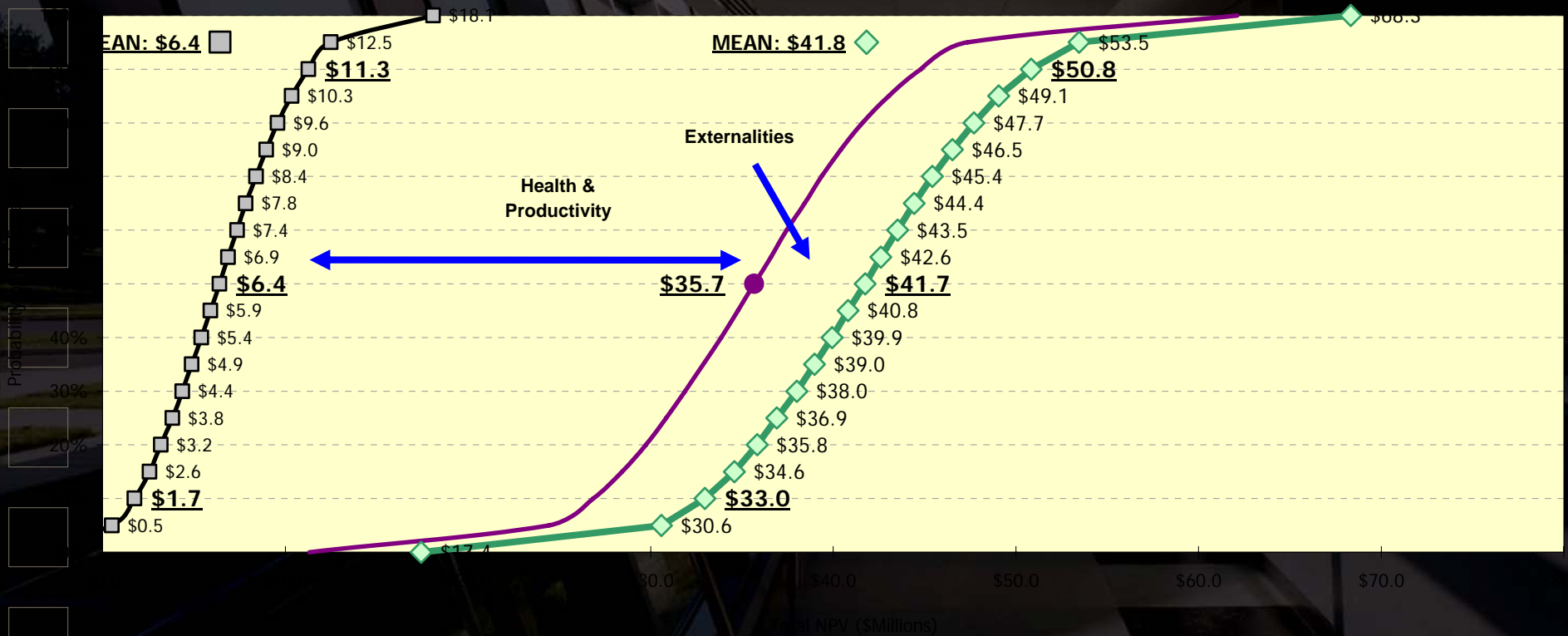
Beware of “Value Engineering”



HDR Sustainable Return on Investment (SROI)

RISK ANALYSIS OF SUSTAINABLE INITIATIVES - JHU NET PRESENT VALUE

—◆— SROI —■— ROI



Finding Utility Incentive Programs....



DSIRE

Database of State Incentives for Renewables & Efficiency

www.dsireusa.org



American Council for an Energy-Efficient Economy

www.aceee.org/index.htm

Labs21 Program

- Environmental Performance Criteria
- Lab21 Project Case Studies
- Fume Hood Commissioning
- Lab Safety
- Chemical Handling



**Laboratories for the 21st Century:
Case Studies**

Case Study Index

- Laboratory Type
 - Wet lab
 - Dry lab
 - Clean room
- Construction Type
 - New
 - Retrofit
- Type of Operation
 - Research/development
 - Manufacturing
 - Teaching
 - Chemistry
 - Biology
 - Electronics
- Service Options
 - Suspended ceiling
 - Utility on-rails corridor
 - Interstitial space
- Featured Technologies
 - Fume hoods
 - Controls
 - Mock and cal systems
 - Electrical loads
 - Water conservation
- Form factors
 - Sustainable design/planning
 - On-site generation
 - Daylighting
 - Building commissioning
- Other Topics
 - Diversity factor
 - Carbon trading
 - Selling concepts to stakeholders
- LEED Rating
 - Platinum
 - Gold
 - Silver
 - Certified

**NATIONAL RENEWABLE ENERGY LABORATORY,
SCIENCE AND TECHNOLOGY FACILITY,
GOLDEN, COLORADO**

Introduction

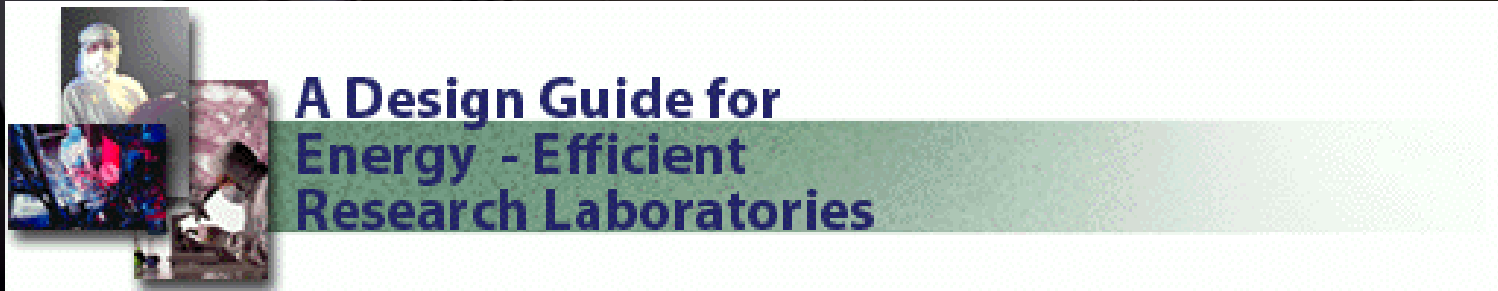
The U.S. Department of Energy's National Renewable Energy Laboratory (NREL) has added a high skilled, energy-efficient new research facility to its campus in Golden, Colorado. Completed in August 2000, NREL's 71,347-sq Science and Technology Facility (StTF) houses nine laboratories for advanced materials synthesis, analysis, characterization, and support, as well as a 10,170-sq process development and integration laboratory (FDL).

As a Laboratories for the 21st Century (Labs21) partner, NREL set aggressive goals for energy savings, daylighting, and achieving a LEED rating of Gold or better (through the U.S. Green Building Council's Leadership in Energy and Environmental Design program). Through the Labs21 program, staff worked with the design team to analyze, design, review, and implement the energy-saving features highlighted in this case study. Staff also coordinated documentation for the LEED submittal, oversaw an analysis to validate the project's energy simulation, and prepared documentation to showcase the project through design awards and other venues.

EPA United States Environmental Protection Agency

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Federal Energy Management Program

Labs21 Program



The screenshot shows a Microsoft Internet Explorer browser window displaying the Labs21 Design Process Manual 1.1. The browser's address bar shows the URL <http://www.labs21.org.uk/DFM/index.htm>. The webpage features a blue and orange header with the text "LABS FOR THE 21ST CENTURY" and three navigation buttons: "Process Manual Home", "Design Process Checklist", and "Sustainable Strategies Checklist". The main content area is titled "Labs21 Design Process Manual 1.1" and contains the following text:

This web-based manual provides guidance on the design process for high-performance laboratories, leveraging the Labs21 tools. It includes the following:

- The [Design Process Checklist](#) specifically lists process-related action items for each stage of the building design and delivery process, with links to relevant Labs21 tools for each action item.
- The [Sustainable Strategies Checklist](#) is a "quick-reference" list of sustainable design strategies, categorized by area of environmental impact (i.e., energy, water, materials, etc), with links to detailed information for each strategy.

This Process Manual is especially helpful to those unfamiliar with the Labs21 Tool Kit and/or the sustainable design process for laboratories.

Labs: Water Intensive Buildings

- Install water meters on buildings
- Bathrooms with low use fixtures
- Identify once-through cooling situations and design closed loop systems
- Improve cooling tower water efficiency
- Landscape design with drought tolerant plants (and improve the irrigation)



Water Consumption Survey. Energy Information Administration,

Domestic Water Conservation

1. Low-flow lavatory faucets (0.5 gpm)
2. Low-flow shower (1.0 gpm)
3. Reclaimed water (irrigation & sewage)
4. High efficiency irrigation system
5. 0.125 – 0.5 gpf urinals

Water Efficient Irrigation



Water Efficient Flow Fixtures



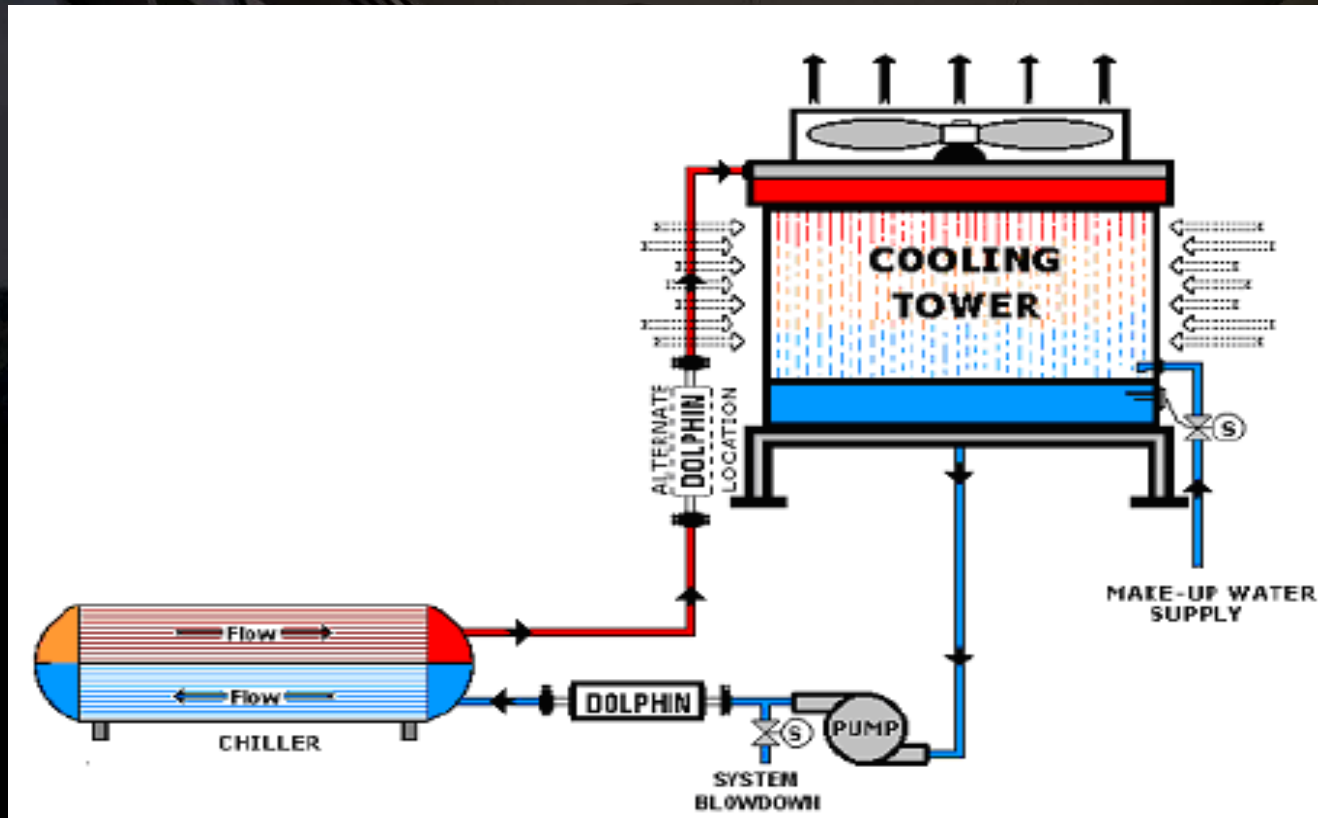
Water Efficient Flush Fixtures



Sustainable Water Treatment



Sustainable Water Treatment

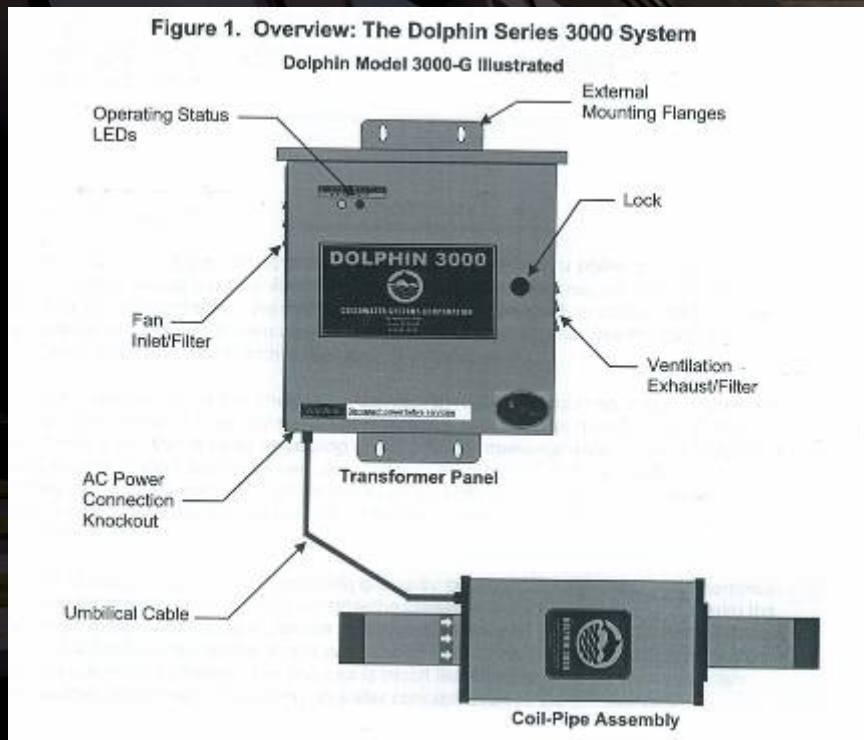


- Conserves Water

- Eliminates toxic chemicals

Sustainable Water Treatment

Figure 1. Overview: The Dolphin Series 3000 System



Lab Energy Efficiency: “Right Sizing”

- Tool Load (Plug Load)
- Variability
- Diversity

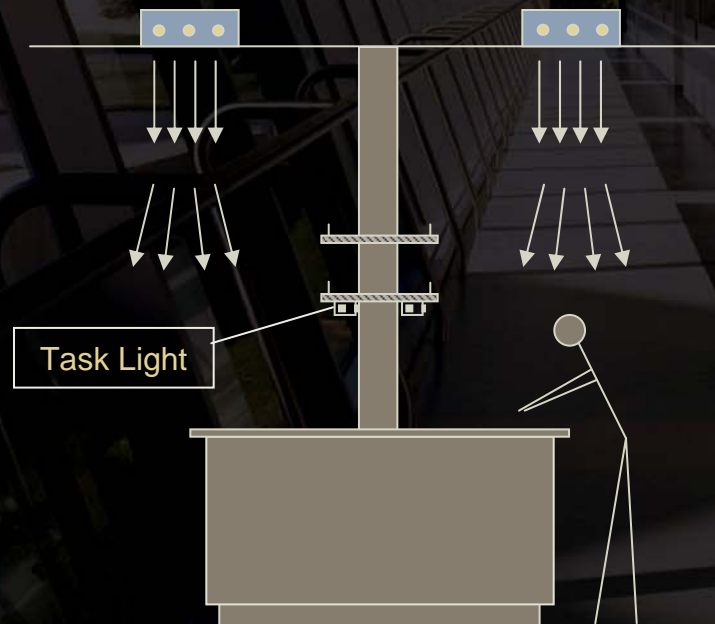


Lab Energy Efficiency: Lighting Design

Typical Benchtop Facility Conditions:



- Lensed & Parabolic Recessed Light Fixtures
- Direct Light Only
- 100 fc at 36" AFF
- **1.25 watts/GF**

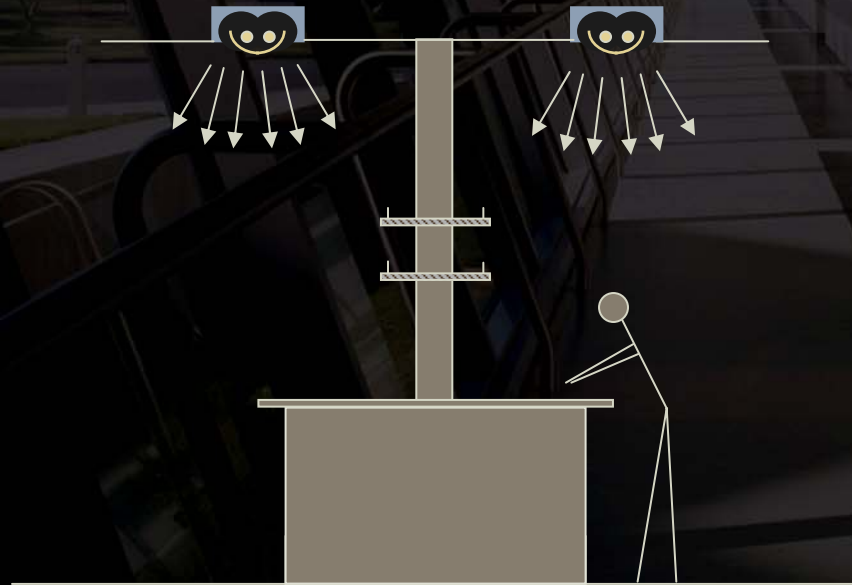


Lab Energy Efficiency: Lighting Design

Improved Benchtop Lighting Design

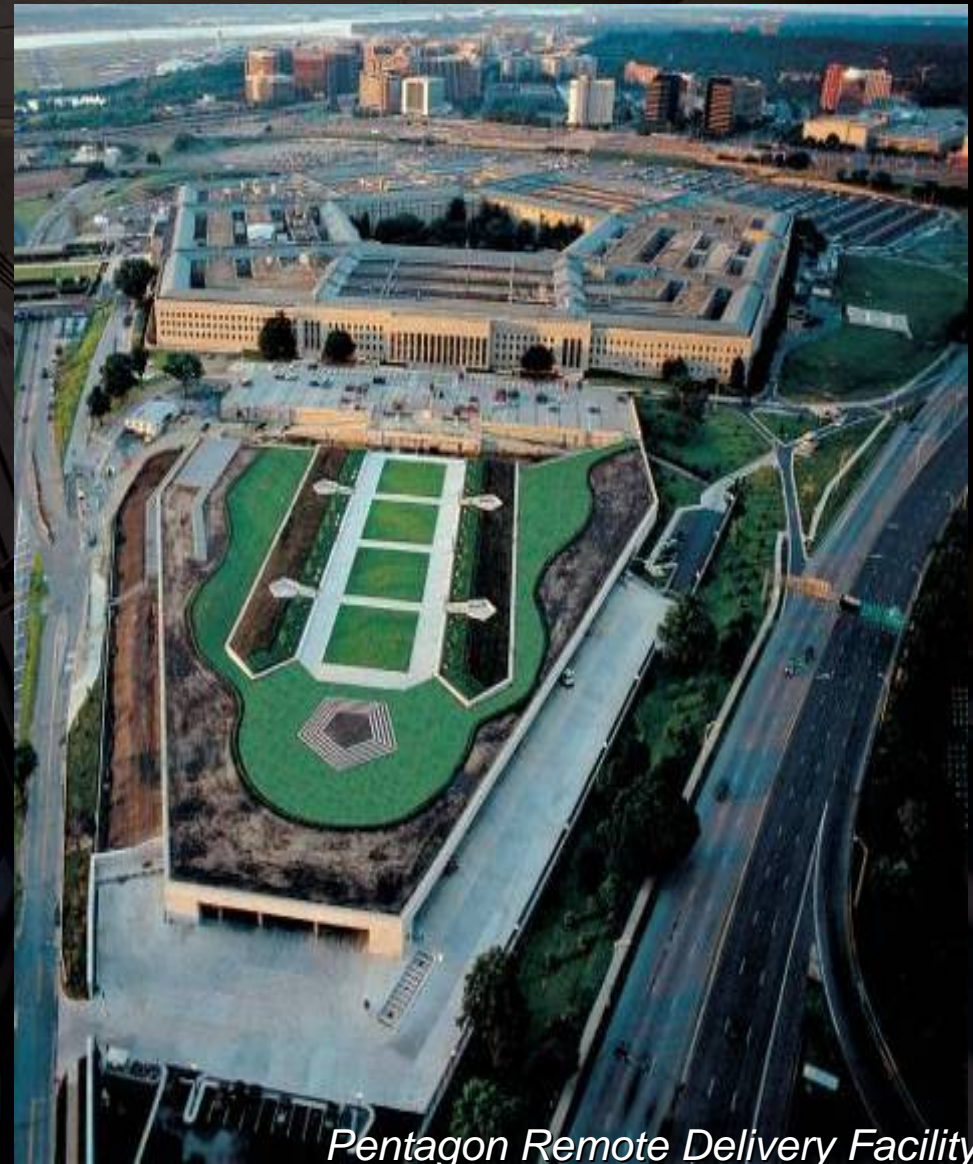


- Lensed & Non-Lensed Recessed Light Fixtures
- Direct and Indirect Light Provided
- 70 fc at 36" AFF
- User Group Visited Mockup at Vendor Site
- **0.96 Watt /SF**



Design Synergies?

- **Vegetated roof**
- **Stormwater treatment**
- **Native vegetation**
- **Water efficient irrigation**

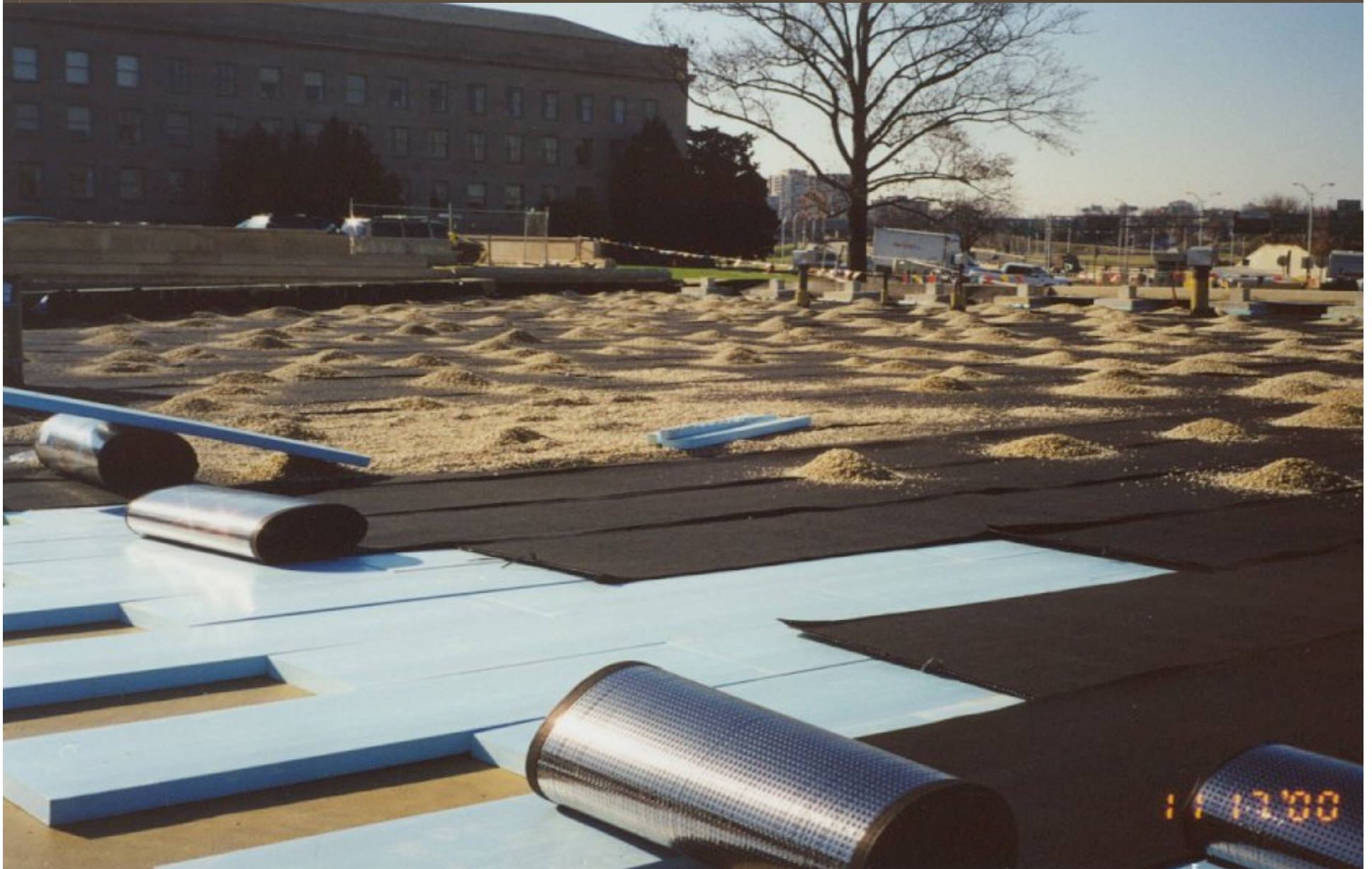


Pentagon Remote Delivery Facility

Design Synergies?



Design Synergies?



Design Synergies?



Design Synergies?



Banner Bank Building, Boise, ID

- **72% decrease in domestic potable water use**
- **80% decrease in potable water for sewage**
- **50% decrease in energy**
- **41% recycled content**
- **92% demolition recycled**
- **LEED Platinum Certified**
- ***Average construction cost!***



Banner Bank Building, Boise, Idaho

Santa Clara County Crime Lab



Santa Clara County Crime Lab



Santa Clara County Crime Lab



Santa Clara County Crime Lab

- **95+% Construction waste diversion**
- **On-site weather station co-regulates irrigation**
- **All toilets & urinals flushed with reclaimed water**
- **Make-up tower uses reclaimed water**
- **On-site stormwater treatment system**
- **Variable primary flow pumping for chilled water**
- **35% decreased annual energy cost**

Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies



Center for Integrated Nanotechnologies

- **Right-sized central plant with built-in redundancy systems**
- **Sensible heat recovery from lab air exhaust**
- **35% reduction in domestic potable water**
- **50% reduction in non-potable irrigation water**
- **30% increased cooling capacity via medium-temp chilled water system**
- **32% decreased annual energy cost**

Brookhaven Center for Functional Nanomaterials



Brookhaven Center for Functional Nanomaterials



Brookhaven Center for Functional Nanomaterials



Brookhaven Center for Functional Nanomaterials



Brookhaven Center for Functional Nanomaterials



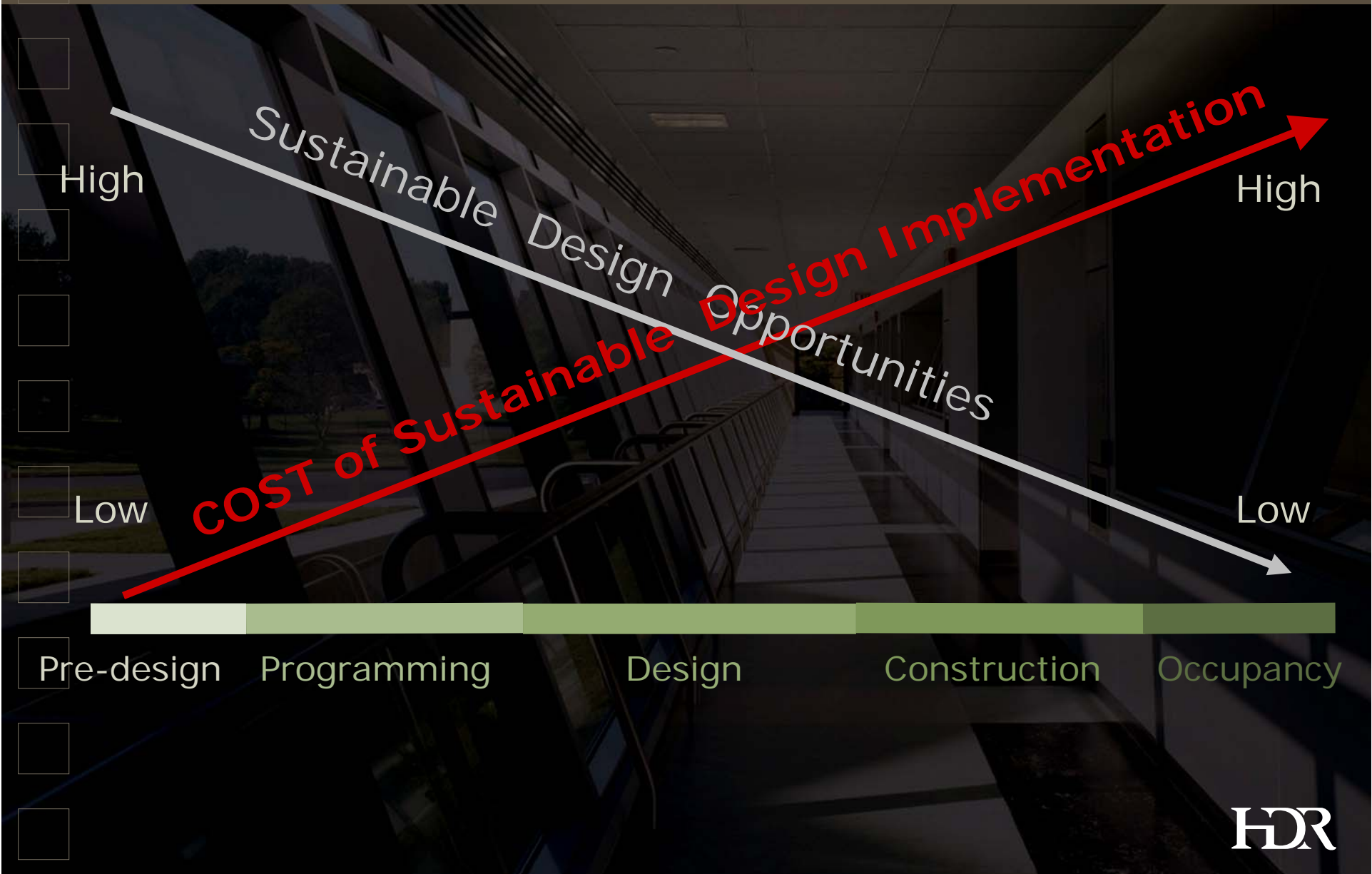
Brookhaven Center for Functional Nanomaterials

- **Energy modeling**
- **28% reduction in domestic potable water**
- **50% reduction in non-potable irrigation water**
- **20% decreased annual energy cost**
- **LEED Silver Certified**

Timing is everything...



Timing is everything...



Remember....

1. *Start sustainability early!*
2. *Design well (then engineer...)*
3. *Decrease initial demand*
4. *Increase systems efficiency*
5. *Seek out design synergies*

One last thing....



1. Design
2. Construction
3. Operation

It takes all three...

Sustainable Design Champions



1. Designer
2. Contractor
3. Operator

Identify “Three Amigos” on the Team

Questions?

David Gibney
HDR Architecture Inc.
david.gibney@hdrinc.com
208.387.7026
www.hdrgreen.com



HDR