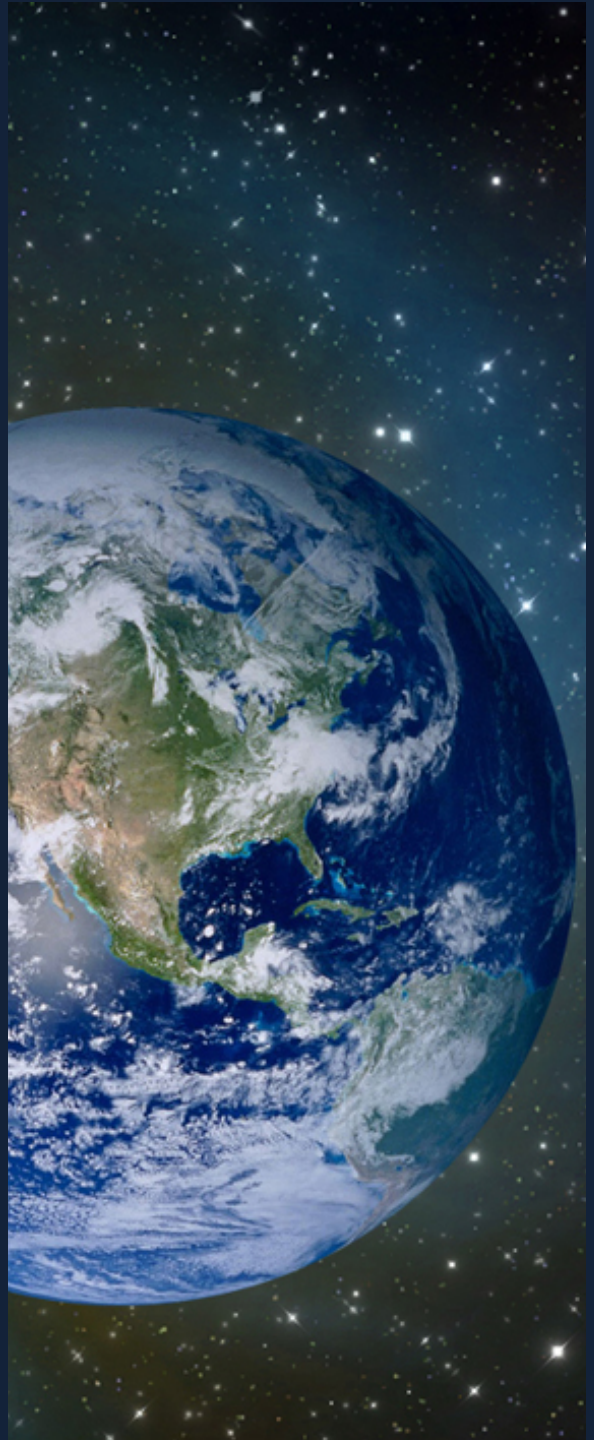


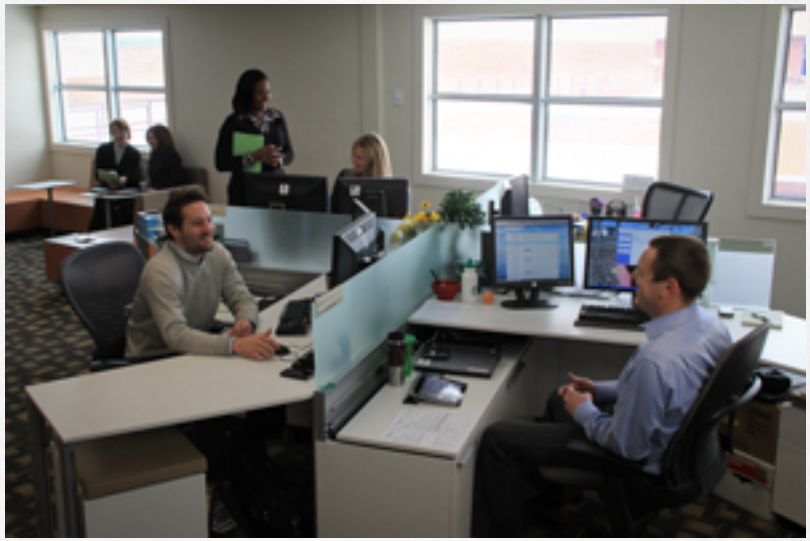
THE FULL VALUE OF DEEP ENERGY RETROFITS

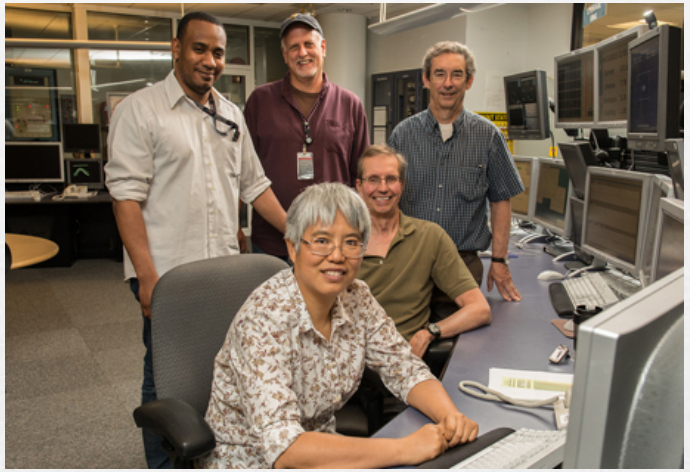
Cara Carmichael
Rocky Mountain Institute

September 16th 2016

Deep Energy Retrofit Forum
Washington D.C.

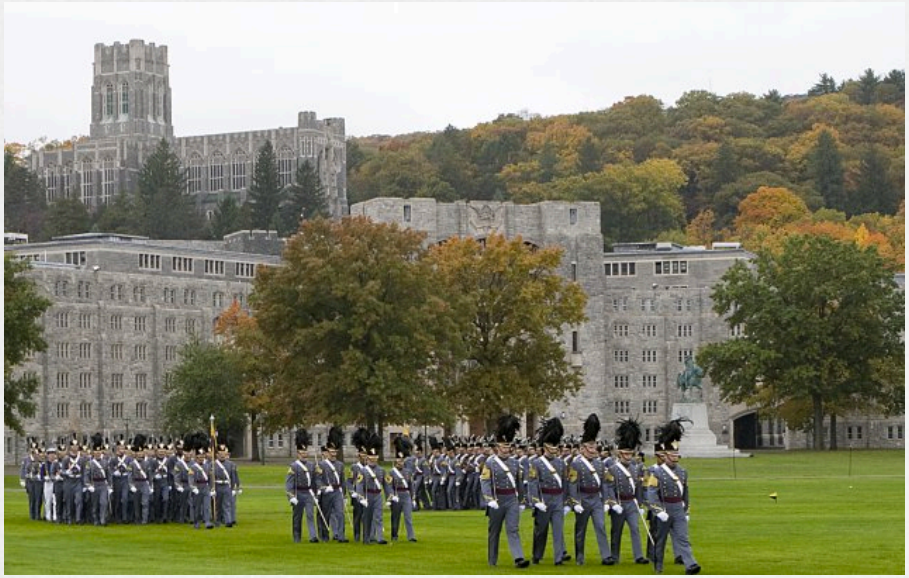
Its about the people!

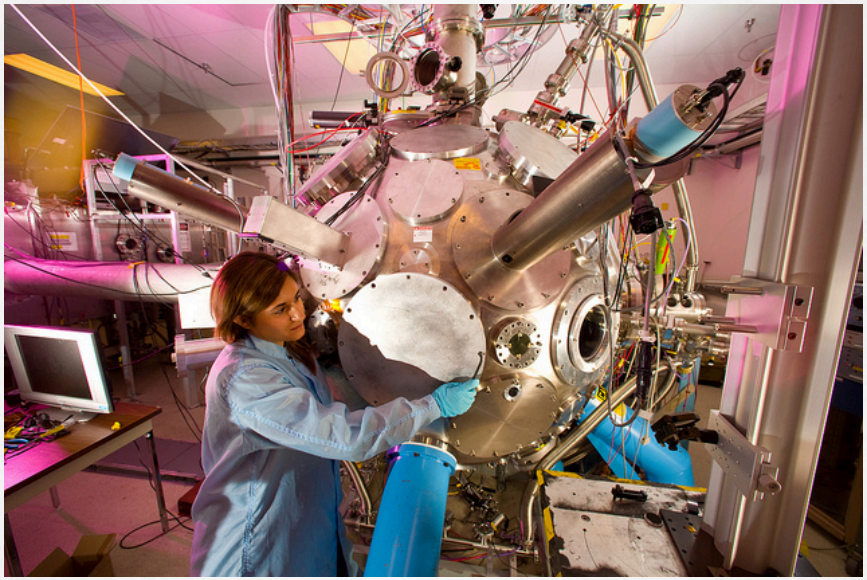




Sources: http://www.gsa.gov/portal/content/114975, http://energy.gov/eere/articles/excellence-energy-awards-military-academies-leading-example,, https://www.ornl.gov/content/zebralliance-research-project-shows-promising-results , https://www.glassdoor.com/Benefits/US-Department-of-Veterans-Affairs-US-Benefits-EI_IE41429.0,33_IL.34,36_IN1.htm

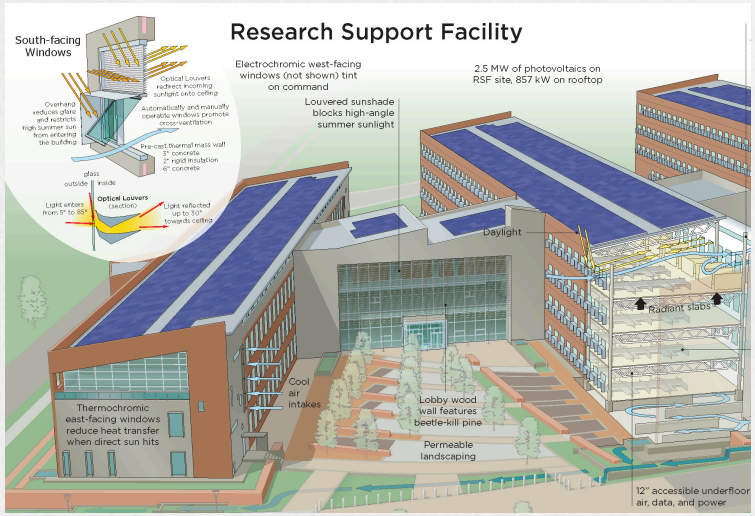
It's about enhancing mission effectiveness





Sources: http://outsidethewire.armytimes.com/2014/09/09/west-point-cracks-top-25-barely-in-u-s-news-annual-college-rankings/, https://www.lanl.gov/newsroom/photo/ , http://www.pppl.gov/organization

It's about federal leadership

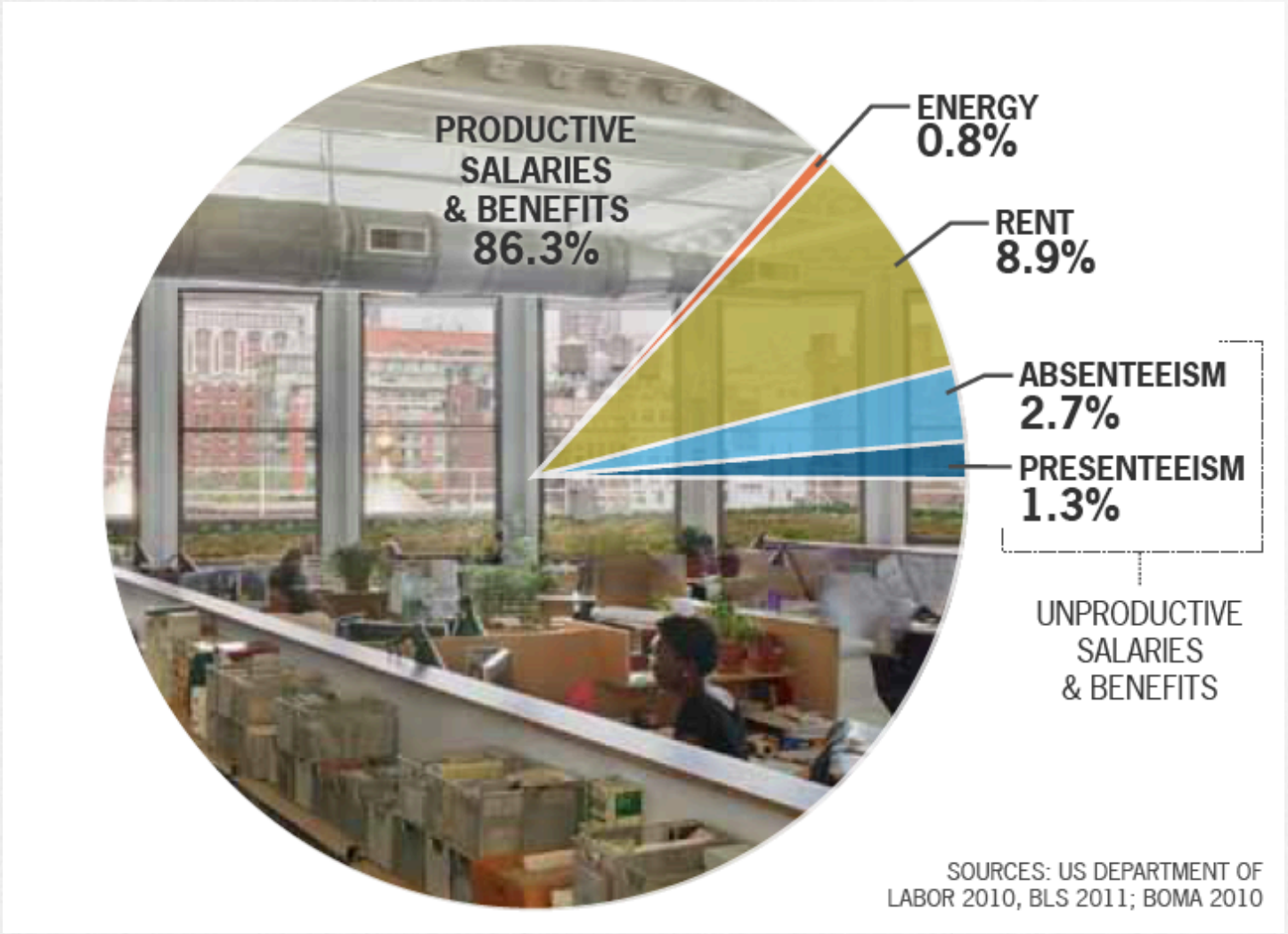


Sources: http://www.reconomy.org/wp-content/uploads/2013/12/Energy4All_Kids_at_Fens_site_Pure_Leapfrog-352x198.jpg, http://www.gsa.gov/portal/content/226603, https://santacruzarchitect.files.wordpress.com/2014/03/rsf-rendering.jpg, http://www.aiatopten.org/node/367

Its about energy security and resilience

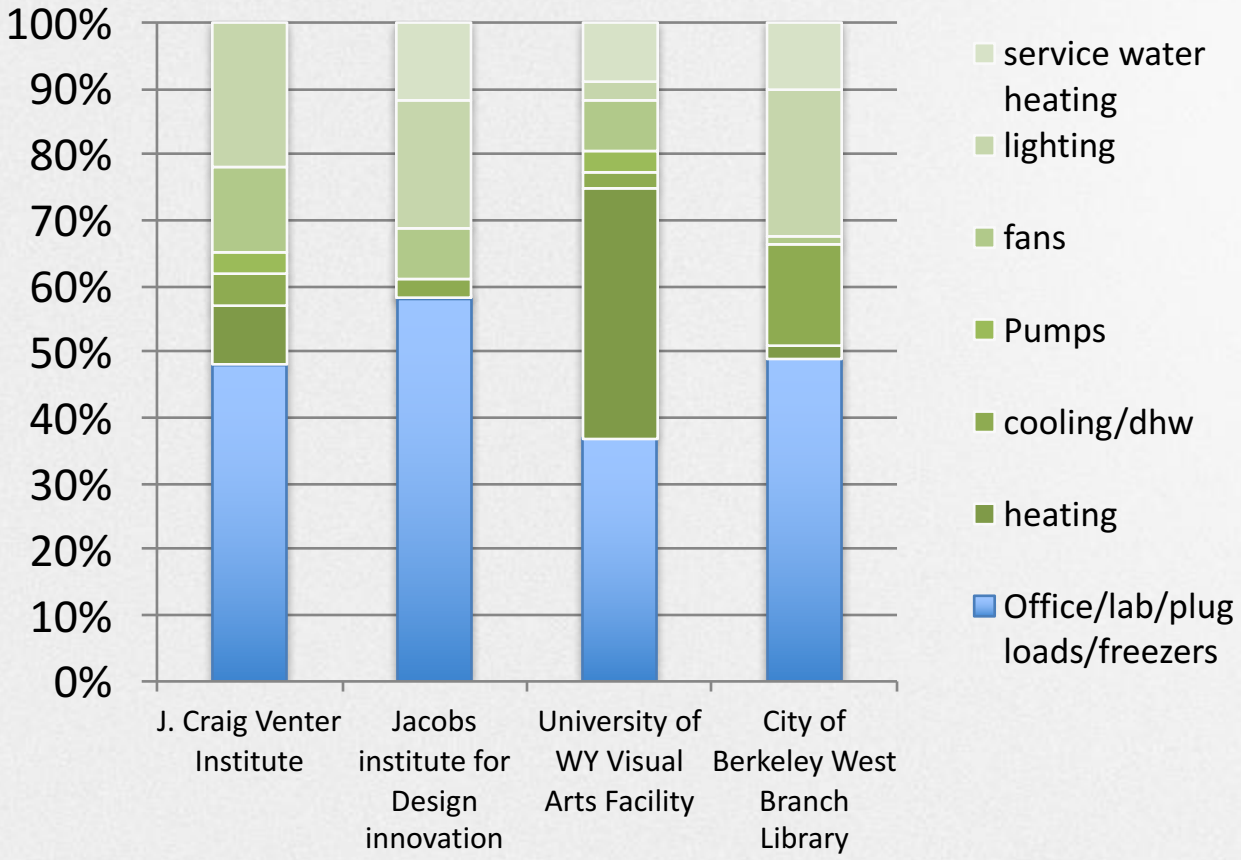
Sources: http://www.reconomy.org/wp-content/uploads/2013/12/Energy4All_Kids_at_Fens_site_Pure_Leapfrog-352x198.jpg http://www.centerre.com/portfolio-items/gsa-solar-photovoltaic-pv-project/?portfolioID=4380 , http://reneweconomy.com.au/2013/5mw-battery-storage-system-heralds-new-era-of-microgrid-75883 http://www.districtenergy.org/blog/2015/06/04/penn-state-partners-with-alstom-to-establish-microgrid-center-of-excellence/

People cost far more than energy



Occupant engagement is critical

As we move toward more efficient and net zero energy buildings, plug loads play a big role in energy use, between 30% - 60% of a buildings energy use.



7.4% reduction in energy use due to behavioral strategies.[2]

- Energy kiosk and educational signage
- Certifications and awards
- Training programs and fact sheets
- Energy competitions

Source: http://www.aiatopten.org/

2. 2013 meta-analysis of 156 field studies http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2273850

What next?

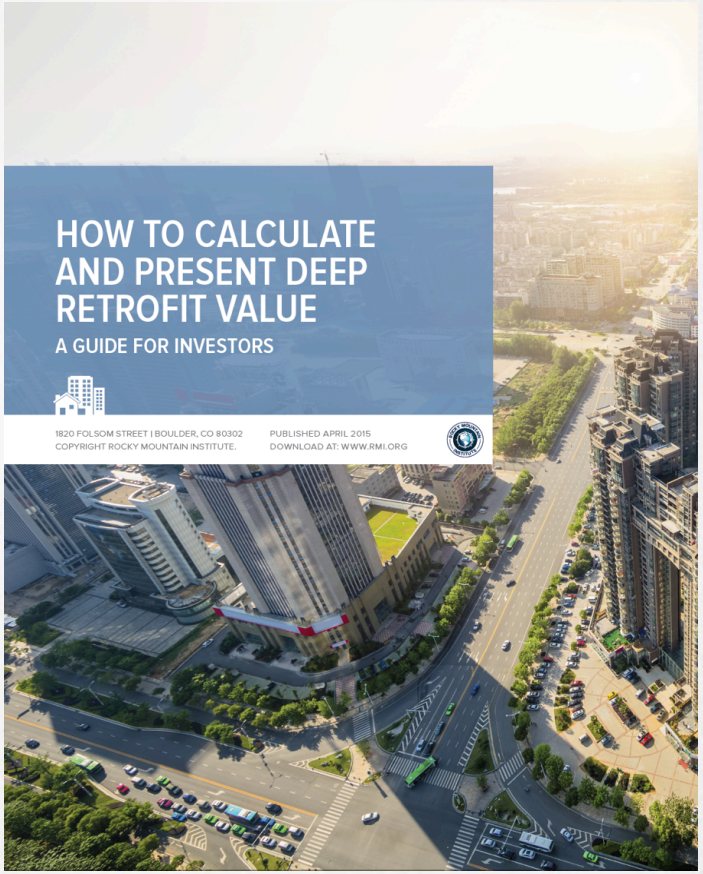
We need a better way to quantify and monetize these benefits.

Resources
RMI's DRV Report:

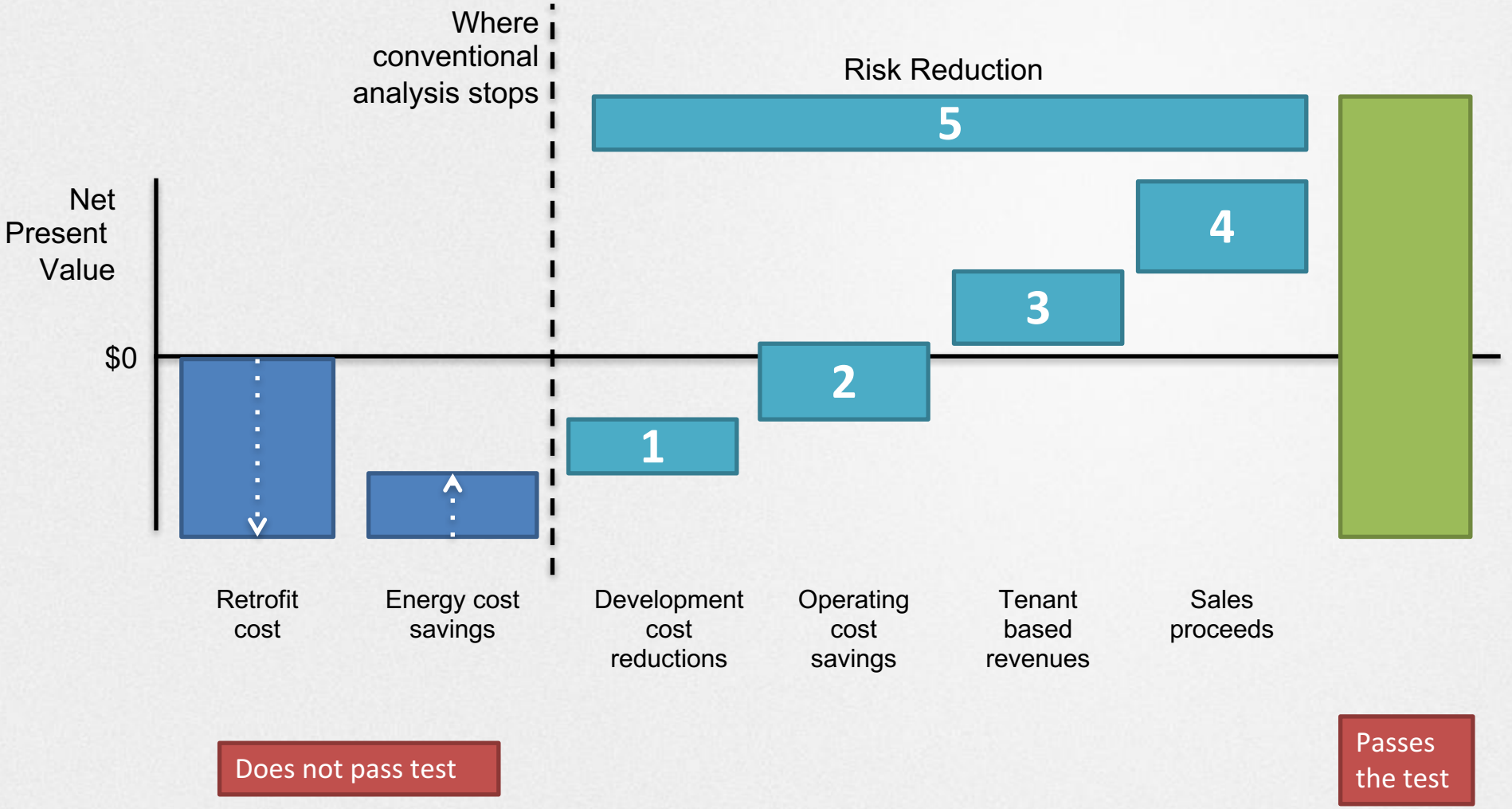
- Published Spring 2015
- Provides guidance for calculation methodologies
- Compiles industry studies and research
- Case studies
- Free at www.rmi.org

Additional resources:

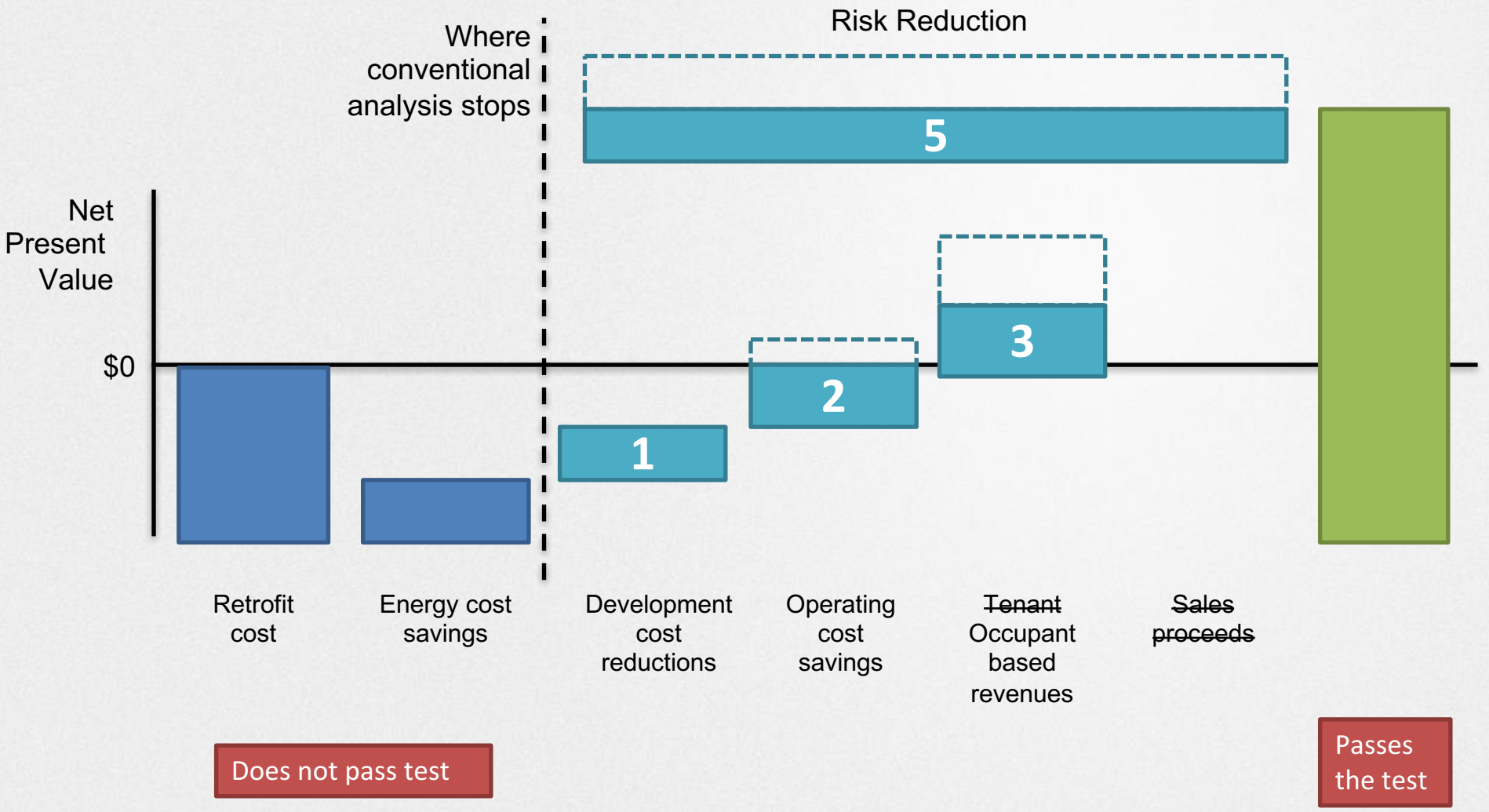
- IREM Courses
- World GBC "Business Case for Green Building" report - 2013.
- Carnegie Mellon BIDS database
- Green Building Finance Consortium



Deep Retrofit Value Categories – Private Sector



Deep Retrofit Value Categories – Public Sector



Deep Retrofit Value Categories – Public sector (Part 1)

Category	Private Sector - Leased buildings	Public Sector
1. Development Cost Savings	• Capital cost savings through integrative design • Subsidies and incentives (i.e. tax credits, rebates, grants, expedited permitting, site density bonuses, fee waivers, subsidized lending, PACE)	• Capital cost savings through integrative design • Subsidies and incentives (i.e. rebates, expedited permitting, site density bonuses) • Alternative financing (ESPC, UESC, ENABLE, PPA's, ESA's) • Portfolio approach – targeting ripe buildings, sharing lessons learned
2. Operating Cost Savings (non-energy)	• Insurance savings – premium reductions and improved technologies can prevent losses • Space Optimization – smaller mechanical equipment increases usable floor area • Maintenance cost savings (9-14%)[1] • Better loan rates due to lower mortgage default rates on green buildings (20%)[2]	• Insurance savings • Space Optimization • Maintenance cost savings

Sources: 1. PNNL 2008, Leonardo Academy 2008, Aberdeen Group 2010
2. Default risk of Securitized Commercial Mortgages: Do Sustainability Property Features Matter? 2015

Deep Retrofit Value Categories – Public sector (Part 2)

Category	Private Sector – Leased buildings	Public Sector
3. Tenant /Occupant based revenues	• Faster lease up time (i.e. Sharp Development leased up in 3 months vs. expected 18 months) • Higher rent rates (2-17%)[1] • Increased tenant retention, reduced vacancy (4%)[2] • More positive negotiations and longer lasting relationships	• Productivity increases (1-11%)[3] • Increased occupant satisfaction (27-76%)[4] • Increased occupant health, reduction in sick days (0-40%)[5] • Increased employee attraction and retention • Increased brand and leadership value

Absentieeism[6]	Annual Absenteeism rate	Equivalent hours lost work	Annual cost to employer
Private Sector	1.7%	35	$765
Public sector	2.2%	42	$1,100

> $500M Value

Sources: 1. Eicholtz, Kok & Quigley (2010), Wiley et al. (2010), Fuerst & Mcallister (2011), Eicholtz, Kok et al. (2011), Newell, Kok et al. (2011), Miller, Morris & Kok (2011), Pogue et al (2011), McGraw Hill Siemens (2012). 2. CBRE Global Market View (2012). 3. LBNL. 4. GSA (2011). 5. Miller, Pogue, Gough & Davis (2009), Cushman & Wakefield et al. (2009), Dunckley (2007), City of Seattle (2005), Romm & Browning (1995).6. Center for Building Performance and Diagnostics, a NSF/UCRC, and ABSIC at Carnegie Mellon, Department of Labor 2003

Deep Retrofit Value Categories – Public sector (Part 3)

Category	Private Sector – Leased buildings	Public Sector
4. Sales proceeds	• Increased sale proceeds (11-26%)[1] • Higher NOI • Increased liquidity	N/A DOE Asset Rating, ASHRAE EQ
5. Risk Reduction	• Reduced exposure to utility price volatility • Reduced risk of business interruption due to critical equipment failure • Increased flexibility and adaptability	• Reduced exposure to utility price volatility • Reduced risk of business interruption due to critical equipment failure • Increased flexibility and adaptability • Increased energy security and resiliency

Sources: 1. Eicholtz, Kok & Quigley (2010), Fuerst & Mcallister (2011), Eicholtz, Kok et al. (2011), Newell, Kok et al. (2011).

WorkPlace 20·20 Projects Evaluation Study

Daylight

New 75%
Old 51%

Window View

New 69%
Old 47%

Air Quality

New 65%
Old 36%

Temperature

New 43%
Old 34%

Figure 6: Effect of Office Space on Stress Level

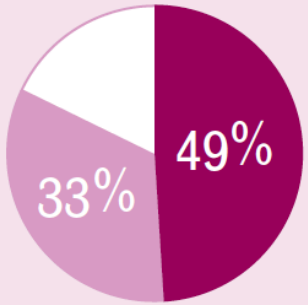


Figure 4: Improved Individual Work Effectiveness

49%
of those surveyed said the new space is better for concentration (26% neutral)

55%
of those surveyed said the new space is better for individual productivity (32% neutral)

Source: GSA The New Federal Workplace (2009)

Rocky Mountain Institute Innovation Center

Type: Commercial office building.

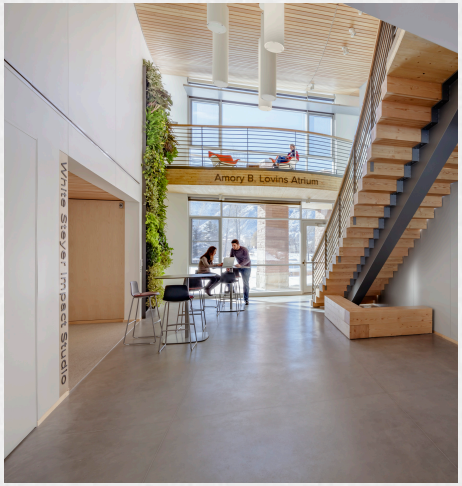
Use: Headquarters of Rocky Mountain Institute, accommodating 50 staff and 80 in convening center

Location: Basalt, Colorado

Size: 15,610 sq. Ft

Completed: Dec 2015

RMI Innovation Center Highlights



Achieves **net-positive energy** (<200 NZE buildings)

The **highest performing** building in the **coldest climate zone** in the US, even before PV

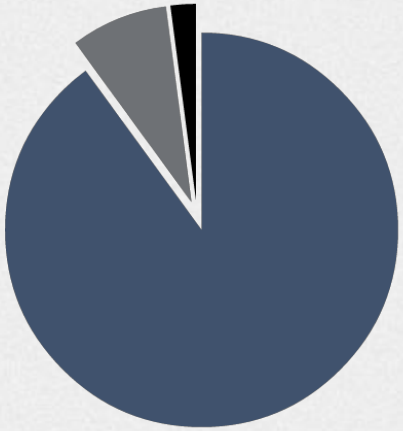
74% more efficient than the average office building in its climate

LEED Platinum certified, Passive House Certified, and PHIUS+ Source Net Zero Project

No cooling system and a small, distributed heating system with equivalent capacity of 1 mid sized home

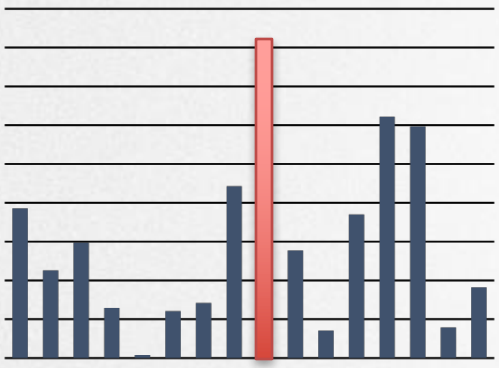
This building serves as a model

The Innovation Center is right in the 'sweet spot' to move the market



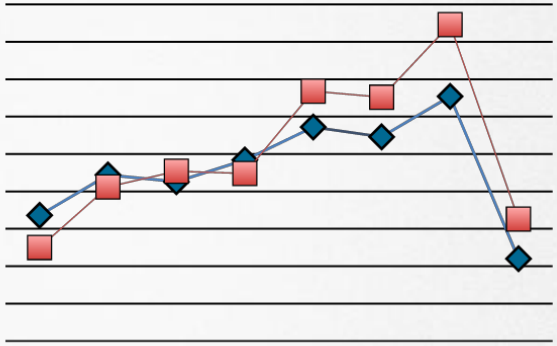
90% / 78%

OF COMMERCIAL / GOVERNMENT BUILDINGS ARE UNDER 25,000 SF



OFFICES

ARE THE BIGGEST USE OF COMMERCIAL BUILDINGS, 2nd BIGGEST IN GOVERNMENT BUILDINGS



HALF

OF COMMERCIAL AND GOVERNMENT BUILDINGS ARE OWNER OCCUPIED

BY 2035, ABOUT THREE-FOURTHS OF U.S. FLOOR SPACE WILL BE NEW OR RENOVATED.

Source: CBECS 2003 and 2012

RMI Innovation Center Costs

The incremental cost associated with achieving net zero energy for the Innovation Center was 10.8% and will deliver a simple payback in just under 4 years.

Our net zero energy building delivers significantly more long-term value than a typical building. Increased productivity, reduced energy costs and reduced maintenance costs contribute >$2.5 M over a 10 year period.

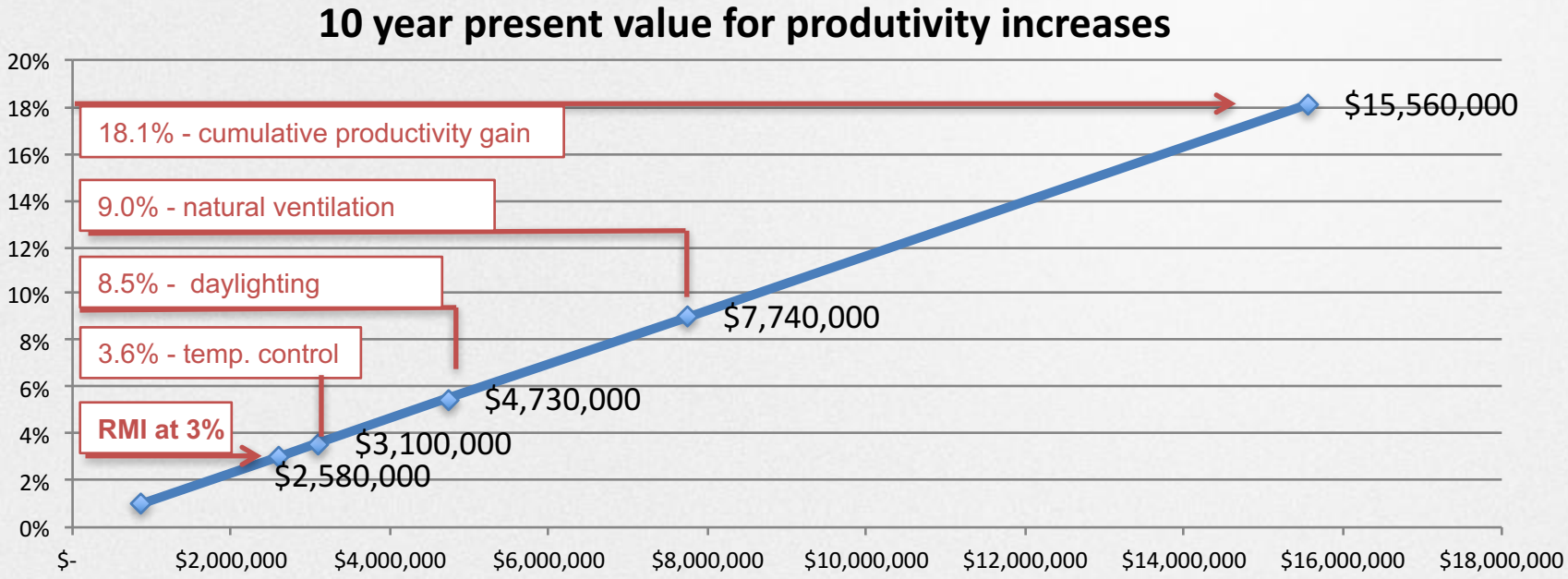
< 4 year payback on NZE

Premium for net zero energy (including construction, design and soft costs)	$86/SF
Annual operating costs	**Annual Savings**
Energy (Compared against a LEED baseline building, includes annual PPA expenses for building related PV, not for PV dedicated to EV charging)	$8,100
Maintenance (reduced exterior repainting, lower HVAC equipment maintenance, reduced lighting bulb replacement)	$3,000
Productivity and Satisfaction (3% gain in revenue per employee due to productivity increase from **individualized temperature controls**, **natural ventilation** and **increased daylight availability**.)	$334,100
Total	$345,200/year or $22/SF
Simple payback	3.9 years

3% productivity increase is conservative

34 studies compiled and analyzed by Carnegie Mellon's Center for Building Performance and Diagnostics show…

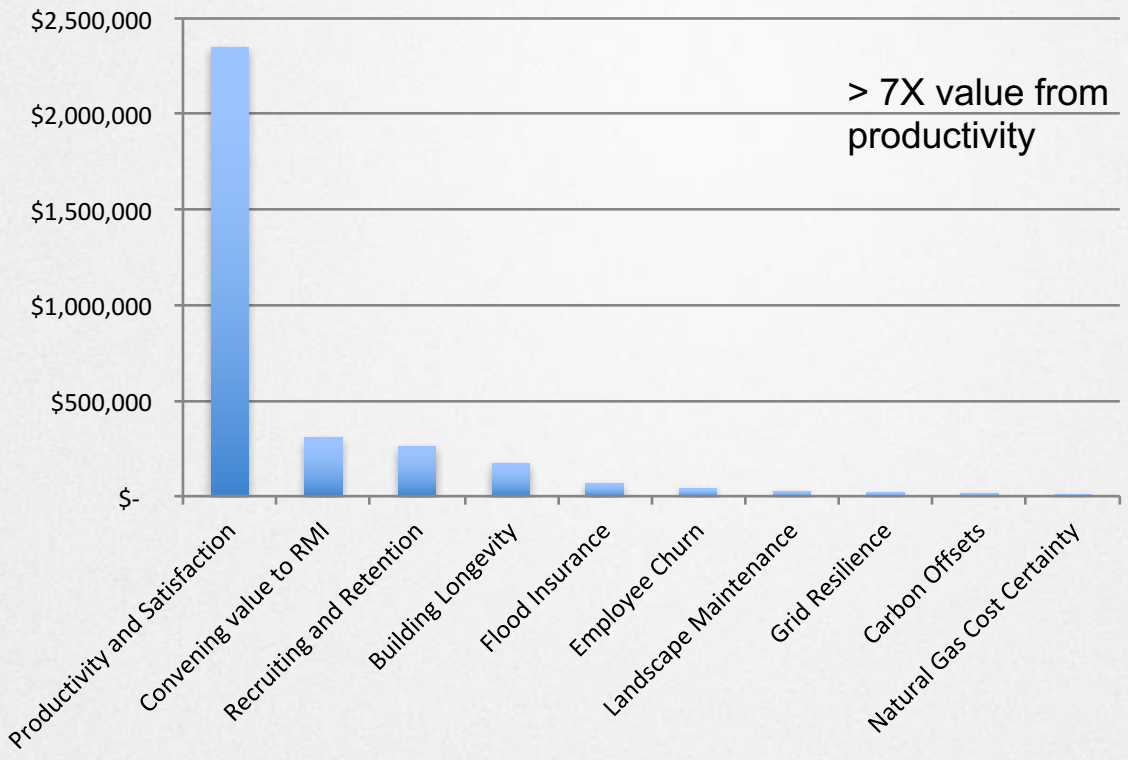
- **3.6% average productivity gain** for individualized temperature control
- **5.5% average productivity gain** for maximized daylighting
- **9% average productivity gain** for mixed-mode or all-natural ventilation.



Other Value provided by NZE

Several additional likely sources of value were considered but they are less significant and some are related to aspects of the building other than its energy performance (i.e. high-end finishes, modular design, etc.)

- Value of convening
- Recruiting and Retention
- Building Longevity
- Flood Insurance
- Employee Churn
- Landscape Maintenance
- Grid Resilience
- Carbon Offsets
- Natural Gas Cost Certainty



What next?

1. Every building should have an informational energy display in the lobby
2. Every major renovation should do a pre and post occupant productivity and satisfaction survey
3. Building owners can advertise the full value and help educate occupants
4. Building occupants can study and publish the results
5. Policy makers can support programs that illustrate and communicate the quantitative link between cost and value
6. Cohort to document calculation methodologies and bound values for the federal government to increase adoption