GSA Green Building Demonstration Projects: Findings & Follow Up

Briefing for the Green Building Advisory Committee
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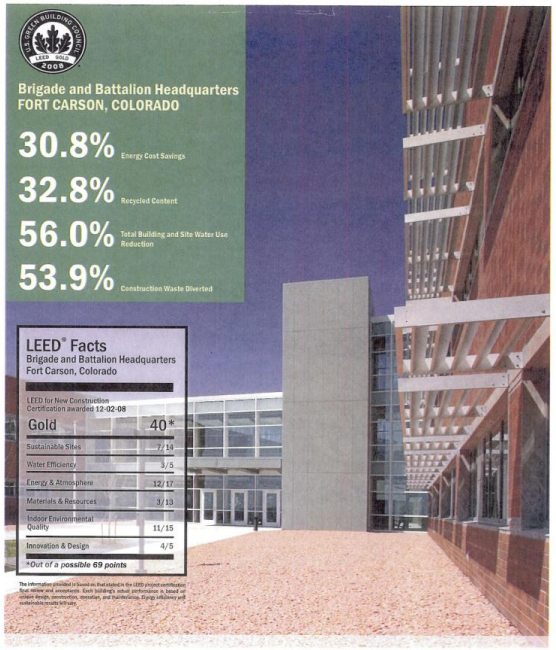


Agenda for Today

- Brief you on major findings of our two green building demonstration projects to date:
  - EPA Region 8 Headquarters building (Denver, CO)
  - Ft. Carson Army base (Colorado Springs, CO)
- Gain your input to prioritize these findings re: their value to the Federal government's efforts to green its building portfolio
- Plus a preview of our latest demo project

Every Building is a Hypothesis Waiting to be Tested

How does the building perform?

How well does it work for people?

Does it meet expectations?

Goals of GSA Demo Projects

- Improve understanding of how sustainable technologies & practices can improve building performance:
  - Test green technologies and strategies
  - Develop benchmarks & performance metrics
  - Identify replicable, scalable best practices
  - Integrate findings into government policy, guidance and practice
  - Disseminate results government-wide & beyond
- More information, including project reports, available at www.gsa.gov/buildingresearch.

First Demonstration Project: EPA Regional HQ Denver, CO

Individual Studies

Underfloor air distribution
Acoustics
Occupant comfort
Satisfaction w/ green features
Workplace functionality
Indoor water use
Green roof
Data Center energy
Daylighting analysis
Furniture & materials
Behavioral change

Second Demonstration Project: Ft. Carson Army Base Colorado Springs, CO

LEED® Facts	
Wilderness Road	
Brigade & Battalion HQ	
Fort Carson, Colorado	
LEED for New Construction	
PLATINUM	52*
Sustainable Sites	11/14
Water Efficiency	4/5
Energy & Atmosphere	15/17
Materials & Resources	6/13
Indoor Environmental Quality	11/15
Innovation & Design	5/5
***Out of a possible 69 points**	

Fort Carson Research Projects

- Goal: Help Ft. Carson reach net zero energy target
- Behavioral Research:
  - How do occupants perceive & interact with green building features?
  - How to motivate energy-saving behaviors?

- Building Systems Research::
  - Analyze performance and optimization potential of:
    - Lighting & Daylighting
    - Building Envelope
    - Building Retrofit

EPA Behavior Studies

- Desk top plug load experiment
  - Automatic shutdown using occupancy sensors
  - Competition to motivate reduced energy use
  - An information campaign
  - Control (no behavior change)

- Indoor water
  - Dual flush toilet water use
  - Method – assessment of water volume per flush

Dual Flush toilets

Signs told occupants how to use the dual flush toilets –

but water use was higher than expected.

The Problem :

People flush down because it is what they are used to doing – it's a strong habit.

Was this causing the greater than expected water use?

The Solution:

Change the handles to fit the habit.

Results showed reduced water use on tested floors.

Economic analysis showed it was cost effective to change handles.

Behavior Change Experiment for Desktop Plug Loads

- Information campaign urging people to shut down devices when away from desk
- Competition among workstation pods to reduce desk top energy use
- Automatic shutdown using occupancy sensors to identify occupant presence

120 Subjects
Each condition tested for one month
Baseline at start
Energy use at end of experiment

Energy use results (extrapolated to whole building

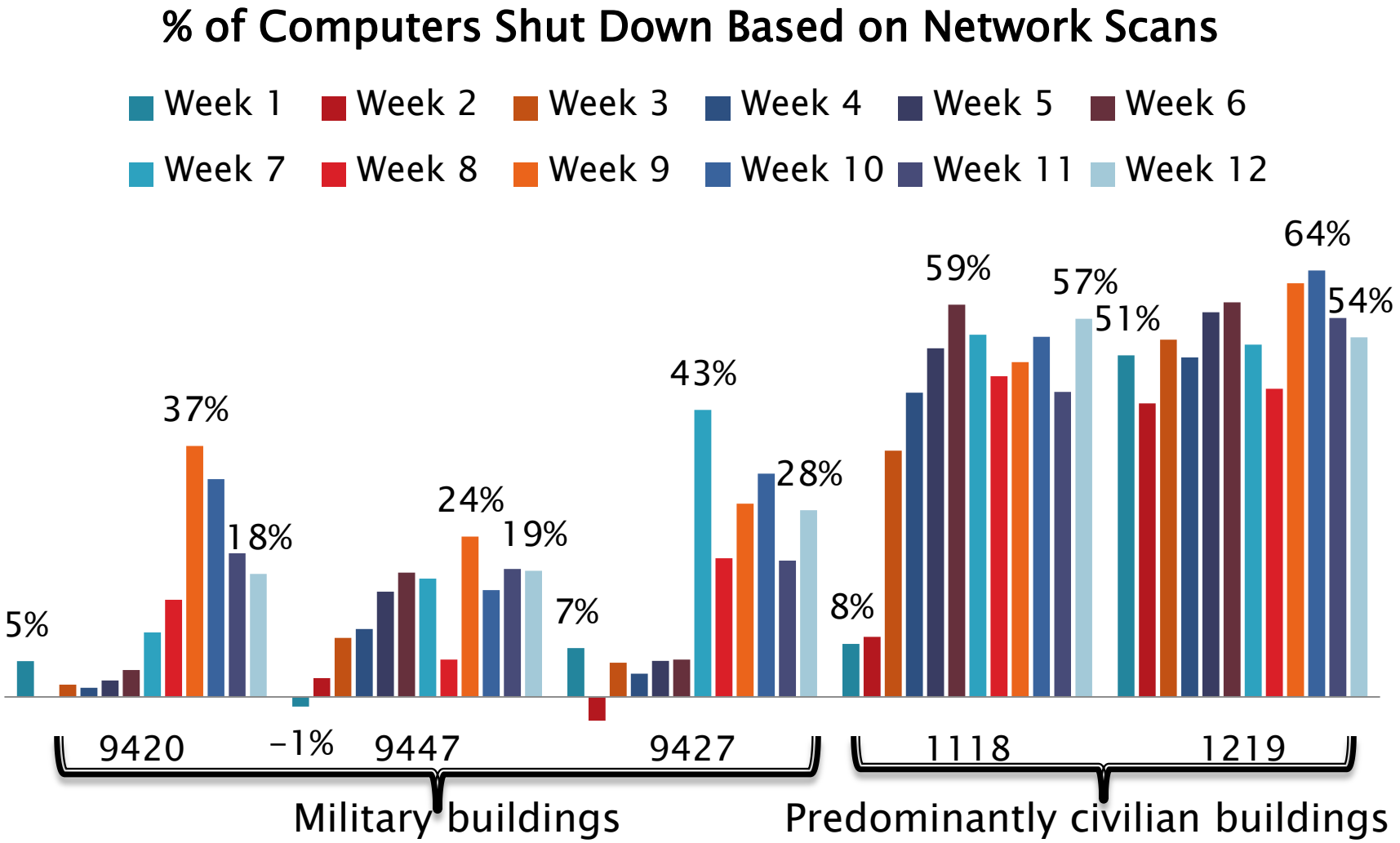
Experimental method	Total annual energy savings (kWh/yr)	Percentage reduction from baseline	Percentage of whole-building electricity reduction)	Total annual cost savings ($/yr)	Total CO_2e savings (tons)
Control system – auto shutdown	34,757	21%	0.9%	$3,476	30
Competition	9,912	6%	0.3%	$991	9
Letters	-407	0%	0.0%	-$41	0

NOTE: results may have been better if people could not opt out of the auto turn off.

Ft. Carson Behavior Research

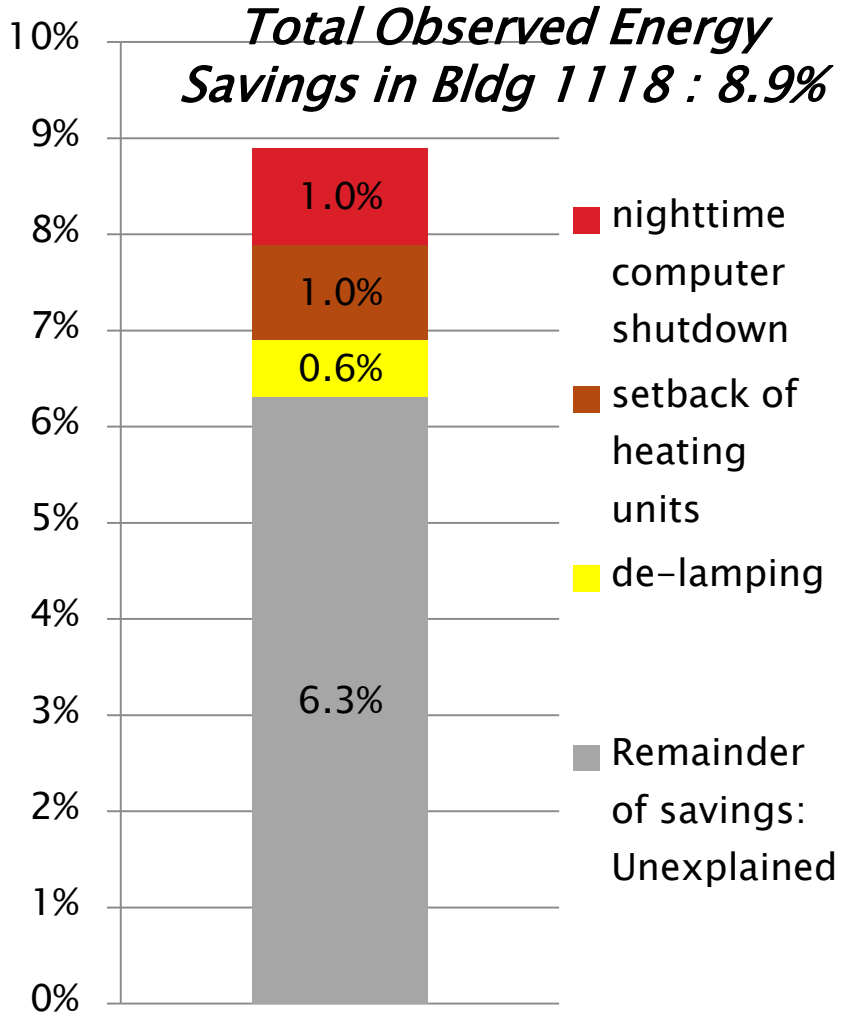
- Focus on performance impact of enhancing role of the building energy monitor
  - Energy Monitor training
  - Weekly building checks
  - Service orders for physical issues with building
  - Communication with occupants about progress, opportunities
- Targeted occupant behaviors
  - Night time computer shutdown
  - Night time temperature setback

Results: Computer Shutdown



One Building's Energy Savings

- Total savings of 8.9%
- However, 6.3% cannot be explained
- Savings from temperature set backs was 3.1% – primarily from natural gas, not electrical



Combined Behavioral Research: Lessons Learned

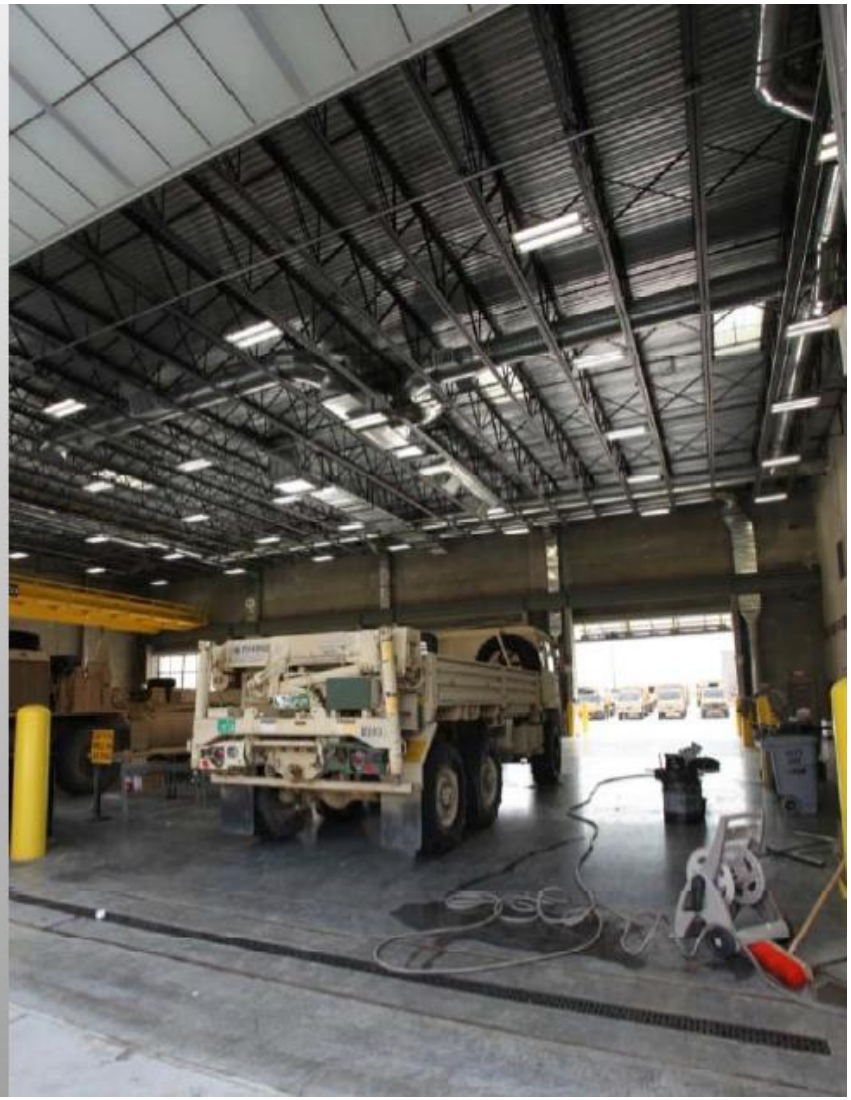
- Behavior change is difficult
- Changing default conditions may be a better option in some contexts
- However, behavior change can be a useful approach – but know when and how to use it and whose behavior to change
- Continue to identify approaches that work best and in what contexts

Key Building Systems Findings & Recommendations

- Lighting/Daylighting Systems (Ft. Carson)
  - Savings can be raised to 90% through strategies to harvest daylight and apply control technologies to drive down loads
- Building Retrofit Optimization (Ft. Carson)
  - A lifecycle cost optimal path to deep energy retrofit
- Data Center Energy Use Reduction (EPA bldg)
  - Major opportunities with short payback periods

Successful Daylighting in Action

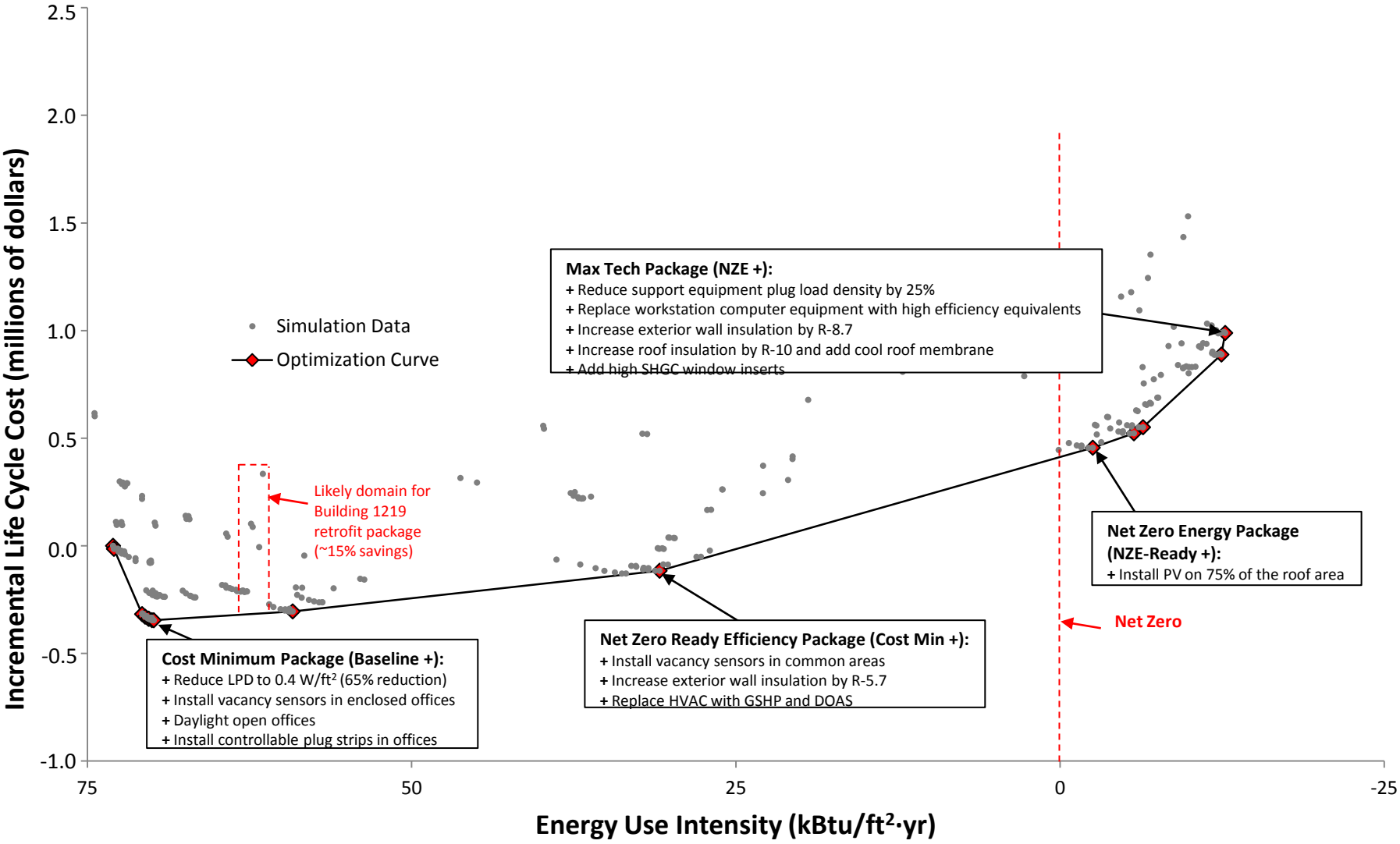
Daylighting Control Issues



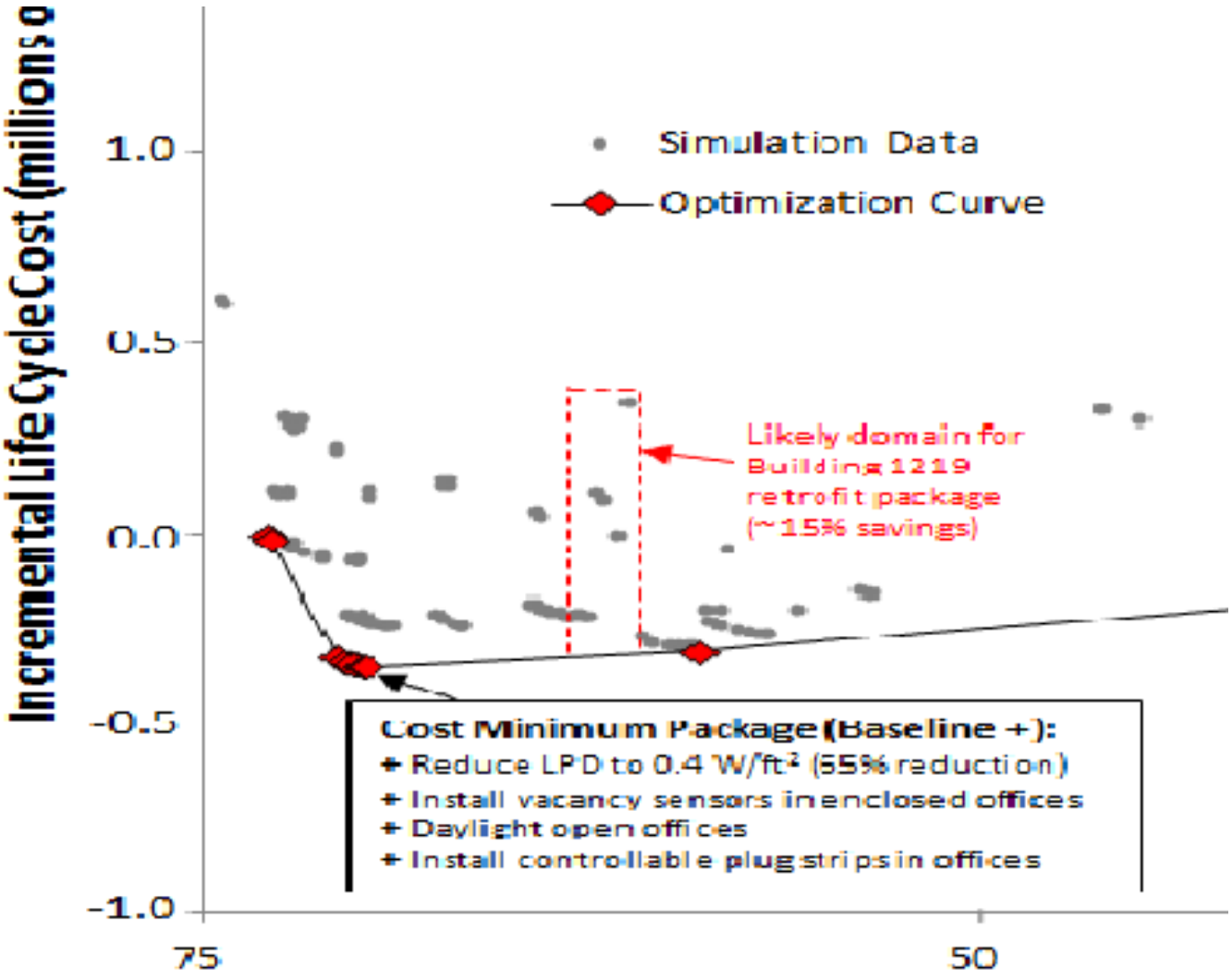
Lighting Recommendations

- Fine tune lighting levels to meet occupant needs
- Provide consistent glare-free daylight in all spaces
- Set electric lighting and controls to provide layers of light
  - Make the lowest acceptable light level the default mode
  - Allow occupants to choose more light (controlled by vacancy sensors rather than occupancy sensors)
- Engage occupants and design the control system to serve them
  - Zone electric light systems to take advantage of perimeter daylight and occupant preferences
  - Use vacancy control in all appropriate spaces

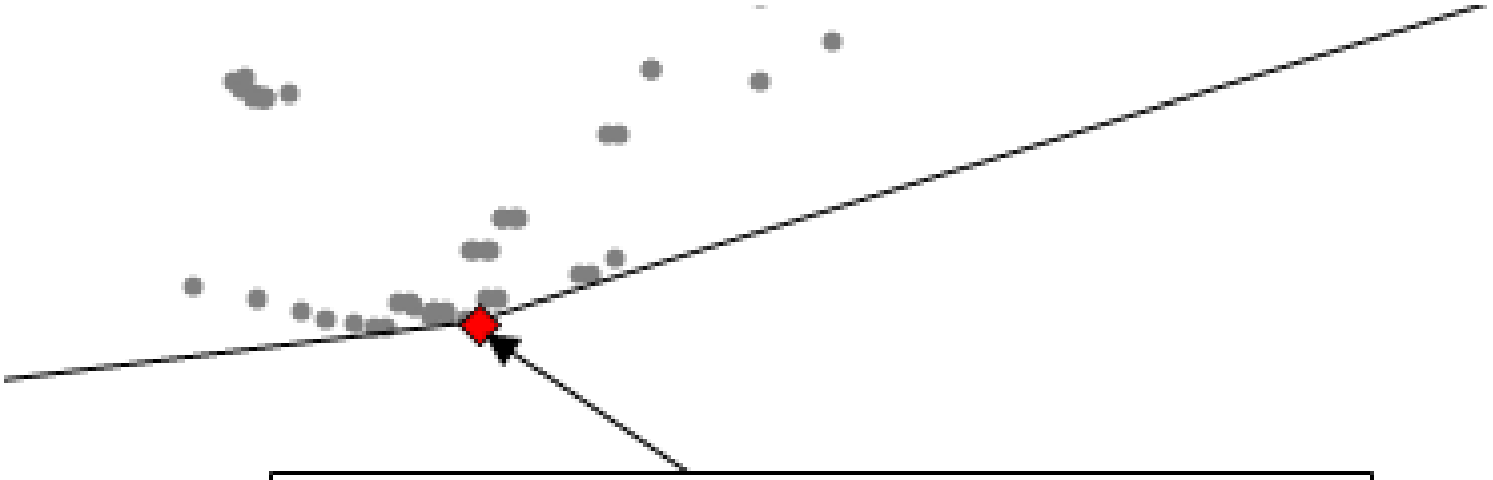
Ft Carson Energy Retrofit Optimization



Cost Minimum Package



Net Zero Ready Efficiency Package



Net Zero Ready Efficiency Package (Cost Min +):

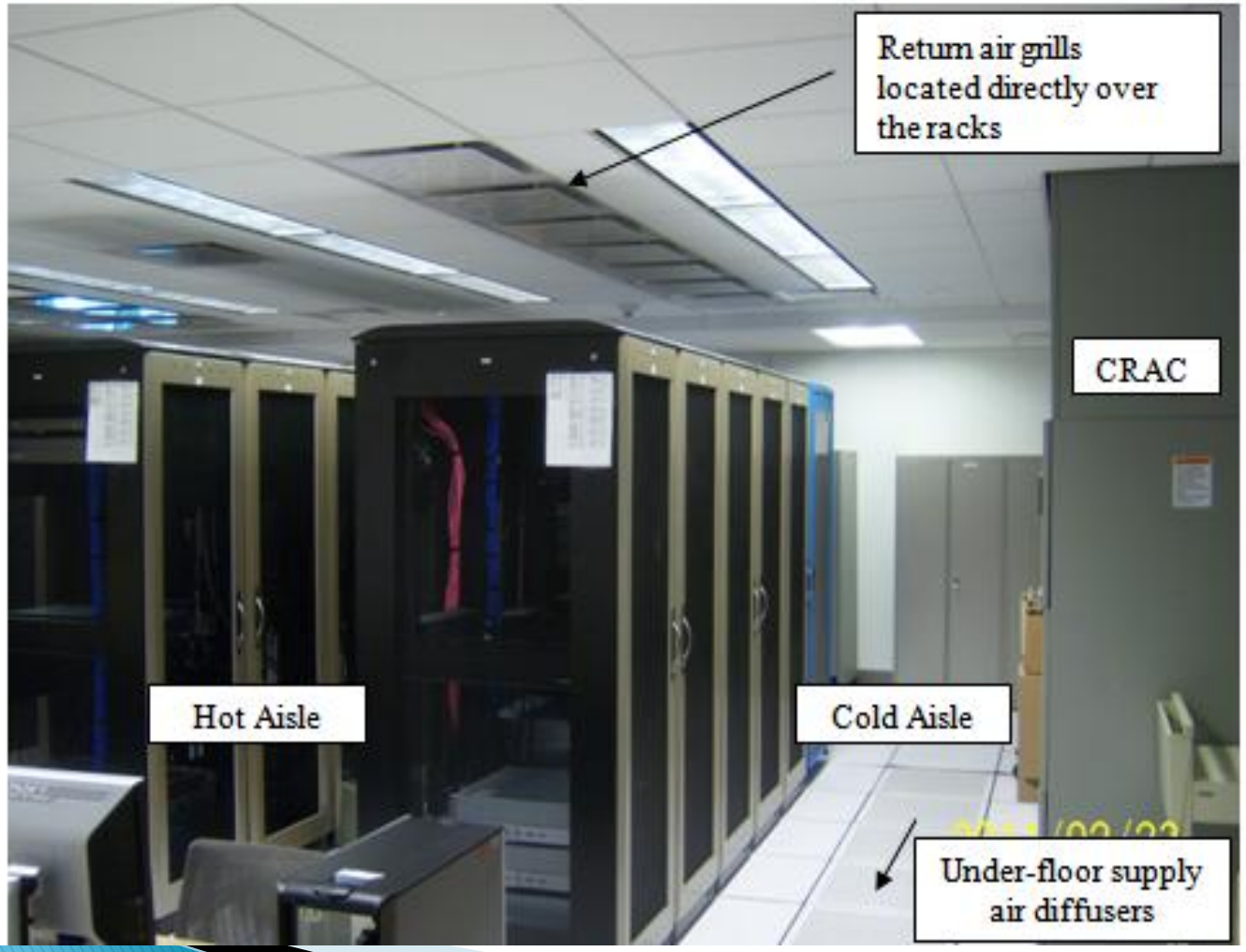
+ Install vacancy sensors in common areas
+ Increase exterior wall insulation by R-5.7
+ Replace HVAC with GSHP and DOAS

Optimization Summary

Model	EUI/Net EUI (kBtu/ft^2·yr)	Net Energy Savings (%)	Incremental TLCC (millions of $)
Baseline	73.0	NA	NA
Cost Min	69.9	4%	-0.3
NZE Ready	30.9	58%	-0.1
NZE	30.9/-2.5	103%	0.5
Max Tech	20.7/-12.7	117%	1.0

- Baseline energy use of 73.0 kBtu/ft^2·yr is indicative of a typical, minimally code compliant low rise office building
- Net Zero Energy Ready Efficiency Package results in 58% energy savings at a negative incremental total lifecycle cost
- Max Tech Efficiency Package results in an annual energy use intensity (not including PV) of 20.7 kBtu/ft^2·yr, which is comparable to that for the RSF (not counting the data center)

EPA Building Data Center Energy Use Reduction



Data Center Energy Reduction Strategy

- Improvements recommended, with estimated payback periods, include:
  - Replace, Virtualize and Consolidate IT Equipment (6.3 years)
  - Optimize Airflow Management (2.0 years)
  - Replace Uninterrupted Power Supply (UPS) with High Efficiency UPS (5.7 years)
  - Install New air handling unit (AHU) with Economizer + Evaporative Cooling (1.8 years)
  - Install Light Switch (0.23 years)

Preview: GSA's Next Demo Project

More to Come…

Your Turn

- **How would you prioritize these research findings re: their value to the Federal government's efforts to green its building portfolio?**

- Which mechanisms would be most effective to transmit these best practices for government-wide implementation: e.g., policies, guidance documents, factsheets, checklists, webinars, etc.?
- What research questions should future demonstration projects pursue?