

Integration of Energy/Sustainable Practices into Standard Army MILCON Designs

Energy and Sustainability Study

SERDP/ESTCP
Symposium

30 November 2010

ACSIM
IMCOM
USACE
CERL/NREL/PNNL



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14. ABSTRACT The Army Corps of Engineers has been tasked with determining the building features construction methods and materials that will optimize energy reduction and sustainability for new construction standard designs in FY13 for five Army building types: Barracks, motor pools Brigade HQ, dining facilities, and Company Operation Facilities. At a minimum, the selected standard designs must meet all applicable energy reduction and sustainable design mandates (e.g., LEED Silver, EPACT 2005, EISA 2007, EO13423, and EO13514). Specific targets include: Plan Army community to be net zero ready, 65% energy reduction (ASHRAE 90.1 2010), 30% domestic hot water reduction, 50% waste water reduction and 25% operating cost reduction. Cost estimates based on building type and climate zones that identify the delta between current construction costs and optimized building designs are also included. This presentation is a summary of that effort, potential impact on all future MILCON construction, and next steps.					
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MILCON FY13 ENERGY ENHANCEMENT STUDY

MS. ALICE SOULEK
Pacific Northwest National Laboratory
P.O. Box 999, MSIN K5-20
Richland, WA 99352
(509) 554-7103
alice.soulek@pnl.gov

The Army Corps of Engineers has been tasked with determining the building features, construction methods and materials that will optimize energy reduction and sustainability for new construction standard designs in FY13 for five Army building types: Barracks, motor pools, Brigade HQ, dining facilities, and Company Operation Facilities.

At a minimum, the selected standard designs must meet all applicable energy reduction and sustainable design mandates (e.g., LEED Silver, EPACT 2005, EISA 2007, EO13423, and EO13514). Specific targets include: Plan Army community to be net zero ready, 65% energy reduction (ASHRAE 90.1 2010), 30% domestic hot water reduction, 50% waste water reduction, and 25% operating cost reduction. Cost estimates based on building type and climate zones that identify the delta between current construction costs and optimized building designs are also included. This presentation is a summary of that effort, potential impact on all future MILCON construction, and next steps.

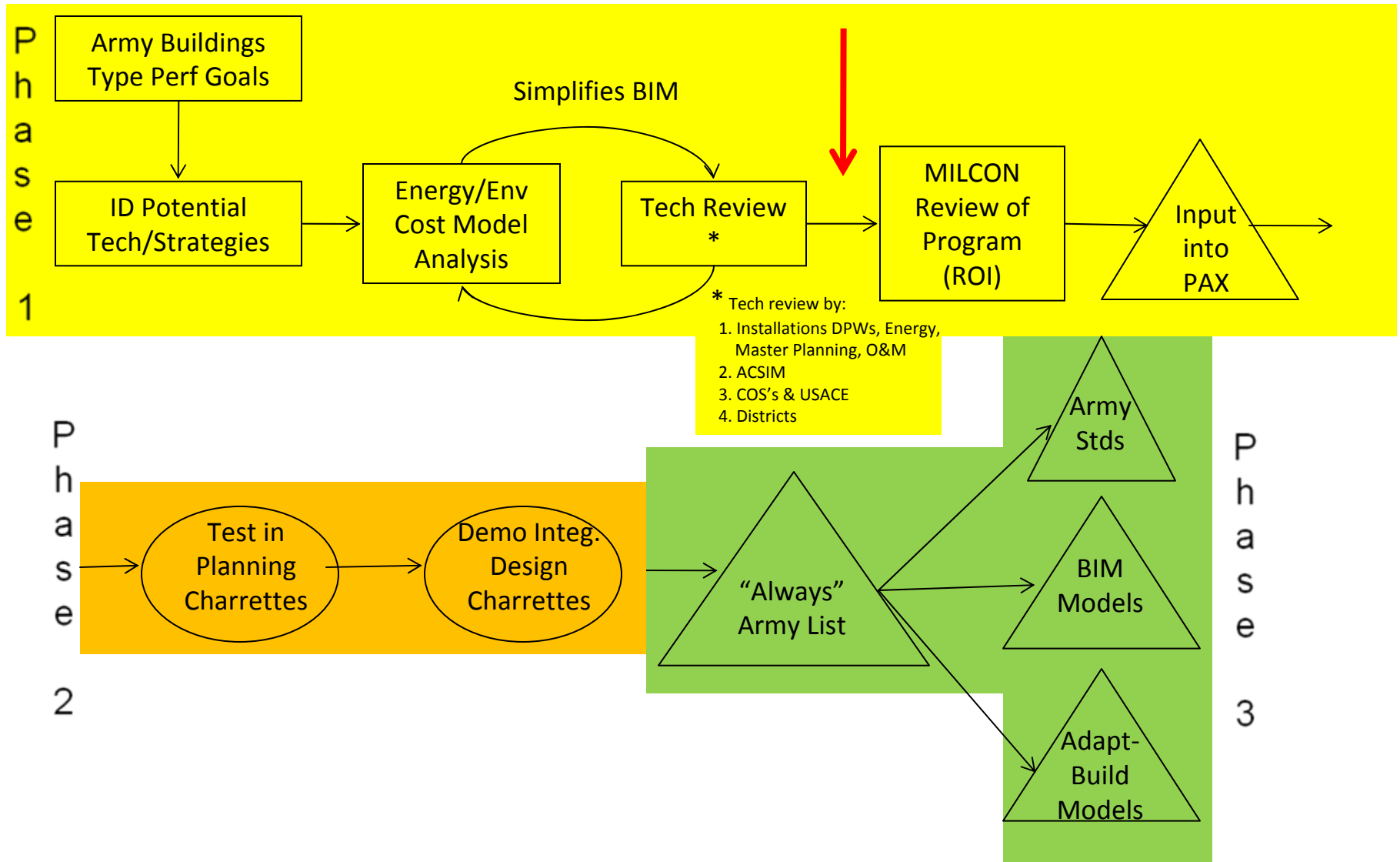
CONCEPT OF OPERATION

- ▶ MILCON-Energy IPT formed April 2010
- ▶ Members: ASA(I&E), USACE, ACSIM, NGB, USAR
- ▶ Selected 5 projects from FY13 FYDP for energy design to full statutory compliance
 - Tactical Equipment Maintenance Facility (TEMF)
 - Company Operations Facility (COF)
 - Brigade Headquarters
 - Barracks
 - Dining Facility
- ▶ Evaluate design of each facility type in three scenarios
 - Full mission scope + full energy compliance w/o regard to Program Amount (PA)
 - Full mission scope + incorporate energy features possible w/in PA
 - Full energy statute compliance + reduce mission scope to stay w/in PA
- ▶ Assess MILCON and post-construction Operations & Maintenance impacts for each scenario
- ▶ Report findings / recommendations

Energy Study Actions

- ▶ Meetings with Centers of Standardization (COS) to discuss building features and modeling parameters
- ▶ CERL – modeling Barracks and Brigade HQ
- ▶ NREL – modeling Dining Facilities, TEMFs and COFs
- ▶ CERL/PNNL – LEED analysis for all building types including water conservation, stormwater and wastewater management
- ▶ USACE HQ reporting results to ACSIM/IMCOM

Integration of Energy/Sustainable Practices into Standard Designs



Construction Related Requirements

- ▶ Energy Policy Act of 2005 (EPAcT 2005), Public Law 109-58 (August 8, 2005)
- ▶ Executive Order (EO) 13423, Strengthening Federal Environmental, Energy, and Transportation Management (January 29, 2007)
- ▶ Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110-140 (December 19, 2007)
- ▶ EO 13514, Federal Leadership in Environmental, Energy, and Economic Performance (October 5, 2009)
- ▶ High Performance and Sustainable Buildings (HPSB) Guiding Principles (December 1, 2008)

Source: Requirements: Excerpts from EPAcT 2005, EO 13423, EISA 2007, EO 13514, and the Guiding Principles. Kim Fowler, March 2, 2010

EISA 2007 Key Sections

- ▶ High Performance Federal Buildings (Title IV – Subtitle C)
 - Section 431 – Energy Reduction Goals for Federal Buildings
 - Section 433 – Federal Building Energy Efficiency Performance Standards
 - Section 438 – Storm Water Runoff Requirements for Federal Projects
- ▶ Energy Efficiency in Federal Buildings (Title V – Subtitle C)
 - Section 523 – Standard Relating to Solar Hot Water Heaters
 - Section 524 – Federally Procured Appliances with Standby Power
 - Section 525 – Federal Procurement of Energy Efficiency Products

Sec. 431: Energy Reduction Goals

▶ Reduce Agency Btu per gross square foot 3% per year, from a 2003 baseline:

- 9% in 2008
- 12% in 2009
- 15% in 2010
- 18% in 2011
- 21% in 2012
- 24% in 2013
- 27% in 2012
- 30% in 2015

▶ Exclusion Criteria from EPA Act still applies:

- http://www1.eere.energy.gov/femp/pdfs/exclusion_criteria.pdf

Section 433: Fed Building Standards

- ▶ DOE to revise Federal building standards to require that the fossil fuel-generated energy use be reduced by:
 - 55% in 2010
 - 65% in 2015
 - 80% in 2020
 - 90% in 2025
 - 100% in 2030 (*Zero Energy Buildings*)
- **Exceptions** (must be approved): if technically impracticable in light of the agency's specified functional needs for that building
- ▶ Sustainable design principles shall be applied to the siting, design, and construction of buildings subject to the standards

Applicable Energy Targets for UEPH

(all in site energy: kBtu/SF-yr)

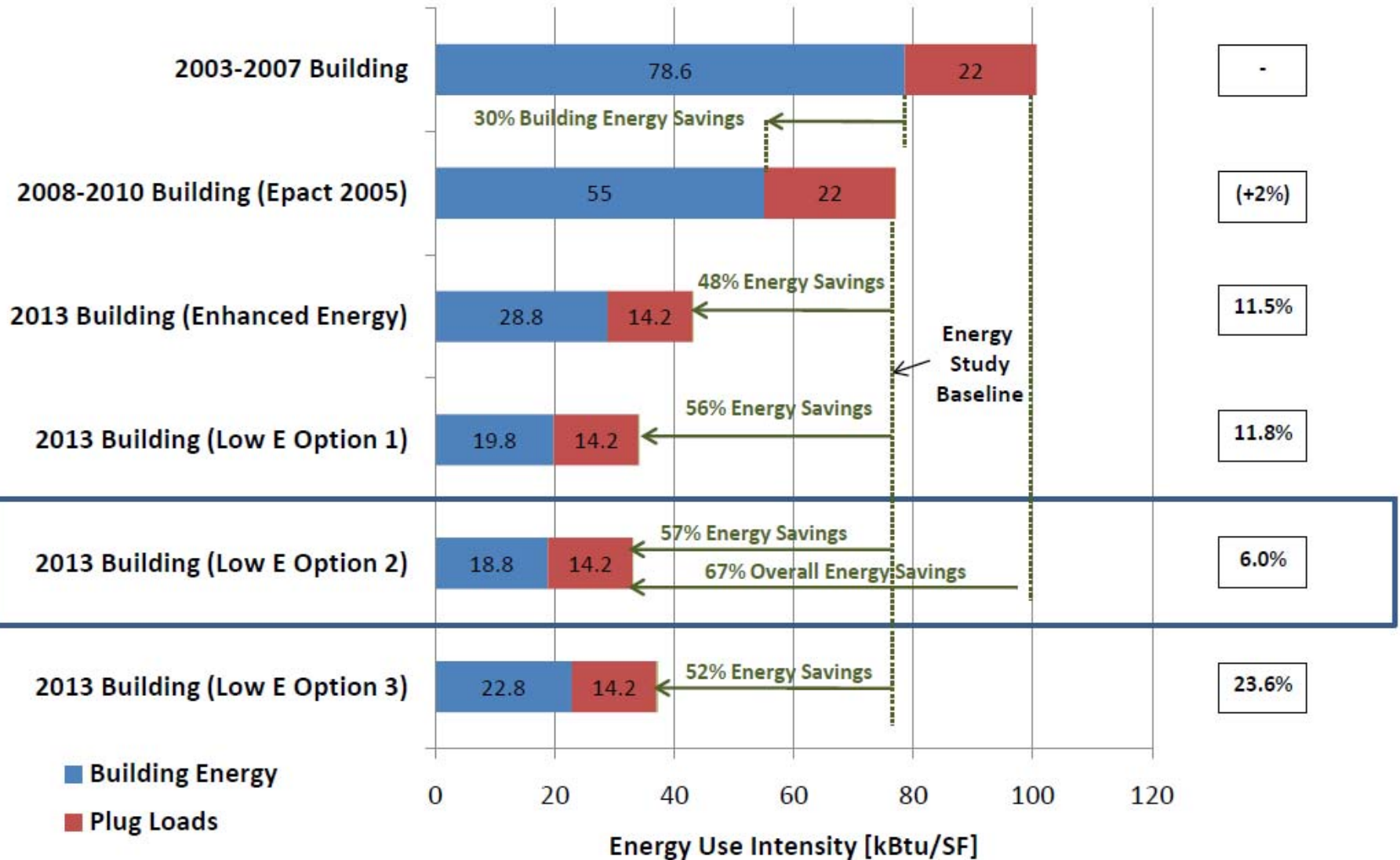
	Houston, TX Zone 2A	Baltimore, MD Zone 4A	Duluth, MN Zone 7	CBECS: Commercial Building Energy Consumption Survey
CBECS 2003	69	75	105	
EISA07 2010 - 55% Better than CBECS	31	34	47	
EISA07 2015 - 65% Better than CBECS	24	26	37	
ASHRAE 90.1-2004 Baseline	102	95	111	
ASHRAE 90-1-2007 Baseline (approx.)	92	86	100	
ASHRAE 90-1-2010 Baseline (approx.)	64	60	70	
EPACT05 - 30% Better Than 90.1-2004	71	67	78	
Without Process Loads				
ASHRAE 90.1-2004 Baseline	82	75	91	
EPACT05 - 30% Better Than 90.1-2004	57	52	64	

- o **EISA 2007 mandates** that in 2015 buildings reduce energy consumption by 65% compared to CBECS 2003 baseline standard.
- o CBECS includes process loads
- o EPACT 2005 does not include process loads

A 65% decrease in energy compared to CBECS would translate to a decrease of 80% or greater compared to ASHRAE 90.1-2007

UEPH Example - Climate Zone 4A

Delta Cost



Sec 438: Storm Water Runoff

Predevelopment hydrology shall be maintained or restored:

- ▶ To the maximum extent technically feasible
- ▶ By the sponsor of any development or redevelopment project
- ▶ Involving a federal facility with a footprint over 5,000 square feet
- ▶ Using site planning, design, construction and maintenance strategies

Energy Efficiency in Federal Agencies

Sec 523: Solar Hot Water Heaters

- ▶ Requires 30 percent of the hot water demand in new Federal buildings (and major renovations) to be met with solar hot water equipment, provided it is life-cycle cost-effective

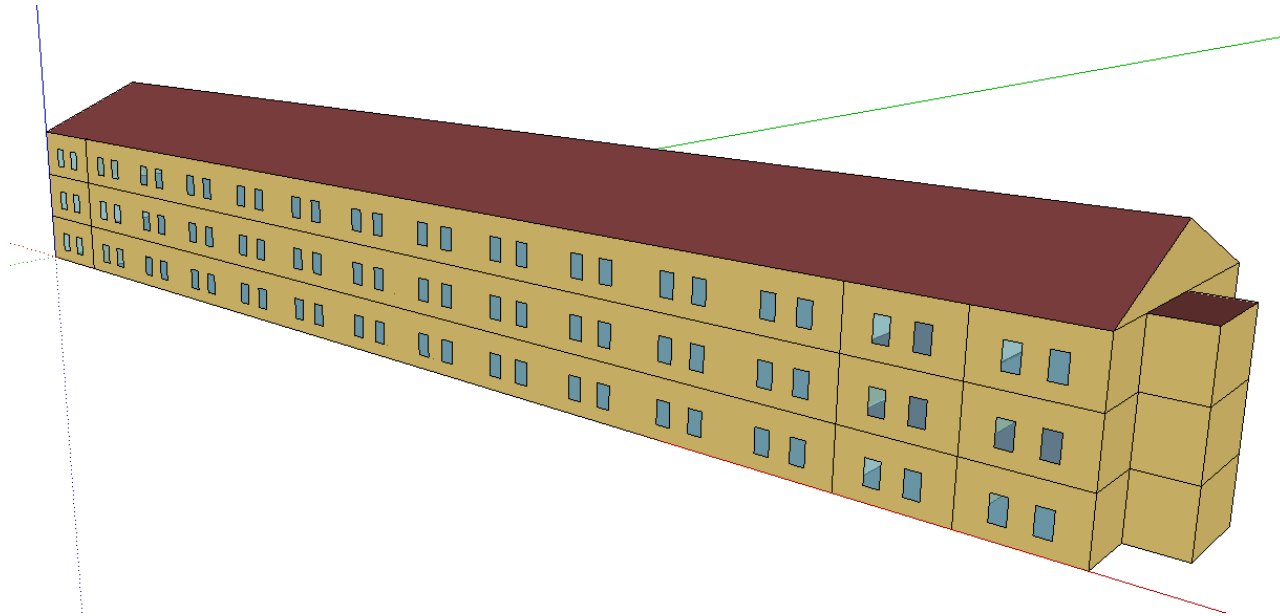
Sec 524: Low Standby Power Appliances

- ▶ Requires DOE, DOD, EPA, and GSA to compile list of cost-effective products
- ▶ Requires agencies to purchase from list

Sec 525: Procurement of Energy Efficient Products

- ▶ Requires GSA and DLA to modify catalogs to ensure procurement of Energy Star and Federal Energy Management Program (FEMP)-designated products as required in EPA Act 2005 (<http://www1.eere.energy.gov/femp/procurement/>)

UEPH (Barracks) Results



Energy Efficiency Measures (EEMs) & Sustainability Measures for UEPH

EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Entrance vestibule
- ▶ Efficient water fixtures
- ▶ Advanced lighting systems with controls
- ▶ DOAS for ventilation
- ▶ Improved chiller and boiler efficiencies
- ▶ All variable efficiency pumps and fans
- ▶ Pressurization and make-up air
- ▶ Condenser heat recovery for DOAS
- ▶ Separate ventilation for living area and laundry
- ▶ Cool roofs in climates 1-5 and window shading
- ▶ Solar water heating (30% min)
- ▶ Total energy recovery @ 80% effectiveness
- ▶ Replace fan coil units in rooms with ceiling radiant heating and cooling

Sustainability Measures

- ▶ Skylights
- ▶ Light tubes
- ▶ Cool Roof (in approved climate zones)
- ▶ Dual flush toilets
- ▶ 1.5 GPM flow shower heads
- ▶ 0.5 GPM flow faucets
- ▶ Rainwater harvesting
- ▶ Permeable asphalt, permeable concrete
- ▶ Swales, bioretention (LID)
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification
- ▶ Parking Lot Lighting:
 - LED parking lot lights
 - Parking lot light pollution reduction
 - Walkway lights

Passive Haus vs. Barracks Insulation Levels

	2A Houston, TX	4A Baltimore, MD	7A Duluth, MN
Walls			
Passive Haus	R-21	R-31	R-56
WBDG, Army Specs - Steel Framed	R-15.5	R-15.5	R-26.8
Roofs			
Passive Haus	R-30	R-45	R-80
WBDG, Army Specs - Steel Framed	R-25	R-30	R-40
Foundation			
Passive Haus	R-10	R-20	R-35
WBDG, Army Specs - Unheated	-	R-15	R-20

- ▶ In certain climate zones, insulation levels are much greater than current standard army design
- ▶ **Yields increase in gross square footage**
- ▶ Architectural challenges
- ▶ Appearance impacts

Improved Lighting Concept

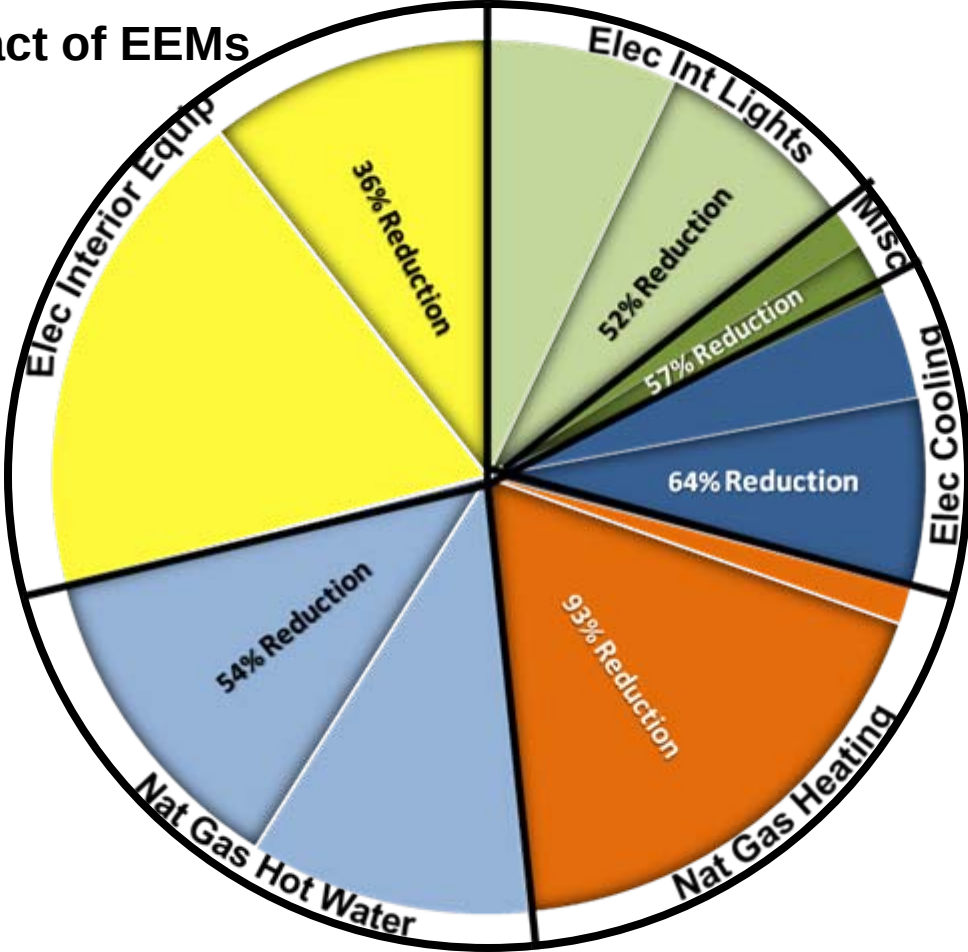
Corridors	4,500	0.50	0.35	30%
Living Quarters	34,720	1.10	0.55	50%
Mechanical/Electrical	2,186	1.50	0.70	53%
Mud Room	96	0.60	0.60	0%
Stairs	1,200	0.60	0.30	50%
Storage	168	0.60	0.50	17%

LPD: Lighting Power Density

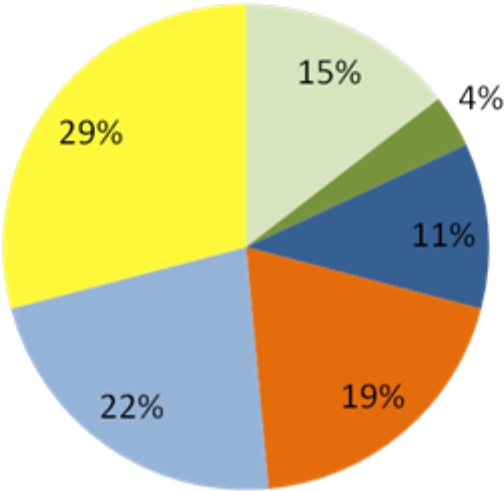
- Lighting expert analyzed barracks lighting
- Compact Fluorescent Lights are still the most energy efficient and cost effective for barracks
- Lighting controls: manual-on, auto off light switches in living quarters

UEPH – Energy Component Breakdown – Climate Zone 4A

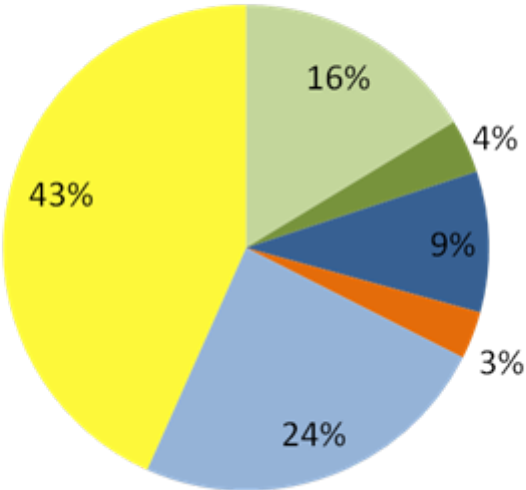
Impact of EEMs



Baseline Model

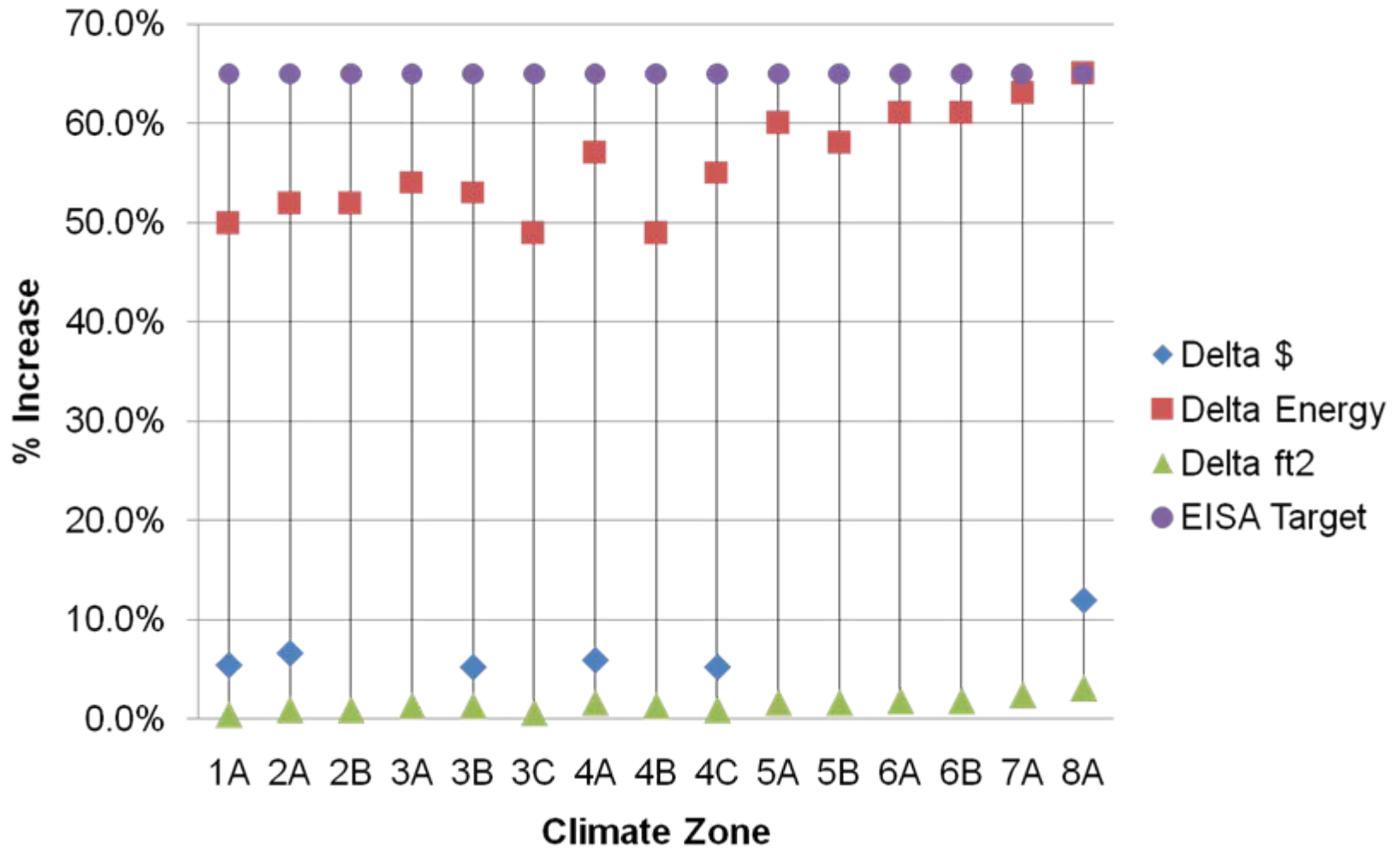


Low Energy Model

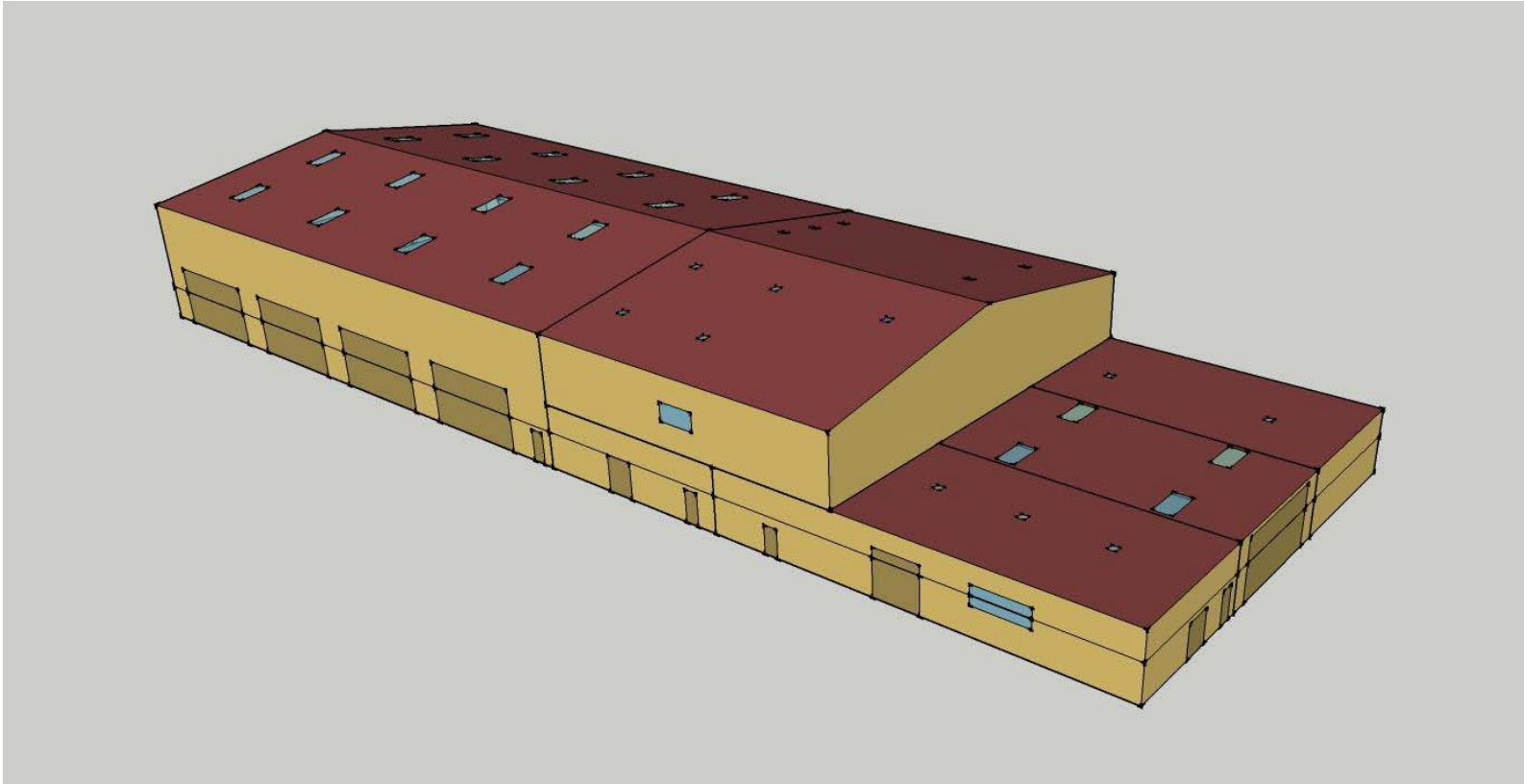


- Elec Int. Lights [kBtu/SF]
- Elec Cooling [kBtu/SF]
- Nat Gas Hot Water [kBtu/SF]
- Misc [kBtu/SF]
- Nat Gas Heating [kBtu/SF]
- Elec Interior Equip [kBtu/SF]

UEPH Delta Cost, Energy, ft2



TEMF (Vehicle Repair Facilities) Results



Energy Efficiency Measures (EEMs) & Sustainability Measures for TEMF

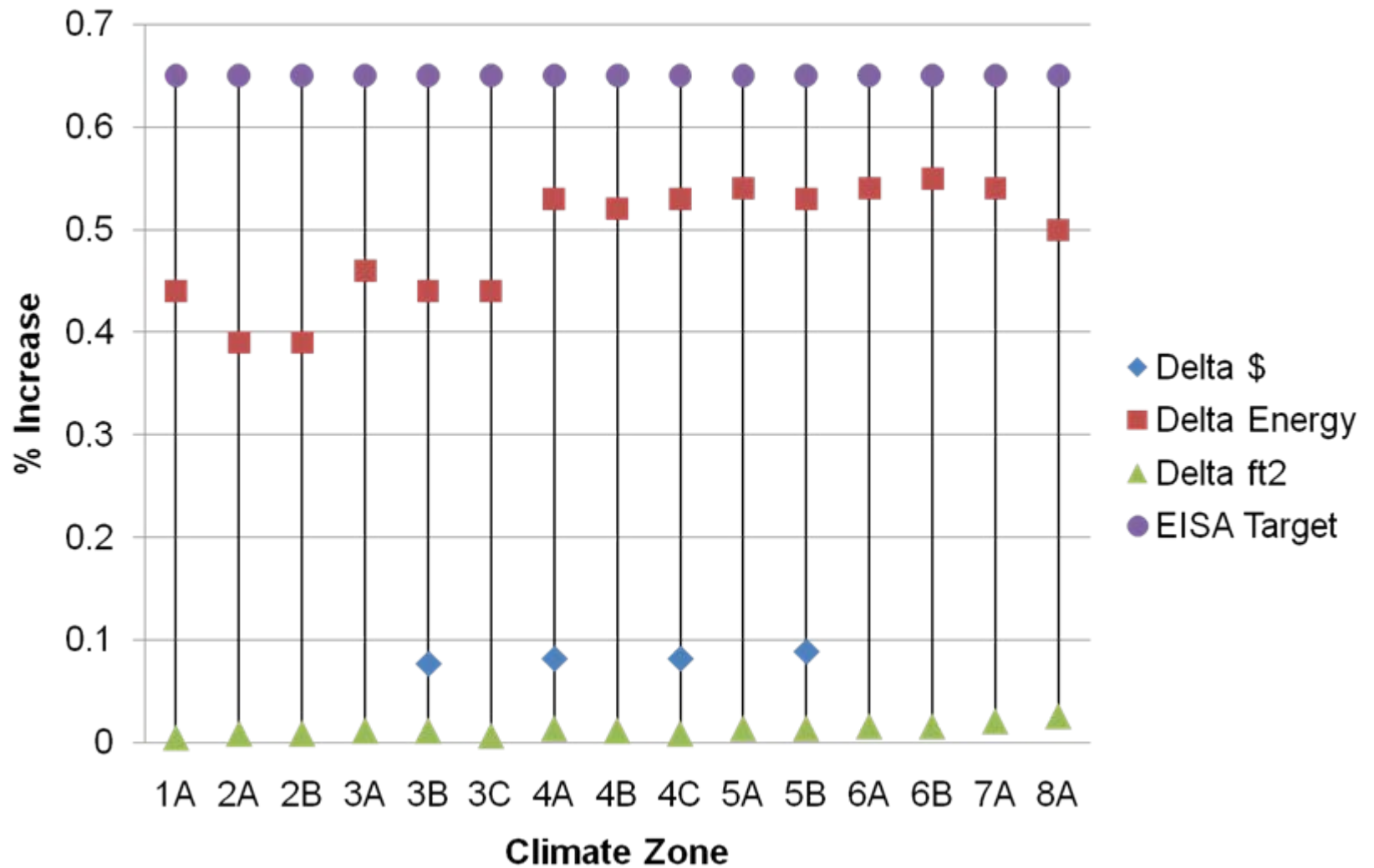
EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Efficient water fixtures
- ▶ Advanced lighting systems with controls
- ▶ Increased fan and HVAC efficiency
- ▶ VAV fans
- ▶ Reduced ventilation in repair bays and vehicle corridor
- ▶ Transfer air from office to repair bays

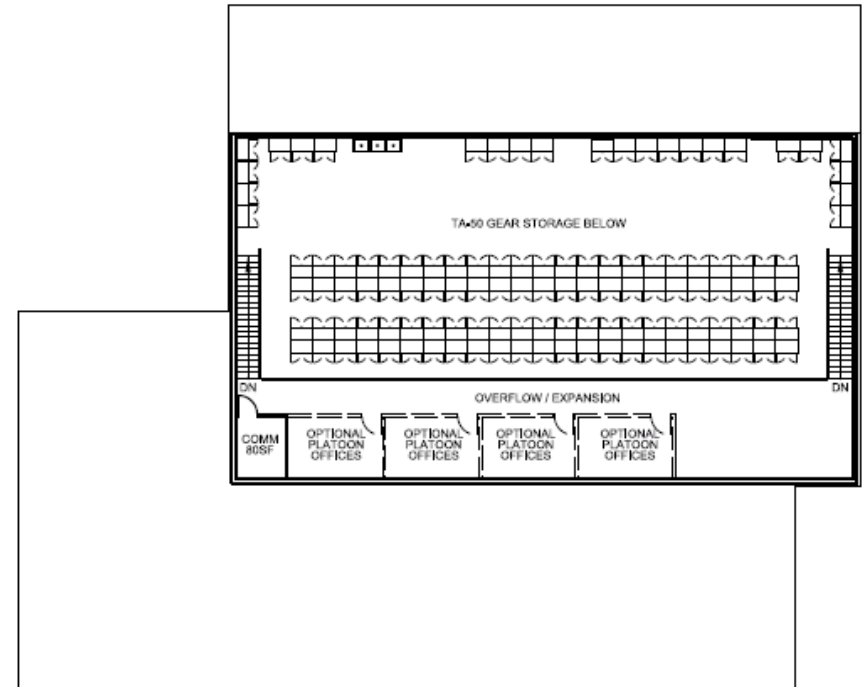
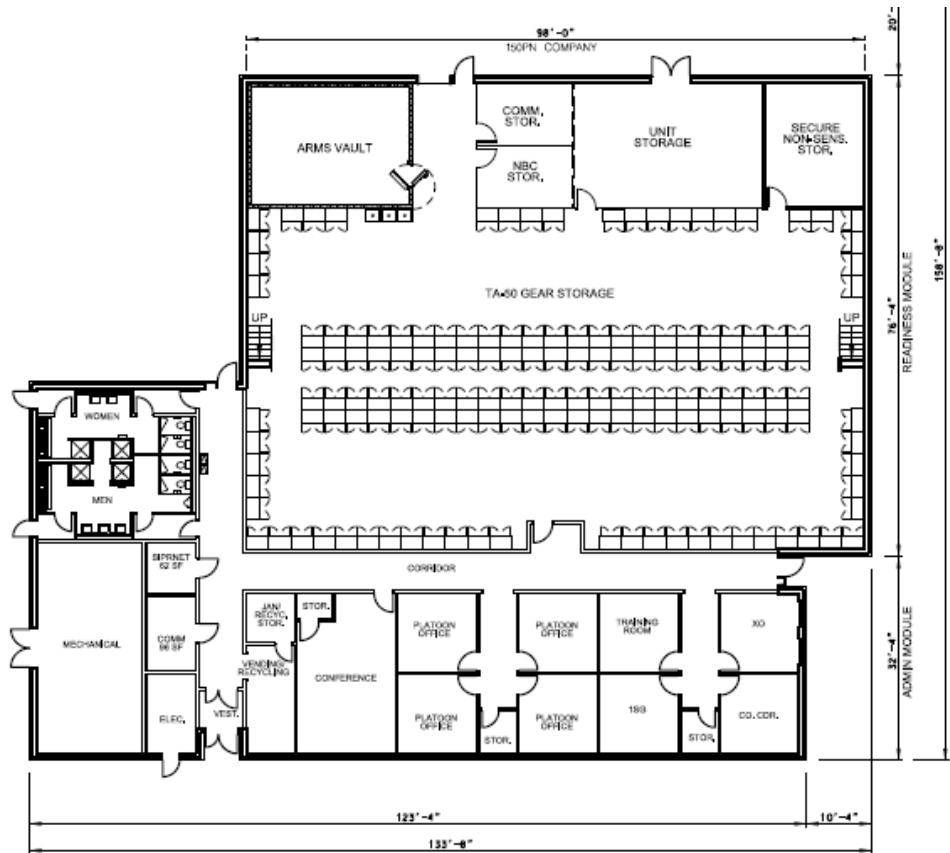
Sustainability Measures

- ▶ Increased vertical glazing size by 50% + increased skylight to floor area (SFA) fraction to 3% over admin/office and consolidated bench areas
- ▶ Added clerestory windows to north side of repair bays
- ▶ Added daylighting controls with 500 lux setpoint
- ▶ Light tubes
- ▶ Dual flush toilets
- ▶ 1.5 GPM flow shower heads, 0.5 GPM flow faucets
- ▶ Rainwater harvesting
- ▶ Permeable asphalt, permeable concrete
- ▶ Swales, bioretention (LID)
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification
- ▶ LED parking lot lights, parking lot light pollution reduction

TEMF Delta Cost, Energy, ft2



COF (Company Ops Facilities) Results



Energy Efficiency Measures (EEMs) & Sustainability Measures for COF Admin

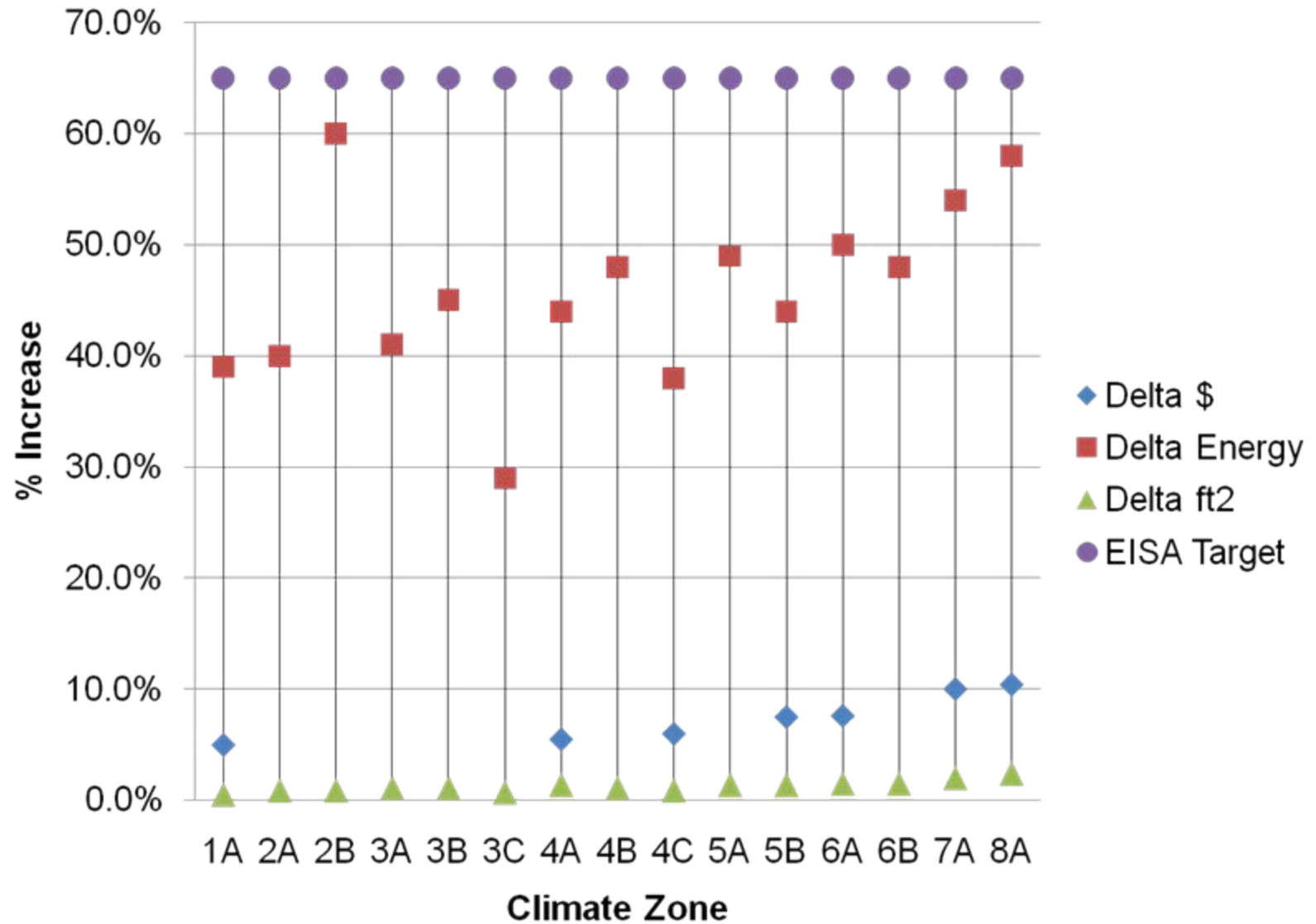
EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Entrance vestibule
- ▶ Advanced lighting systems with controls
- ▶ Cool roof in climate zones 1-5
- ▶ Window shading
- ▶ VAV with ventilation air
- ▶ Pressurization and make-up air system with high efficiency variable volume fan for systems
- ▶ High efficiency chillers with COP > 4
- ▶ High efficiency condensing boilers for heating and hot water >90%
- ▶ High to premium efficiency variable speed fans and pumps
- ▶ Sensible heat recovery for system with indirect evaporative pre-cooling

Sustainability Measures

- ▶ Dual flush toilets
- ▶ 1.5 GPM flow shower heads, 0.5 GPM flow faucets
- ▶ Waterless urinals
- ▶ Rainwater harvesting
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification

COF Admin Delta Cost, Energy, ft2



Energy Efficiency Measures (EEMs) & Sustainability Measures for COF Readiness Bay

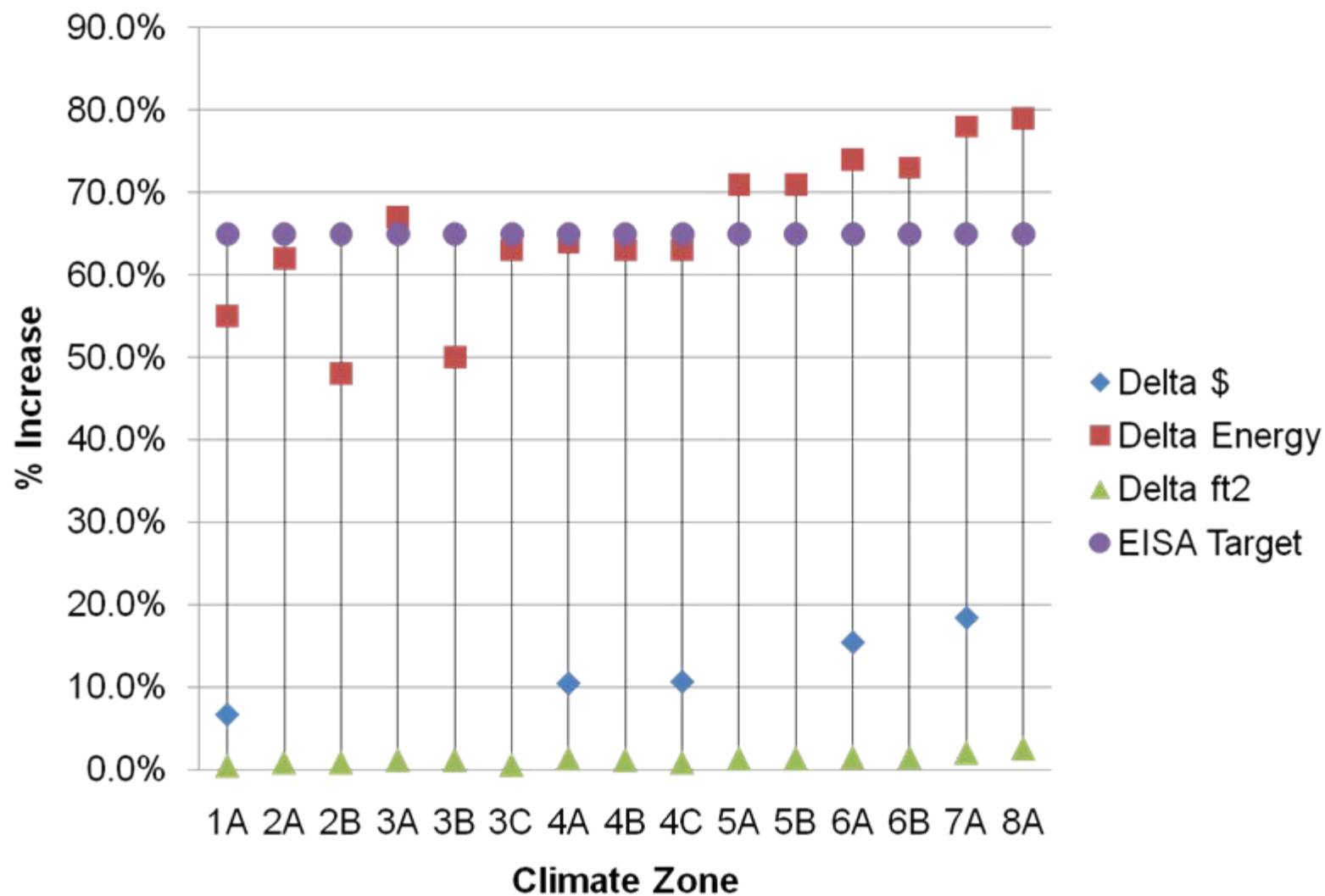
EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Advanced lighting systems with controls
- ▶ Cool roof in climate zones 1-5
- ▶ High efficiency HVAC - ERV and VAV in climate zones 1A, 2A, 3A, 3C, 4A-4B
- ▶ IDEC and VAV in climate zones 4C-8A
- ▶ High efficiency HVAC - DOAS, ERV and Fan Coils in climate zones 2B and 3C
- ▶ Demand control ventilation in all densely occupied spaces using CO2 sensors
- ▶ Transpired solar collectors in climate zones 2A-8A
- ▶ Reduce the volume (reduce height) of the readiness bays

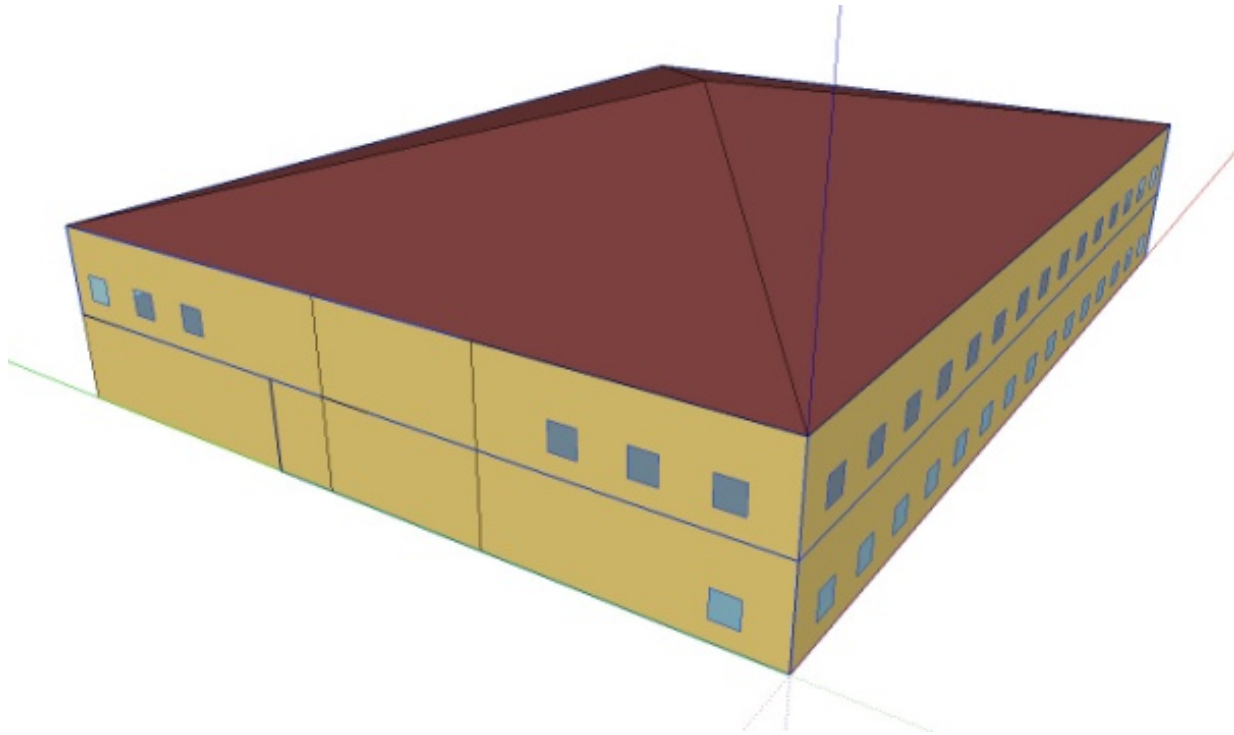
Sustainability Measures

- ▶ Increased Skylight to Floor Area (SFA) fraction to 3% over readiness bays, platoon offices, mezzanine corridor, and storage spaces
- ▶ Added daylighting controls with 500 lux setpoint
- ▶ Dual flush toilets
- ▶ Waterless urinals
- ▶ 0.5 GPM flow faucets
- ▶ Rainwater harvesting
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification

COF Readiness Bay Delta Cost, Energy, ft2



Bde HQ (Brigade Headquarters) Results



Energy Efficiency Measures (EEMs) & Sustainability Measures for Bde HQ

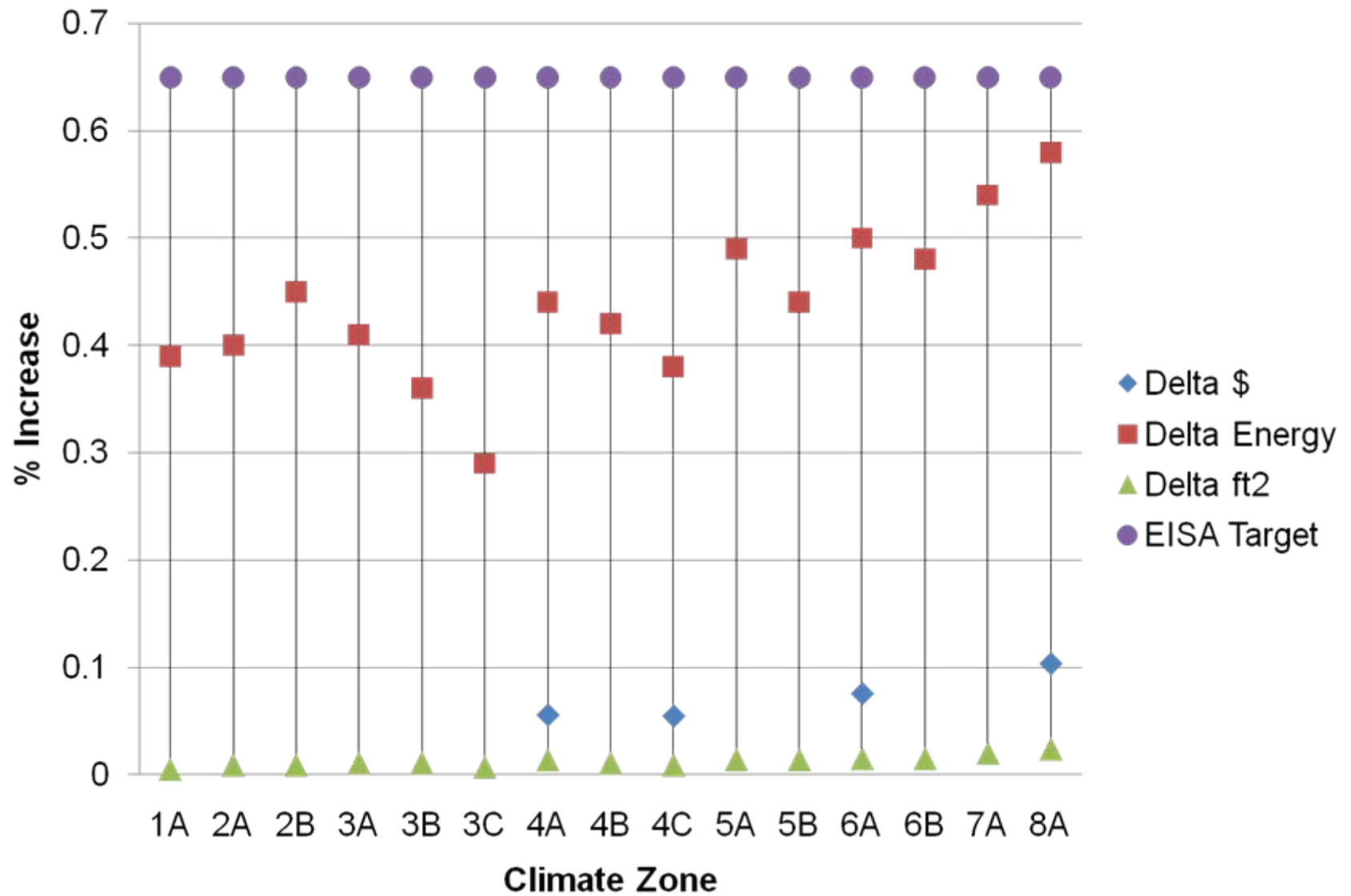
EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Entrance vestibule
- ▶ Advanced lighting systems with controls
- ▶ Cool roof in climate zones 1-5
- ▶ Window shading
- ▶ VAV with ventilation air
- ▶ Pressurization and make-up air system with high efficiency variable volume fan for systems
- ▶ High efficiency chillers with COP > 4
- ▶ High efficiency condensing boilers for heating and hot water >90%
- ▶ High to premium efficiency variable speed fans and pumps

Sustainability Measures

- ▶ Dual flush toilets
- ▶ 1.5 GPM flow shower heads, 0.5 GPM flow faucets
- ▶ Waterless urinals
- ▶ Rainwater harvesting
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification

Bde HQ Delta Cost, Energy, ft2



DFAC (Dining Facilities) Results



Energy Efficiency Measures (EEMs) & Sustainability Measures for DFAC

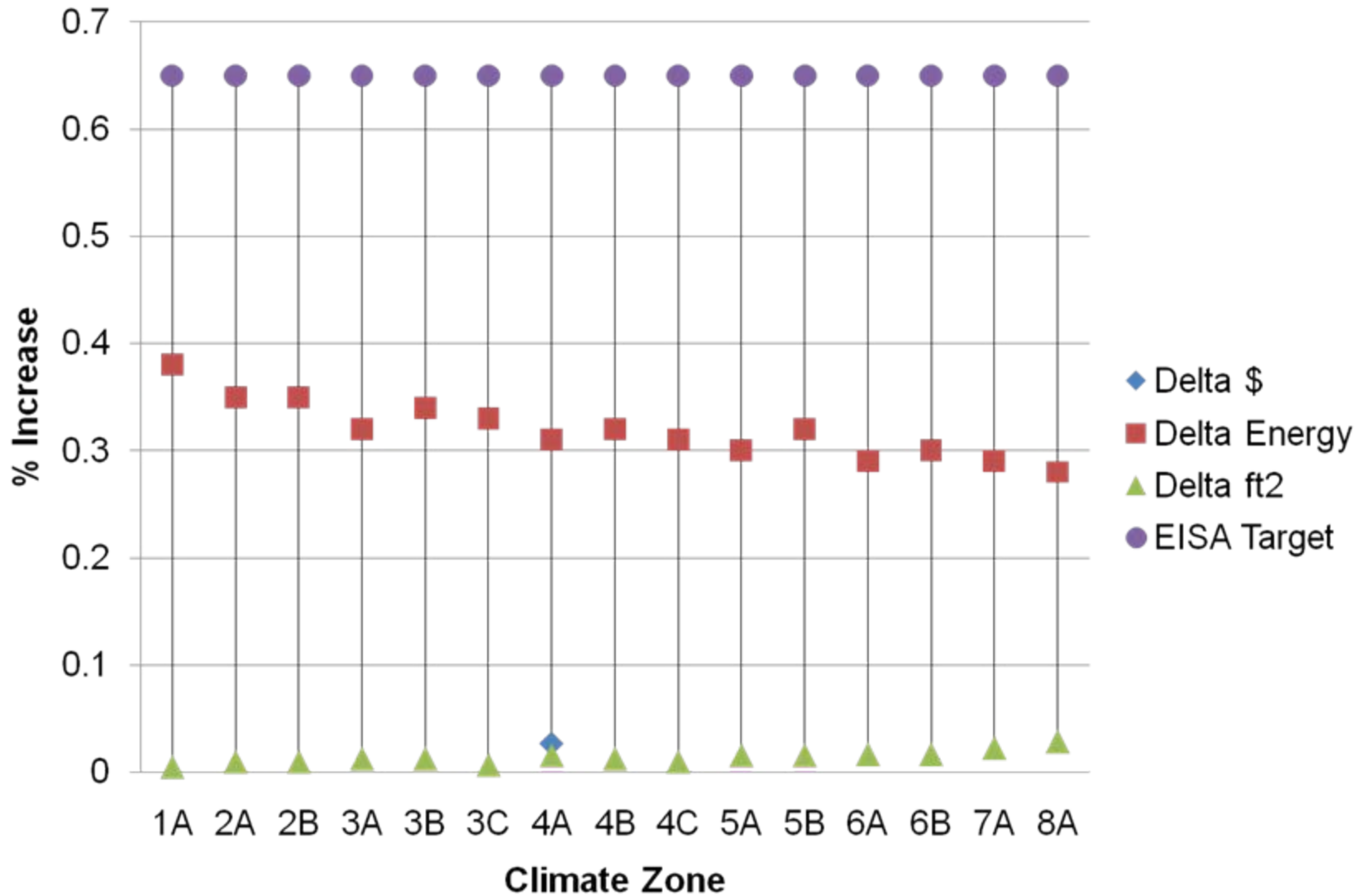
EEMs

- ▶ Increased insulation levels
- ▶ Advanced windows
- ▶ Increased air tightness
- ▶ Advanced lighting systems with controls
- ▶ Added high efficiency HVAC system
- ▶ Increased fan efficiencies
- ▶ Increased cooling coil efficiencies
- ▶ Reduced flow in exhaust hoods by adding side panels and adding side panels with demand controls
- ▶ Increased efficiency of refrigeration units including lighting power density
- ▶ Kitchen equipment replaced with all-electric equipment plus reductions in HVAC equipment

Sustainability Measures

- ▶ Increased Skylight to Floor Area (SFA) fraction to 3% over office, dining and server areas
- ▶ Cool roof in climate zones 1-5
- ▶ Added daylighting controls with 500 lux setpoint
- ▶ Dual flush toilets
- ▶ 1.5 GPM flow shower heads, 0.5 GPM flow faucets
- ▶ Waterless urinals
- ▶ Rainwater harvesting
- ▶ Enhanced Commissioning
- ▶ Measurement & Verification

DFAC Delta Cost, Energy, ft2



Summary Totals

	PA	Revised PA	SF	Revised SF	# of Blds
FY13 MILCON	728,178,000	797,603,000	2,823,501	2,870,376	64
FY13 MILCON Army Reserve	424,282,000	454,364,000	1,314,787	1,329,484	37
Totals	1,152,460,000	1,251,967,000	4,138,288	4,199,860	101
	$\Delta = 8.6\%$ \$ 99,507,000		$\Delta = 1.5\%$ 61,572		

LEED Volume Program

- ▶ Volume certification will streamline the documentation and certification process thereby:
 - Recognizing standardized and consistently delivered performance throughout a portfolio of buildings.
 - Helping the Army achieve % of LEED Certified buildings within an integrated, cohesive process
- ▶ Results in cost savings, risk reductions, and increases numbers of certified buildings within a specified time frame
- ▶ Submittal documentation: Credit templates, quality control and education plans

TechNotes

#	Name
1	1_Daylight_Dimming_Photosensor.doc
2	2_Daylight_Light_Shelf.doc
3	3_Daylight_Light_tubes.doc
4	4_Daylight_Sunlight_tracking.doc
5	5_Water_Dual_Flush_Toilets.doc
6	6_Water_High_Efficiency_Toilets.doc
7	7_Water_Low-Flow_Showerheads.doc
8	8_Water_Ultra_Low_Flow_Faucets.doc
10	10_Enhanced_Cx.doc

#	Name
11	11_Permeable_Pavement.doc
12	12_Desiccant_HVAC.doc
13	13_Solar_Hot_Water.doc
14	14_Overhead_Radiant_Heating .doc
15	15_Radiant_Floor_Heating-Commercial.doc
16	16_Radiant_Floor_Heating&Cooling-Residential.doc
17	17_Heat_Island_Roof.doc
18	18_Ground_Source_Heat_Pumps .doc
19	19_LED_Parking_Lot.doc
20	20_Light_Pollution_Reduction.doc

Website Link: <https://eportal.usace.army.mil/sites/COS/HQ/default.aspx>

TechNotes were funded by ESTCP as a Technology Transfer of the Fort Bragg Fire Station/Emergency Services integrated, whole building design strategy

Mapping to LEED

Mapping Mandates/Policies/Standards (MPS) to LEED®

- Required
- ◐ Less Stringent Requirements/Building or Site Specific
- Related/Best Practices Guidance

[Click on Credit Name for LEED® NC 2009 Rating System](#)

Enter Page Number by Page Up/Down Arrows to See Credit Language

Sustainable Sites		Pts															
Prereq 1	Construction Activity Pollution Prevention, p. 1																
Credit 1	Site Selection, p. 2	1															
Credit 2	Development Density and Community Connectivity, p. 3	5															
Credit 3	Brownfield Redevelopment, p. 5	1															
Credit 4.1	Alternative Transportation—Public Transportation Access, p. 6	6															
Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms, p. 7	1															
Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles, p. 8	3															
Credit 4.4	Alternative Transportation—Parking Capacity, p. 10	2															
Credit 5.1	Site Development—Protect or Restore Habitat, p. 12	1															
Credit 5.2	Site Development—Maximize Open Space, p. 13	1															
Credit 6.1	Stormwater Design—Quantity Control, p. 14	1															
Credit 6.2	Stormwater Design—Quality Control, p. 15	1															
Credit 7.1	Heat Island Effect—Non-roof, p. 16	1															
Credit 7.2	Heat Island Effect—Roof, p. 17	1															
Credit 8	Light Pollution Reduction, p. 19	1															
Possible Points: 26		Subtotals: Required Only															
Water Efficiency																	
Prereq 1	Water Use Reduction—20% Reduction, p. 21																
Credit 1	Water Efficient Landscaping, p. 23	2 to 4															
	Reduce by 50%	2															
	No Potable Water Use or Irrigation	4															
Credit 2	Innovative Wastewater Technologies, p. 25	2															

* This last column only is based on a study by ERDC/CERL to determine which LEED credits were being achieved in past projects by the 5 building types.

1-2 building types achieved =

3-4 building types achieved =

5 building types achieved =

► Where we are today

- Building energy modeling and cost estimates complete
- Basic energy package developed plus multiple options added for each building type to find optimal energy configuration.
 - Cost estimates developed for basic energy package plus selected energy options in climate zones where MILCON FY13 projects located

► What we are learning

- With a few modifications to our current designs (tighter building envelope) we are near or at the break-even point where we stop saving money over the life of the building and each successive increment of energy savings cost more and more.
- We may not get to 65 percent energy savings in all building types in all climatic regions . May need to look at the process loads (building function) or introduce a renewable source.
- <10 percent project cost increase is likely with pay back approaching the full life of the facility in some cases.

► Design Challenges

- Wall and roof design with increased continuous insulation and no thermal bridges - **New construction practice for the US – education effort, increased gross SF**
- Increased air tightness (from 0.25 cfm/SF to 0.15 cfm/SF at 75 Pa) – **Recommend policy change to current Army practice**
- Advanced appliances: No plasma TVs, EnergyStar+ LCD TVs, microwave ovens refrigerators, washers; best in class dryers, only Compact Fluorescent Lamps for plug-in lamps – may contribute to more than 20% of energy use reduction – **Recommend changes in policy (ACSIM) Incentives to require highest energy efficiency appliances from top three manufacturers**
- Master Planning: Central Plants with co-generation: **Recommend changes in policies and advanced planning**
- Will need to utilize renewables to get 65% reduction in fossil fuel use as required by EISA2007 – **Recommend change to Army practice – may be enterprise/regional or community links**

Contact Info:

Alice Soulek

alice.soulek@pnl.gov

Cell: 509-554-7103



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