Greenhouse Gas Benefits of Building Re-use vs. New Construction

A Presentation before the Federal Facilities Council

National Academy of Sciences

January 29, 2013

Facilities Context

- The Department of Defense owns 345,000 buildings
- 105,000 of them are over fifty years old
- 42 % of US carbon emissions come from existing buildings (DOE)

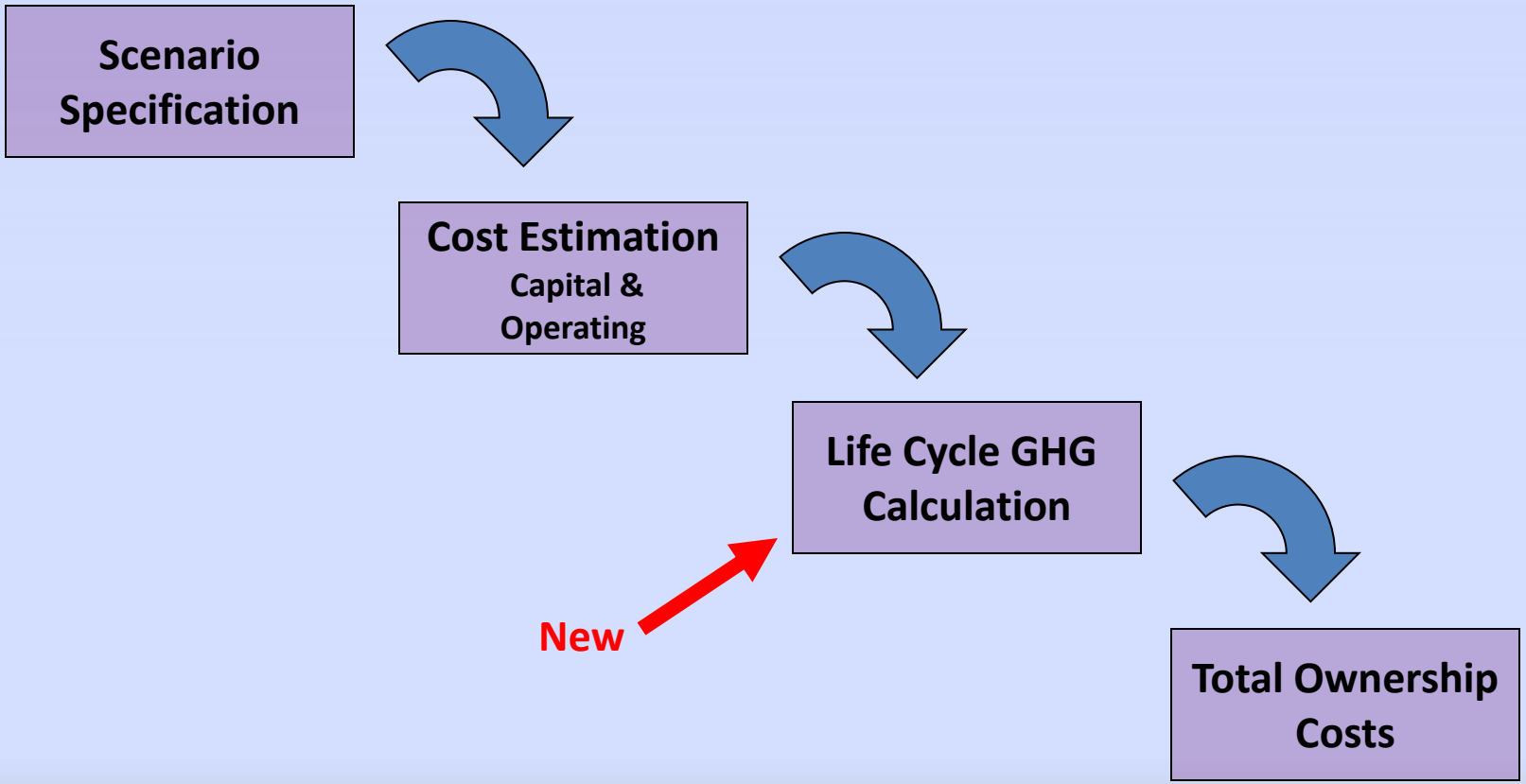
Legal and Policy Framework

- National Historic Preservation Act of 1966 (Amended)
- Energy Policy Act of 2005
- Energy Independence and Security Act of 2007
- Executive Order 13423: Federal Environment, Energy, and Transportation Management (2007)
- Executive Order 13514: Federal Leadership in Environment, Energy, Economic Performance (2009)

What the Study Looked at

1. Modernization costs of Pre-War Buildings compared to new construction
2. Life cycle energy costs achieved through modernization at a LEED Silver level compared to new construction.
3. Scope 3 GHG savings associated with the reuse of Pre-War Buildings
4. Impact on project NPV of monetizing GHG emissions in TOC analysis
5. Project cost and GHG differences by varying historic preservation and AT/FP standards
6. Challenges associated with replicating our approach

A New Step for TOC Analysis



PROJECT TEAM MEMBERS

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Installations

- Fort Bliss, El Paso TX
- St. Juliens Creek Annex, Norfolk Naval Shipyard, Chesapeake VA
- F.E. Warren AFB, Cheyenne WY

BUILDING SELECTION CRITERIA

- ✓ Non-residential
- ✓ “Typed” historic/non-historic DoD buildings
- ✓ Pre- World War II
- ✓ Masonry
- ✓ Cohesive technology (avoid buildings with additions)
- ✓ Climate variability

Original Design Intelligence

Built-in green design characteristics which contribute to an ability to naturally conserve energy

- ✓ **Durable materials**
- ✓ **Natural lighting and ventilation**
- ✓ **Heat wells**
- ✓ **Open floor plans**
- ✓ **Site orientation**
- ✓ **Basements**
- ✓ **Tall ceilings**
- ✓ **Plaster walls**

FORT BLISS
BUILDINGS 1 AND 115

Building 115
1911- Barracks

Building 1
1906 Hospital

ST. JULIENS CREEK ANNEX
Buildings 61 and 168

Building 61
1917 - Warehouse

Building 168
1941 - Warehouse

F.E.WARREN AIR FORCE BASE (NHL)
BUILDINGS 222 AND 323

Building 222
1906-1909 Barracks

Building 323
1906-1909 Stables

DoD Building Treatment Terms

- "Adaptive reuse & rehabilitation" are terms of art outside DoD
- The DoD term for "major rehabilitation" is "modernization"
- Modernization means: *"the alteration or replacement of facilities solely to implement new or higher standards to accommodate new functions or to replace a building component that typically lasts more than 50 years."*
- This study compares the costs and GHG of modernization with new construction

Building Scenarios

Sustainment/Status Quo

- Formulated for measuring baseline energy consumption

Demolition and New Construction

- LEED Silver certifiable construction – 2009 LEED for New Construction and Major Renovations

Full Modernization with Strict Application of Historic Preservation Standards (HPS)

- Full modernization with a strict application of Historic Preservation Standards (HPS) and other DoD facility design standards
- LEED Silver

Full Modernization with Strict Application of AT/FP

- Full rehabilitation/modernization but with strict application of Anti-terrorism/ Force Protection requirements through building hardening, seismic and other DoD facility design standards
- LEED Silver

Applicable design standards include:

- ✓ Whole Building Design
- ✓ UFC 1-200-01 General Building Requirements
- ✓ UFC 4-610-01 Administrative Facilities
- ✓ UFC 1-900-01 Selection of Methods for the Reduction, Reuse and Recycling of Demolition Waste
- ✓ UFC 3-310-04 Seismic Design for Buildings
- ✓ DoD Minimum Antiterrorism Force Protection Standards for Buildings
- ✓ Secretary of Interior's Standards for Rehabilitation of Historic Buildings

GHG Calculators

Scope 1: Direct energy use on site

- World Resources Institute, GHG Protocol

Scope 2: Purchased energy not controlled onsite

- EPA eGRID

Scope 3: New building materials

- Athena Institute, EcoCalculator
- Economic Input-Output Life Cycle Assessment Model (EIO-LCA)

Scope 3: Transportation for demolition and waste disposal

- World Resources Institute, GHG Protocol

GHG SCOPE CALCULATOR

CO2 analysis for FEW 222-02: Demo and New Construction

FOUNDATIONS AND FOOTINGS						121,059
Foundation Wall	Cast-in-place concrete (R-7.5 XPS Continuous insulation)	-	Sq ft	8.92	Athena	-
	Cast-in-place concrete (R-7.5 EPS Continuous insulation)	5,130	Sq ft	8.73	Athena	**44,785**
	Concrete block (R-7.5 XPS Continuous insulation)	-	Sq ft	15.33	Athena	-
	Concrete block (R-7.5 EPS Continuous insulation)	-	Sq ft	15.14	Athena	-
Foundation Slab	4" Poured Concrete Slab	10,530	Sq ft	4.06	Athena	**42,752**
Footing	Poured Concrete Footing	99	Volume (yd3)	338.61	Athena	**33,522**
Concrete Repairs						
	Epoxy/adhesives for concrete repairs	-	$	1.18	EIO-LCA	-
	Concrete leveling	-	$	1.190	EIO-LCA	-

- Athena EcoCalculator is primary source, supplemented by EIO-LCA
- Need for standardizing cost estimate categories with carbon calculators
- Athena updating its calculator in response to this study

Findings: Cost Effectiveness

- ✓ Pre-War Buildings can be cost effective compared to new construction on a TOC basis (w/ and w/o factoring GHG)
- ✓ **Example:** Building 115 at Fort Bliss:

Installation/Building/Project Alternative	Life Cycle Cost: Net Present Value with GHG (a)		Life Cycle Cost: % Difference from New Construction	
Fort Bliss				
Building 115				
FTBL 115-02: Demolition and New Construction	$	4,956,278	NA	
FTBL 115-03: Modernization with HPS	$	3,791,391	-23.5%	(b)
FTBL 115-04: Modernization with Full AT/FP	$	4,009,546	-19.1%	(b)

Notes:
(a) Incorporates CO2e monetary value on a per MT basis.
(b) Achieved 15% NPV Cost Reduction Target =

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

Findings: Energy Performance

- ✓ Modernization of Pre-War Buildings can achieve comparable levels of energy consumption as new construction at LEED Silver level
- ✓ "Original design intelligence" features contribute to existing building performance
- ✓ **Example:** Building 222 at F.E. Warren:

	MT CO2e Emissions (a)			
Installation/Building/Project Alternative (b)	**Scope 1**	**% Difference from New Construction**	**Scope 2**	**% Difference from New Construction**
F.E. Warren				
Building 222				
FEW 222-02: Demolition and New Construction	5.0	NA	6,121	NA
FEW 222-03: Modernization with HPS	3.2	-36.9%	6,063	-0.9%
FEW 222-04: Modernization with AT/FP	5.6	11.2%	6,072	-0.8%

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

Findings: Total GHG Impacts

- ✓ On a life-cycle GHG basis, Pre-War Buildings generate less total GHG compared to new construction
- ✓ GHG savings from initial construction (Scope 3) is the driver of this result
- ✓ **Example:** Building 222 at F.E. Warren:

	MT CO2e Emissions (a)			
Installation/Building/Project Alternative (b)	**Scope 3**	**% Difference from New Construction**	**TOTAL**	**% Difference from New Construction**
F.E. Warren				
Building 222				
FEW 222-02: Demolition and New Construction	2,320	NA	8,445	NA
FEW 222-03: Modernization with HPS	1,070	-53.9%	7,136	-15.5%
FEW 222-04: Modernization with AT/FP	1,446	-37.7%	7,524	-10.9%

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

Findings: Monetized GHG Impacts

- ✓ Adding monetized GHG impacts reflects true "economic cost" of construction but does not have a significant impact on TOC results
- ✓ Putting a monetary value of GHG emissions raises construction costs by 1.7% to 3%
- ✓ **Example:** Building 1 at Fort Bliss:

Table X: Performance Objective #3: Reduction in NPV Cost Attributable to GHG Savings

Installation/Building/Project Alternative	NPV Life Cycle Costs with Monetized GHG (a)	Contribution of GHG to NPV Life Cycle Cost Reduction		
		NPV of Life Cycle CO2e	$ Difference from New Construction	GHG Difference as % of Total New Construction NPV
Fort Bliss				
Building 1				
FTBL 001-02: Demolition and New Construction	$ 9,592,548	$ 277,641	NA	NA
FTBL 001-03: Modernization with HPS	$ 8,282,166	$ 243,725	$ (33,916)	-0.354%
FTBL 001-04: Modernization with AT/FP	$ 8,777,667	$ 254,887	$ (22,754)	-0.237%

Notes:
(a) Incorporates CO2e monetary value on a per MT basis.

Sources: Seraph LCC; BAE Urban Economics, Inc., 2012.

Findings: Replication of Demonstration

- ✓ No off-the shelf carbon calculator that integrates Scope 1, 2, & 3 emissions
- ✓ Existing calculators oriented to new construction, not historic rehabilitation or modernization
- ✓ Need easy cross-walk between cost estimation systems and carbon calculators
- ✓ Conclusion: not ready for “prime time”

Findings

- ✓ *DoD's Pre-War masonry buildings are an underutilized resource for meeting DoD GHG carbon reduction goals*
- ✓ ATFP and Progressive Collapse requirements tend to be rigidly and prescriptively applied, raising construction costs and introducing additional Scope 3 GHG emissions
- ✓ Prior modernization treatments result in loss of original energy saving design features in Pre-War Buildings
- ✓ Differences in GHG in alternatives resulted from the amount of new building materials introduced and transportation of demolition debris

More Findings

- ✓ Cost estimates and construction bid requests should include materials quantities in addition to costs to evaluate and validate GHG impacts.
- ✓ Design professionals with practical experience with archaic building materials and systems are critical to the development of accurate planning level specifications
- ✓ GHG emission tradeoffs of proposed new materials and building options should be evaluated early in the conceptual design process

Recommendations

- ✓ Incorporate life-cycle GHG emissions analysis into DoD MILCON and SRM programs
- ✓ More emphasis on existing buildings as viable project alternative to meet mission requirements
- ✓ More Emphasis on Existing Buildings as Viable Project Alternative 3 GHG emissions
- ✓ Observation of prior modernization treatments that result in loss of original energy saving design features in Pre-War Buildings
- ✓ Conclusion: not ready for “prime time”

Recommendations

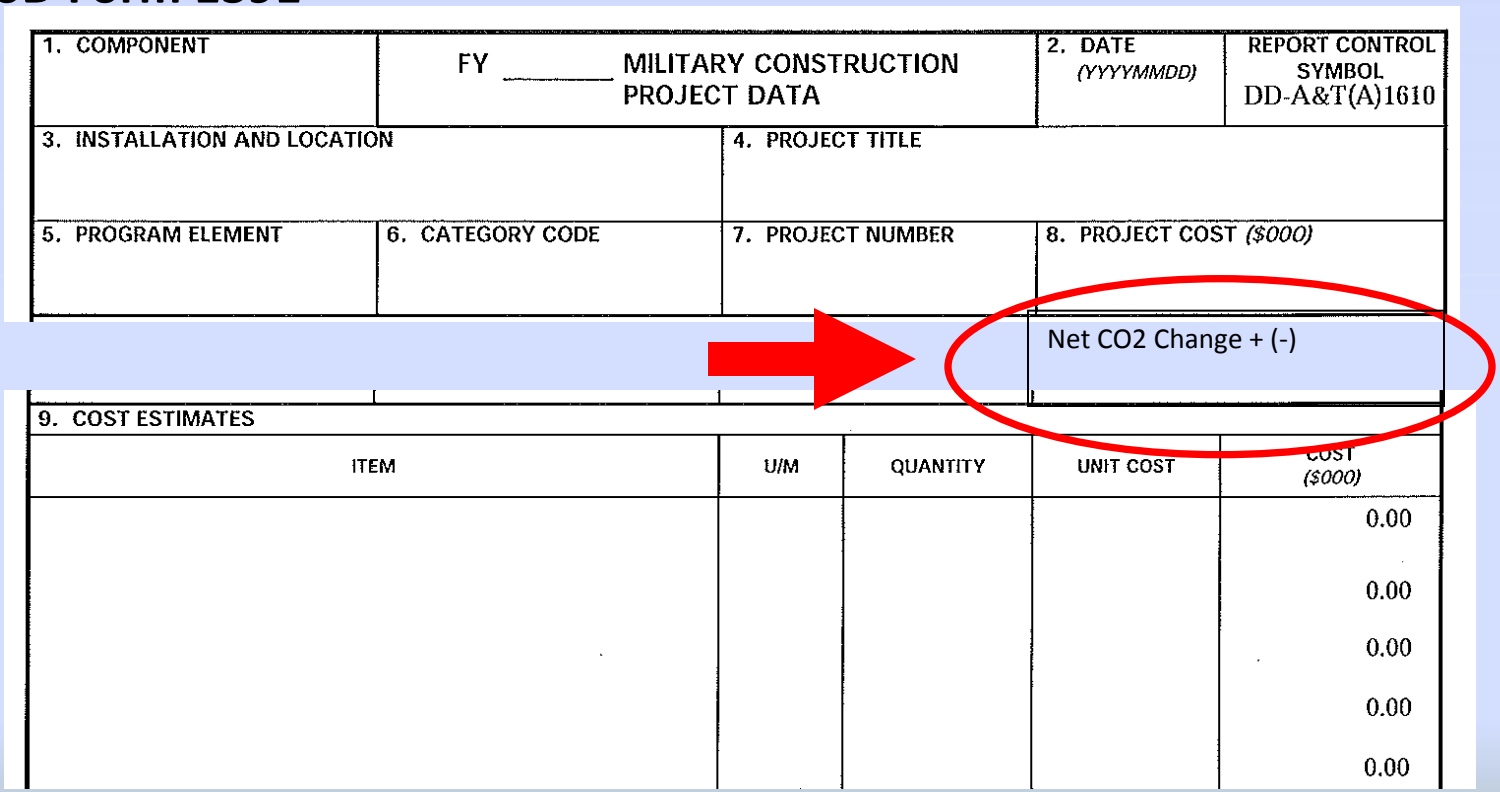
- ✓ Incorporate life-cycle GHG emissions analysis into DoD MILCON and SRM programs
- ✓ Invest in formulation of carbon calculator system
- ✓ Place more emphasis on existing buildings as viable project alternatives to meet mission requirements
- ✓ Identify characteristic strengths and vulnerabilities by class of building
- ✓ **Place more emphasis on existing buildings to meet DoD energy reduction goals**
- ✓ Avoid modernization treatments that result in loss of original energy saving design features in Pre-War Buildings

Next Steps

- Formulate an installation master planning tool that provides risk-adjusted cost benefit analysis of alternative ATFP compliance treatments addressing site wide vs. building specific ATFP compliance issues
- Determine if modernization of Cold War buildings would produce different results
- Integrate Co2e metric into MILCON project TOC life-cycle analysis on 1391s

Adding GHG as a Factor in MILCON Decision-making

DoD Form 1391



1. COMPONENT	FY _____ MILITARY CONSTRUCTION PROJECT DATA	2. DATE *(YYYYMMDD)*	REPORT CONTROL SYMBOL DD-A&T(A)1610
3. INSTALLATION AND LOCATION		4. PROJECT TITLE	
5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST *($000)*
			Net CO2 Change + (-)

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST *($000)*
				0.00
				0.00
				0.00
				0.00
				0.00

- **A change in metrics to provide incentives**

QUESTIONS, PLEASE!

MORE INFORMATION?

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Report Website: http://serdp-estcp.org/Program-Areas/Energy-and-Water/(list)/1/(active)/no

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