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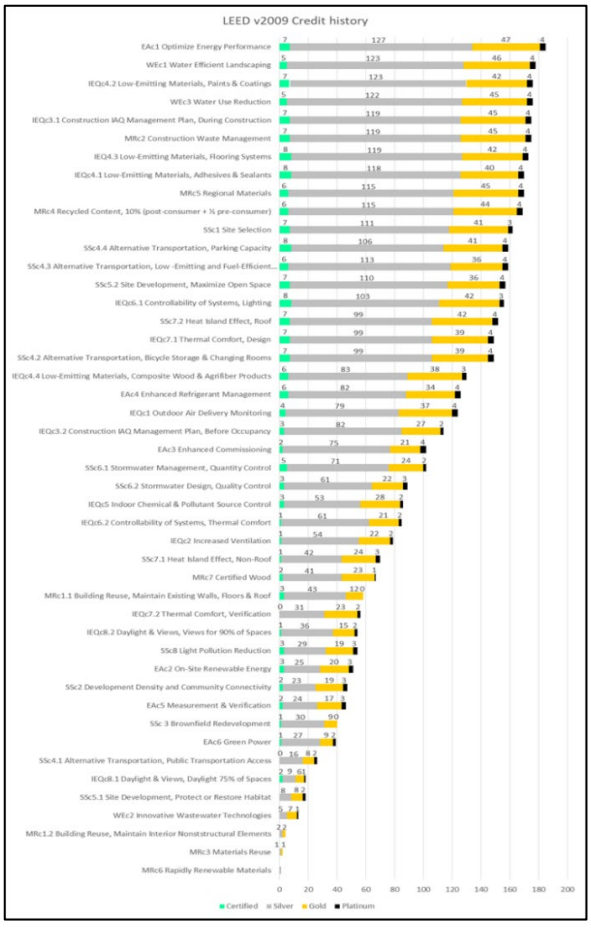
Assessment of LEED 2.2 and LEED 2009 Implementation in Meeting Army SDD Policy Goals

Lucas D. Spiewak, Annette L. Stumpf, and
Heather R. FitzHenry

March 2023



Construction Engineering Research Laboratory

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Abstract

This report describes our analysis of how Army Leadership in Energy and Environmental Design (LEED®) certification data demonstrates success in meeting Army sustainable design and development (SDD) policy goals.

Specifically, the research team evaluated how LEED 2.2 and v2009 credits related to Army SDD policy objectives, then identified trends over time in Army LEED 2.2 and v2009-rated Projects. This is a historical assessment of actual project data, captured before the Army transitioned to the newer LEED v4.

This report explains how implementation of LEED NC 2.2 and v2009 credits helped Army projects achieve SDD policy objectives. Emphasis was placed on LEED credits that directly related to SDD policy requirements which Army construction and major renovation projects needed to meet.

Figures throughout the report illustrate how many Army LEED certified projects earned LEED New Construction credits 2.2 from FY2009 to FY2016 and LEED v2009 credits from FY2011 to FY2016. Some figures also rank the LEED 2.2 and LEED v2009 credits from most popular to least popular.

Implementation of the Army's 2013 SDD policy requiring LEED certification has allowed analysis of how Army military construction (MILCON) projects achieved energy, water, and waste goals on a large scale.

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Preface

This study was conducted for the Energy and Facilities Engineering Division (DAIN-ODF), Operations Directorate, Office of the Deputy Chief of Staff (DCS), G-9 Installations, under Military Interdepartmental Purchase Request (MIPR) 11268079, "FY2018 Technical Assessment and Implementation Support for the US Army Sustainable Design and Development Policy." The technical monitor was Ms. Brandy Reed, Headquarters, Department of the Army.

The work was performed by the Installation Readiness Branch of the Infrastructure, Science, and Engineering Division, US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Mr. Chuck Schroeder was branch chief; Mr. Tim Shelton was division chief; and Dr. Justin Berman, was the technical director for Infrastructure, Science, and Engineering. The deputy director of ERDC-CERL was Ms. Michelle Hanson, and the director was Dr. Andrew Nelson.

COL Christian Patterson was commander of ERDC, and Dr. David W. Pittman was the director.

1 Introduction

1.1 Background

The built environment has a significant impact on natural resources. There are more than 128 million residential housing units and 4.9 million office buildings existing in the US as of 2009 (EPA 2009).

Buildings account for about 40% of total US Energy Consumption, and 40% of carbon dioxide emissions (EESI, n.d.).

Building construction generates an estimated 2–2.5 lb* of solid waste per square foot. The proportion of landfill area used for the purposes of building construction and demolition waste is 35%.

Sustainable Design and Development (SDD) aims to minimize waste, non-renewable energy use, and pollution associated with building construction and operation, and increase occupant wellbeing concurrently. In April 2000, the Deputy Assistant Secretary of the Army (Installations, Housing, & Partnerships) established the Army's policy of incorporating SDD principles into installation planning and infrastructure projects, which included developing technical guidance to implement the Army's SDD policy.

Army SDD policy update issued 27 October 2010, and again on 16 December 2013 (ASA [IE&E] 2013) required all Army new construction and major renovation military construction (MILCON) projects to be certified using US Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED®) rating tool, at the *Silver* level. The Army SDD policy also requires projects to meet the requirements of Unified Facilities Criteria (UFC) 2-100-01 and UFC 3-210-10 (DoD 2022a, 2020).

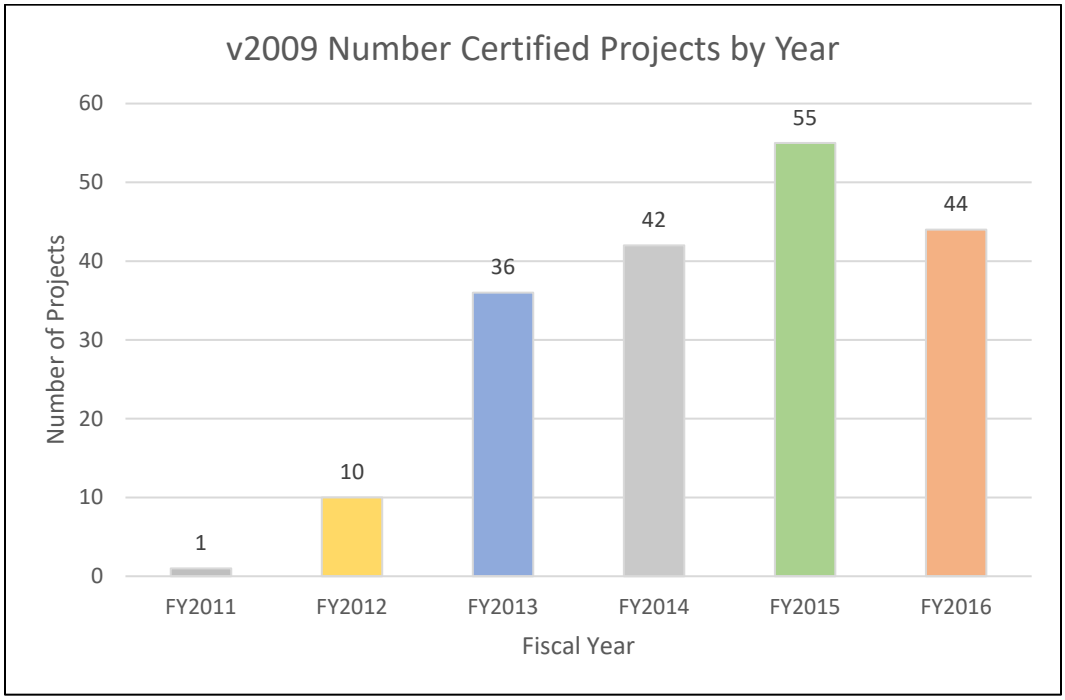
* For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf .

The findings in this report cover the time period before the more recent Sustainable Design and Development policy issued in January 2017 which governs current projects.*

The coherence of the LEED rating system implementation has allowed the collection and use of a wide variety of data on Army new construction and major renovation projects. The LEED third-party rating system is a nationally accepted benchmark which allows us compare modeled project performance with other Army or private sector buildings.

Between 2008 and 2016, LEED certified buildings amounted to nearly 56 million ft², with 594 certified projects. Projects were certified under two rating systems in this period, LEED 2.2 (USGBC 2005) and its successor, LEED v2009 (USGBC 2016). Figure 1 depicts the number of Army LEED v2009 projects that were certified each year between FY2011 and FY2016.

Figure 1. Number of Army LEED v2009 projects certified by year.

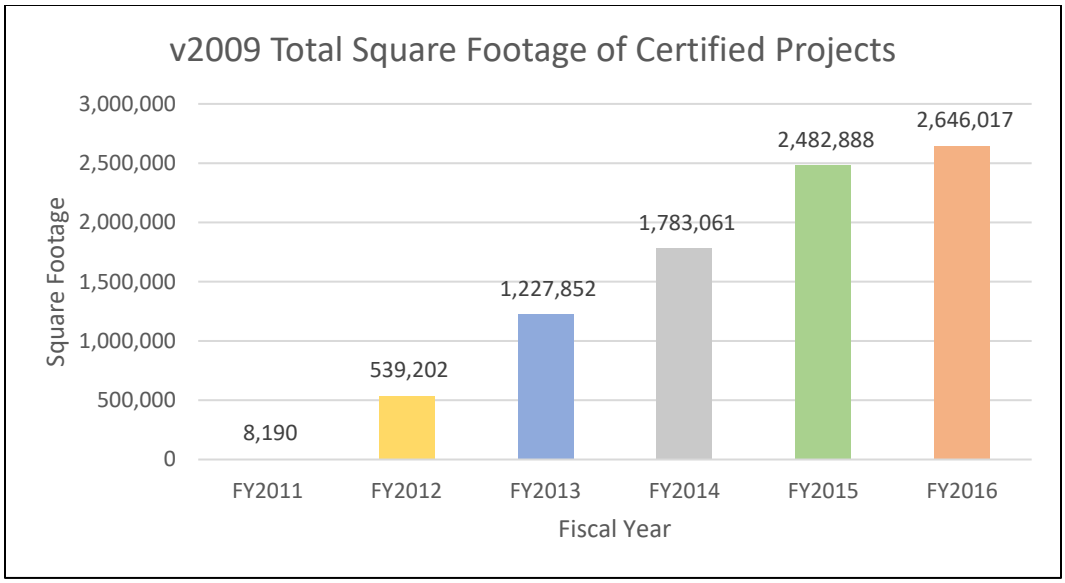


The number of Army LEED v2009 projects certified each fiscal year increased from FY2011 to FY2015 and decreased in FY2016. There were 188 LEED v2009 projects certified in total between FY2009 and FY2016.

* The more recent policy can be found at https://www.wbdg.org/ffc/army-coe/policies-and-guidance-army-design-and-construction/army-sdd-policy-update.

Figure 2 shows the total square footage of LEED v2009 projects certified each year between FY2011 and FY2016.

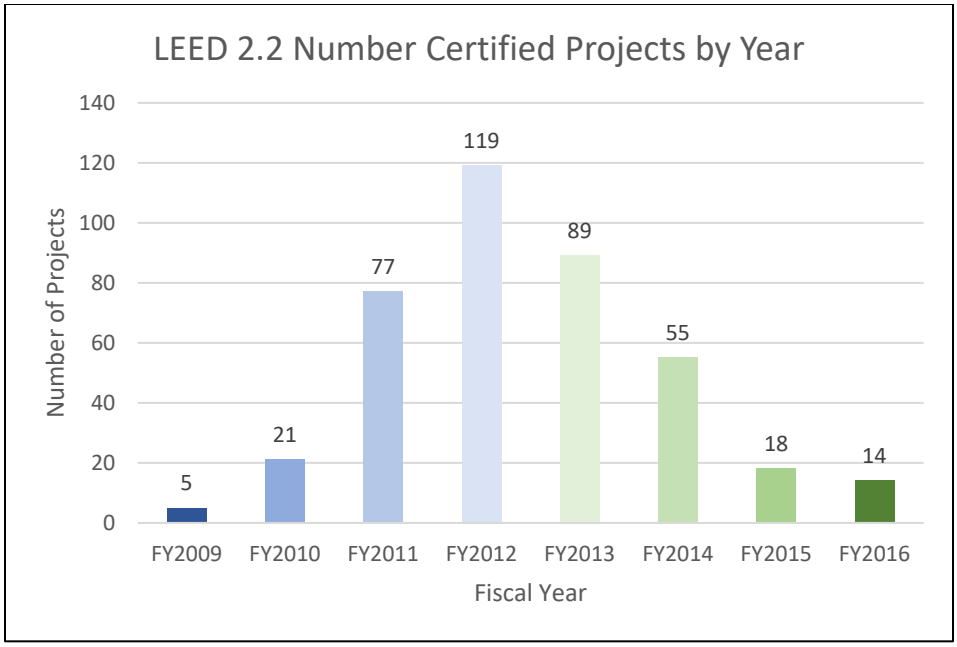
Figure 2. Square footage of LEED v2009 projects by year.



Amount of square footage certified in each fiscal year increased from FY11 to FY16. Although fewer projects were certified in FY16 than in FY15, those projects' total square footage was larger than the total square footage registered in FY2015.

Figure 3 shows the number of LEED 2.2 Army projects that were certified each year between FY2009 and FY2016.

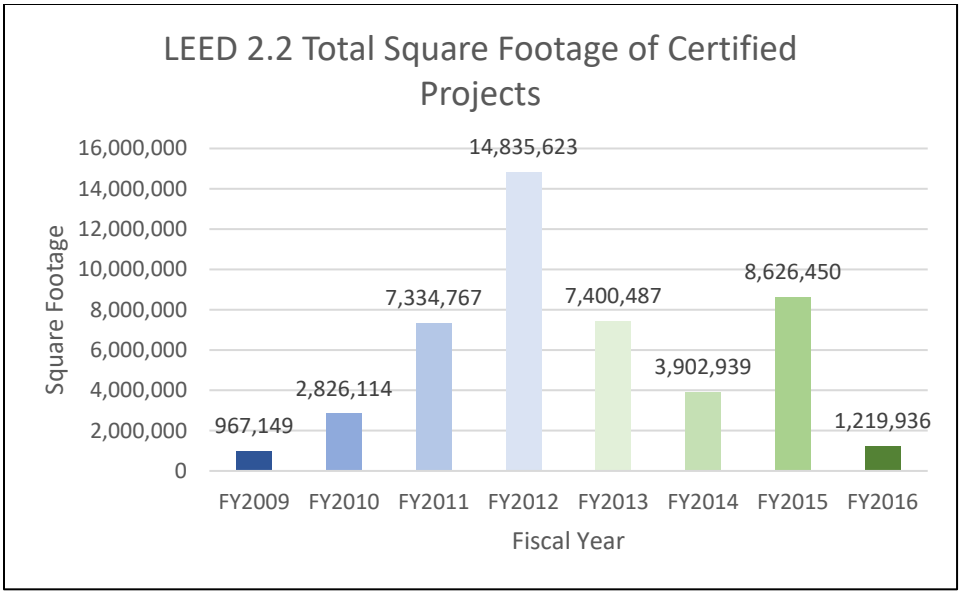
Figure 3. Number LEED 2.2 projects certified by year.



The number of LEED 2.2 Army projects certified each fiscal year increased from five projects in FY09 to 119 in FY12, and then decreased to 14 projects FY16. 398 LEED 2.2 projects were certified in total between FY2009 and FY2016.

Figure 4 shows the amount of square footage certified under LEED 2.2 from FY2009-FY2016. Although fewer projects were certified in FY15 than in FY14, those projects' total square footage was larger than the total square footage registered in FY2014.

Figure 4. Square footage of LEED 2.2 projects by year.



1.2 Objectives

The objectives of this work were to (1) assess how LEED implementation demonstrated success in meeting policy goals set out in the SDD Policy Update 16 December 2013 and (2) to identify trends in LEED 2.2 and LEED v2009 rated Army construction projects from FY2008–FY2016.

1.3 Approach

To achieve these objectives, researchers did the following:

- Evaluating LEED 2.2 and v2009 rated projects on the basis of SDD policy objectives,
- Identifying trends over time in Army LEED 2.2 and v2009-rated projects

2 Siting and Site Development

2.1 Sustainable Design and Development (SDD) Policy Update's relevance to siting and site development

The 2013 update to the Army SDD Policy provides guidance on siting and site development supplementing UFC 1-200-02 (DoD 2022b). This policy gives preference to brownfields and emphasizes connectivity to existing utility and transportation infrastructure. In addition, new construction within flood hazard areas or other areas of climatic instability are prohibited, unless these site characteristics themselves are instrumental to the function of the project.

2.2 LEED support of Army SDD goals

2.2.1 Sustainable Sites (SS) Credit 1: Site Selection

The site selection credit, SSc1 (USGBC 2016), is aimed at reducing the environmental impact from building construction by imposing site requirements. These prohibit the following:

- Development of prime farmland
- Development less than 5 ft above the 100-year flood plain
- Development of land identified as a habitat for threatened or endangered species
- Development within 100 ft of wetlands
- New development within 50 ft of a water body which could support fish, recreation, or industry use
- Land that has been public parkland, unless compensated by a trade

These requirements support SDD Policy update guidance to minimize construction in areas of climatic instability.

2.2.1.1 LEED 2.2

From FY2008 to FY2016, 332 of 406, or 81.8%, of LEED 2.2 projects earned this credit.

2.2.1.2 LEED v2009

Implementation of this credit is unchanged from LEED 2.2.

From FY2008 to FY2016, 162 of 188, or 86%, of Army LEED v2009 projects achieved this credit.

2.2.2 SS Credit 2: Development Density and Community Connectivity

This credit, SSc2 (USGBC 2016), is intended to preserve land by encouraging development in urban areas. The requirements for this credit can be met by the following:

- Construction on previously developed site in a community with a minimum density of 60,000 ft^2/acre net
- Construction on previously developed site within 0.5 mi of residential zone with a density of 10 units per acre net and within 0.5 mi of ten basic services

This credit supports achievement of "optimal densities," as per the 2013 SDD Policy Update, Section 5.a.i.a (ASA [IE&E] 2013).

2.2.2.1 LEED 2.2

From FY2008 to FY2016, 89 of 406, or 21.9%, of Army LEED 2.2 projects earned this credit.

2.2.2.2 LEED v2009

Implementation of this credit is unchanged from LEED 2.2.

From FY2008 toFY2016, 47 of 188, or 25%, of Army LEED v2009 projects earned this credit.

2.2.3 SS Credit 3: Brownfield Redevelopment

This credit, SSc3 (USGBC 2016), is awarded for the rehabilitation of contaminated or damaged sites. It supports SDD Policy Update, Section 5.a.i (ASA [IE&E] 2013) preference for brownfields in the siting of new construction.

2.2.3.1 LEED 2.2

From FY2008 to FY2016, 49 of 406, or 12.1%, of Army LEED 2.2 projects earned this credit.

2.2.3.2 LEED v2009

Implementation of this credit is unchanged from LEED 2.2.

From FY2008 to FY2016, 40 of 188, or 21%, of Army LEED 2009 projects achieved this credit.

2.2.4 SS Credit 4: Alternative Transportation

Alternative transportation credit SSc4 (USGBC 2016) encompasses four credits which can be earned separately. These credits are the following:

1. SSc4.1 *Alternative Transportation—Public Transportation Access*
2. SSc4.2 *Alternative Transportation—Bicycle Storage and Changing Rooms*
3. SSc4.3 *Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles*
4. SSc4.4 *Alternative Transportation—Parking Capacity*

2.2.4.1 LEED 2.2

From FY2008 to FY2016, 75 of 406, or 18.5%, of Army LEED 2.2 projects earned this credit.

2.2.4.2 LEED v2009

Implementation of this credit remains unchanged from LEED 2.2.

Table 1 shows the number of Army LEED v2009 projects that earned credit SSc4 from FY2008 to FY2016, 26 of 188, or 14%, of projects earned this credit.

Table 1. Ratio of Army LEED projects that earned credit SSc4.

Standard Number	LEED 2.2	LEED v2009
4.1	75/406	25/188
4.2	321/406	140/188
4.3	338/406	146/188
4.4	301/406	144/188

2.2.5 SS Credit 4.1: Alternative Transportation—Public Transportation Access

This credit, SSc4.1 (USGBC 2016), is intended to reduce land development and pollution impacts resulting from automobile use. All alternative transportation credits share this intention. This credit is earned by locating the project within half of a mile of a commuter rail station or within a quarter mile of a campus or public bus stop.

2.2.6 SS Credit 4.2: Alternative Transportation—Bicycle Storage and Changing Rooms

This credit, SSc4.2 (USGBC 2016), is earned by providing secure bicycle racks or other storage for 5% of peak building users. Storage must be within 200 yd of a building entrance. In addition to bicycle storage, changing and shower facilities must be provided for 0.5% of Full-Time Equivalent (FTE) occupants.

For residential buildings, this credit is earned by providing covered storage facilities able to secure bicycles of 15% or more of building occupants. Changing and shower facilities are not required.

2.2.7 SS credit 4.3: Alternative Transportation—Low Emitting and Fuel-Efficient vehicles

This credit, SSc4.3 (USGBC 2016), can be earned in the following three ways:

1. By providing low-emitting and fuel-efficient vehicles for 3% of FTE occupants in addition to providing preferred parking for these vehicles.
2. By providing preferential parking for low-emitting and fuel-efficient vehicles amounting to 5% of the total site vehicle parking capacity.
3. Through the installation of alternate-fueling stations for 3% of site total vehicle parking capacity.

LEED defines low emitting and fuel-efficient vehicles as vehicles, which score a 40 or better on the American Council for an Energy Efficient Economy or are classified as Zero-Emission Vehicles by the California Air Resources Board (USGBC 2016).

2.2.8 SS credit 4.4: Alternative Transportation—Parking Capacity

This credit, SSc4.4 (USGBC 2016) can be earned in the following four ways:

1. Parking capacity must meet local zoning requirements and should provide preferred parking for carpools amounting to 5% of total provided parking spaces. This option is for nonresidential construction.
2. In projects that will provide parking for less than 5% of building Full-Time Equivalent, providing preferential parking carpools for 5% or total provided parking spaces is required. This option is for nonresidential construction.
3. Size of parking needs to be in accordance with minimum zoning requirements and provide support programs for shared vehicle usage. This might include dedicated carpool drop-off areas, dedicated parking for carpools, car share services, or shuttle services to transit. This option is for residential construction.
4. Providing no new parking.

Preferential parking refers to parking closest to the main entrance. Offering parking passes at discounted rates specifically to qualified occupants also qualifies as preferential parking.

3 Mitigation of Heat Island Effect

3.1 SDD Policy Update's relevance to heat island effect

SDD Policy Update, Section 5.a.i.b (ASA [IE&E] 2013) gives guidance on mitigation of heat island effect referencing UFC1-200-02 (DoD 2022b) and ASHRAE 189.1-2011, Section 5.3.2.3 (ASHRAE 2011).

3.2 LEED 2.2 alignment with SDD goals

3.2.1 SS Credit 7.1: Heat Island Effect—Non-Roof

3.2.1.1 LEED 2.2

This credit, SSc7.1 (USGBC 2005), is intended to reduce heat islands and thus limit their effect on microclimate and habitat, both human and wildlife. This credit is awarded for constructing 50% of site hardscape as either shaded, paved with materials with a solar reflectance index (SRI) greater than 29, or with open grid pavement system. Alternatively, projects with a minimum of 50% of parking spaces under cover also qualify, if the structure that covers the parking has an SRI of 29 or more.

From FY2008 to FY2016, 175 of 406, or 43.1%, of LEED 2.2 projects earned this credit.

3.2.1.2 LEED v2009

The implementation of this credit, SSc7.1, changed from LEED 2.2 to v2009 (USGBC 2016). The changes were minor, consisting of extra guidance on shading. Shade could be provided by existing tree canopies or trees installed at occupancy that could expect to provide shade within five years. Shade providing structures could also consist of solar panels or green roofs in addition to shading with an SRI of 29 or greater.

From FY2008 to FY2016, 69 of 188, or 36.7%, of Army LEED v2009 projects earned this credit.

3.2.2 SS Credit 7.2: Heat Island Effect—Roof

3.2.2.1 LEED 2.2

This credit, SSc7.2 (USGBC 2005) is intended to reduce heat islands in order to minimize impact in microclimate and human and wildlife habitat. This credit is awarded for meeting an SRI of 78 for low slope roofs or 29 for steep-sloped roofs over 75% of the roof's area. Alternatively, a green roof covering 50% of the roof area will satisfy the requirements of this credit.

From FY2008 to FY2016 321 of 406, or 78.1%, of LEED 2.2 projects earned this credit.

3.2.2.2 LEED v2009

The implementation of this credit changed from LEED 2.2 to v2009 (USGBC 2016). An option for compliance with multiple roof materials was added.

From FY2008 to FY2016 152 of 188, or 80.9%, of LEED v2009 projects earned this credit.

4 Reduction of Light Pollution

4.1 SDD Policy Update's relevance to reduction of light pollution

SDD Policy Update, Section 5.a.i.c (ASA [IE&E] 2013) gives guidance on mitigation of reduction of light pollution referencing ASHRAE 90.1-2010 Section 9 (ASHRAE 2010) and ASHRAE 189.1-2011 Section 5.3.3 (ASHRAE 2011). Exceptions are allowable if there is conflict with Army security policy.

4.2 LEED alignment with SDD goals

4.2.1 SS Credit 8: Light Pollution Reduction

This credit, SSc8 (USGBC 2016), is intended to reduce light pollution emission from buildings and sites in order to increase night sky access, improve nighttime visibility, and minimize impact on nocturnal environments.

4.2.1.1 LEED 2.2

From FY2008 to FY2016 128 of 406, or 31.5%, of LEED 2.2 projects earned this credit.

4.2.1.2 LEED v2009

From FY2008 to FY2016 54 of 188, or 28.76% of LEED v2009 projects earned this credit.

5 Storm Water Management

5.1 SDD Policy Update's relevance to storm water management

SDD Policy Update, Section 5.a.i.d (ASA [IE&E] 2013) specifies guidelines for storm water management. It references the Energy Independence and Security Act (EISA) of 2007 Section 438, and UFC 3-210-10 (DoD 2020). Projects of 5,000 ft^2 and greater must comply with these standards and maintain predevelopment hydrology.

5.2 LEED 2.2 alignment with SDD goals

5.2.1 SS Prerequisite 1: Construction Activity Pollution Prevention

SS Prerequisite 1: *Construction Activity Pollution* (USGBC 2005) is a prerequisite for achievement of sustainable sites credits, meaning that projects are unable to earn any credits in the sustainable sites area without demonstrating compliance in this area.

The requirements for this prerequisite are the creation and implementation of an *Erosion and Sedimentation Control Plan* during construction, in order to limit the amount of erosion and pollution generated during the construction process. While this prerequisite does not have a direct correspondence to the SDD Policy Update as it pertains to site development, it supports SDD Policy Update, Section 5.a.i.d: *Storm Water Management* (ASA [IE&E] 2013).

5.2.1.1 LEED 2.2

From FY2008 to FY2016 406 of 406, or 100%, of Army LEED 2.2 projects met this prerequisite.

5.2.1.2 LEED v2009

Implementation of this prerequisite is unchanged from LEED 2.2 to LEED v2009.

From FY2008 to FY2016, 188 of 188, or 100% of Army LEED v2009 projects met this prerequisite.

5.2.2 SS Credit 6.1: Stormwater Design—Quantity Control

This credit, SSc6.1 (USGBC 2016) is intended to reduce the level of natural water hydrology disruption through reduction of impervious cover, promotion of on-site water infiltration, limiting or eliminating stormwater runoff pollution, and eliminating contaminants. Any surface area with a hard surface or building on it is impervious because storm water cannot soak into it. The goal of stormwater management is to allow stormwater to soak back into the ground as much as possible, or to reduce contaminants and slow stormwater runoff into nearby bodies of water to minimize erosion.

In cases with existing imperviousness area less than or equal to 50% of the total surface area, this credit can be earned by implementing a stormwater management plan that limits the peak discharge rate and quantity to predevelopment levels for one- and two-year 24-hr design storms, or by implementing a stream channel protection and quantity control strategies.

In cases where existing imperviousness is greater than 50%, this credit can be earned by implementing a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the two-year 24-hr design storm. Suggestions on how to meet these requirements include infiltration promotion, green roofs, and pervious paving.

These requirements are more stringent than EISA of 2007 requirements, which stipulates projects over 5,000 ft^2 "maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow."

5.2.2.1 LEED 2.2

From FY2008 to FY2016 223 of 406, or 54.9%, of LEED 2.2 projects earned this credit.

5.2.2.2 LEED v2009

From FY2008 to FY2016, 102 of 188, or 54.3%, of LEED v2009 projects earned this credit.

5.2.3 SS Credit 6.2: Stormwater Design—Quality Control

This credit, SSc6.2 (USGBC 2016), is intended to reduce disruption and pollution of natural water flows by managing storm water runoff. This credit is earned by implementing a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90% of the average annual rainfall using acceptable best management practices (BMPs).

"BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports" (LEED for New Construction & Major Renovation).

As for SSc6.1 *Stormwater Design: Quantity Control*, these requirements are more stringent than the EISA of 2007 standards referenced in the 2013 SSD Policy Update (ASA [IE&E] 2013). EISA requirements address "temperature, rate, volume, and duration" of stormwater, but does not address the TSS.

5.2.3.1 LEED 2.2

From FY2008 to FY2016 215 of 406, or 53.0%, of LEED 2.2 projects earned this credit.

5.2.3.2 LEED v2009

From FY2008 to FY2016 89 of 188, or 47%, of LEED v2009 projects earned this credit.

6 Invasive Plants

6.1 SDD Policy Update's relevance to invasive plants

SDD Policy Update 5.a.i.e (ASA [IE&E] 2013) specifies guidelines for invasive plant treatment. Referencing ASHRAE 189.1-2011 (ASHRAE 2011), invasive plants will not be introduced to the site, and existing invasive species will be removed and destroyed.

6.2 LEED alignment with SDD goals

Invasive plant management is a part of SS Credit 5.1 *Site Development: Protect or Restore Habitat* (USGBC 2016). This credit does not explicitly address removal of invasive plants but encourages planting of native or adapted plants which require little irrigation and maintenance. The removal of invasive plants does not earn projects any points.

7 Energy Performance

7.1 SDD Policy Update's relevance to energy performance

SDD Policy Update 5.a.ii.a (ASA [IE&E] 2013) specifies guidelines for energy performance. Projects will at a minimum meet UFC 1-200-02 (DoD 2022b) requirements (based on ASHRAE 90.1-2010 [ASHRAE 2010]) and maximize energy efficiency with regards to life-cycle cost-effectiveness. Plug and process loads are to be included in energy calculations.

7.2 LEED alignment with SDD goals

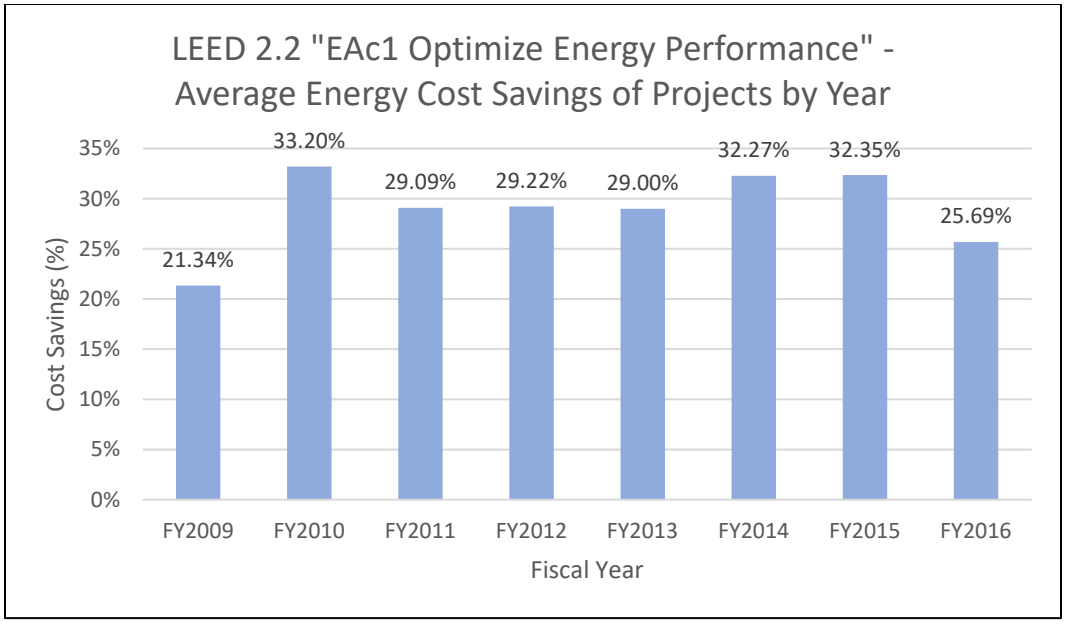
7.2.1 LEED 2.2 Energy and Atmosphere (EA) Credit 1: Optimize energy performance

This credit, EAc1 (USGBC 2005), is intended to encourage achievement of increasing levels of energy performance with the aim of reducing environmental and economic impacts of energy use. This credit is earned through either a whole building energy simulation, use of ASHRAE Advanced Energy design guide for Small Office Buildings (2004), or use of Advanced Buildings Core Performance Guide (USGBC 2007). This credit is graduated with more efficient buildings earning more points. The energy baseline for this credit is based on ASHRAE 90.1-2004 (ASHRAE 2004b).

It is notable that this credit is awarded because of resulting energy cost savings, not directly on energy use intensity (EUI). It is also notable that the Army's guidelines are based on a more recent (2010) version of ASHRAE 90.1 than LEED 2.2 (USGBC 2005).

Figure 5 shows the average energy cost savings as calculated for EAc1 *Optimize Energy Performance* between FY2009 and FY2016, based on ASHRAE 90.1-2007 (ASHRAE 2007).

Figure 5. LEED 2.2 average energy cost savings by year for EAc1.



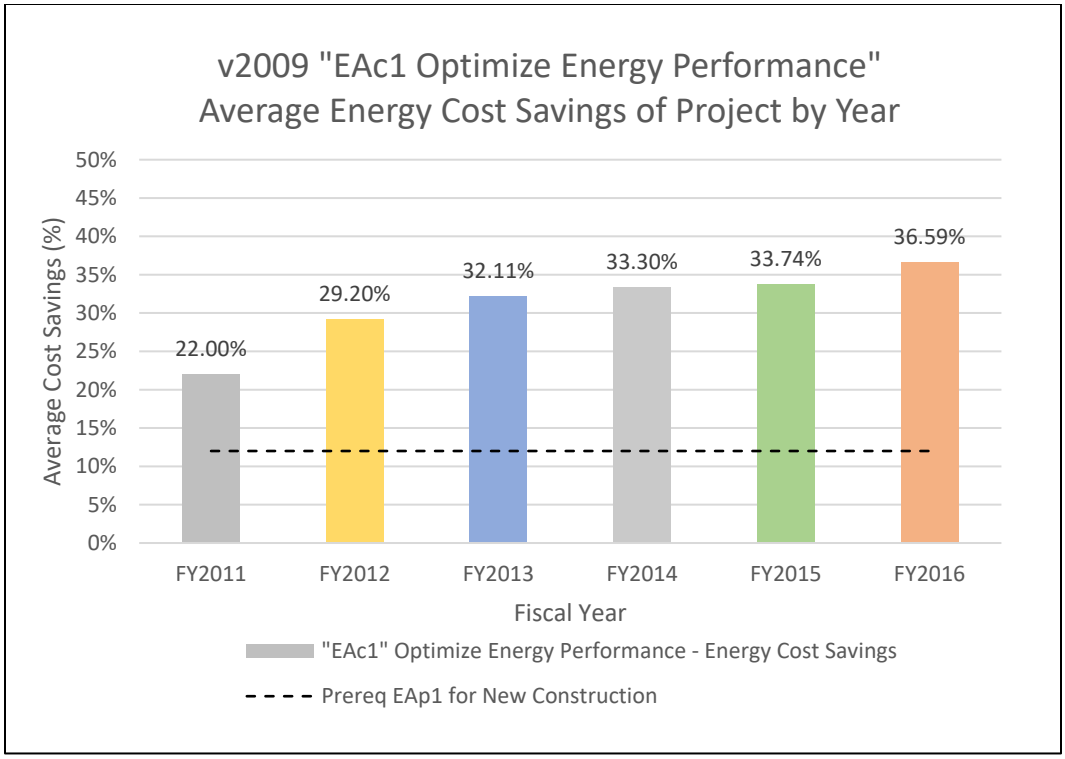
Average energy cost savings as calculated for EAc1 *Optimize Energy Performance* ranged from 21.43% to 33.20% in FY09 to FY16, as based on ASHRAE 90.1-2007.

7.2.2 LEED v2009 EA Credit 1: Optimize energy performance

In LEED v2009 (USGBC 2016), the credit was changed from LEED 2.2. The point value earned by this credit has been separated into more detail. In addition, the energy baseline calculations used to calculate energy offset percentage use ASHRAE 90.1-2007 instead of ASHRAE 90.1-2004.

Figure 6 shows the average energy cost savings by year for Army LEED v2009 projects between FY2001 and FY2016.

Figure 6. LEED v2009 average energy cost savings by year.



Average energy cost of LEED v2009 projects savings as calculated for EAc1 *Optimize Energy Performance* increased 7.4% from FY2012 to FY2016, as based on ASHRAE 90.1-2007.

8 Renewable Energy

8.1 SDD Policy Update's relevance to renewable energy

SDD Policy Update 5.a.ii.b (ASA [IE&E] 2013) specifies guidelines for renewable energy. Renewable energy systems should be designed to operate without reliance on utility power, and to be able to divert power to support mission critical assets. Solar water heaters should provide a minimum of 30% of facility hot water demand when this is life cycle cost effective and should achieve the highest amount that is life cycle cost effective.

8.2 LEED alignment with SDD goals

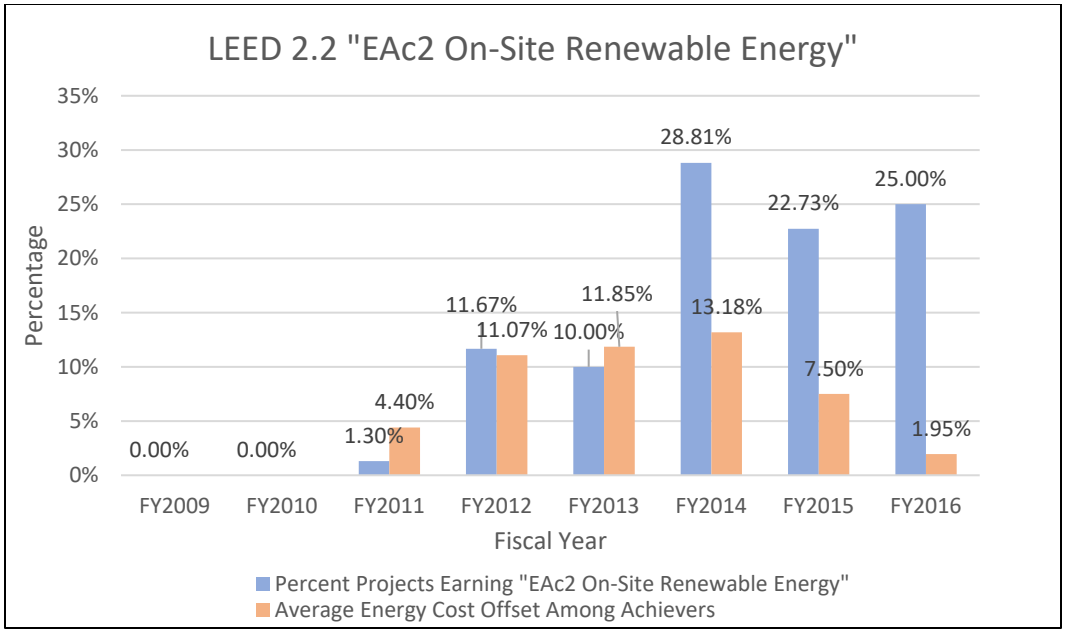
8.2.1 LEED 2.2 Energy and Atmosphere Credit 2: On-Site Renewable Energy

This credit, EAc2 (USGBC 2005) is intended to encourage on-site renewable energy self-supply to reduce environmental and economic impacts resulting from fossil fuel energy use. This credit is earned by using on-site renewable energy systems to offset building energy cost. Points are awarded on a scale according to the percentage of energy cost offset by the renewable energy system.

From FY2008 to FY2016 48 of 406, or 11.8%, of LEED 2.2 projects earned this credit.

Figure 7 shows the amount of on-site renewable energy Army LEED 2.2 projects achieved between FY2009 and FY2016.

Figure 7. LEED 2.2 EAc2 *On-Site Renewable Energy Use*.



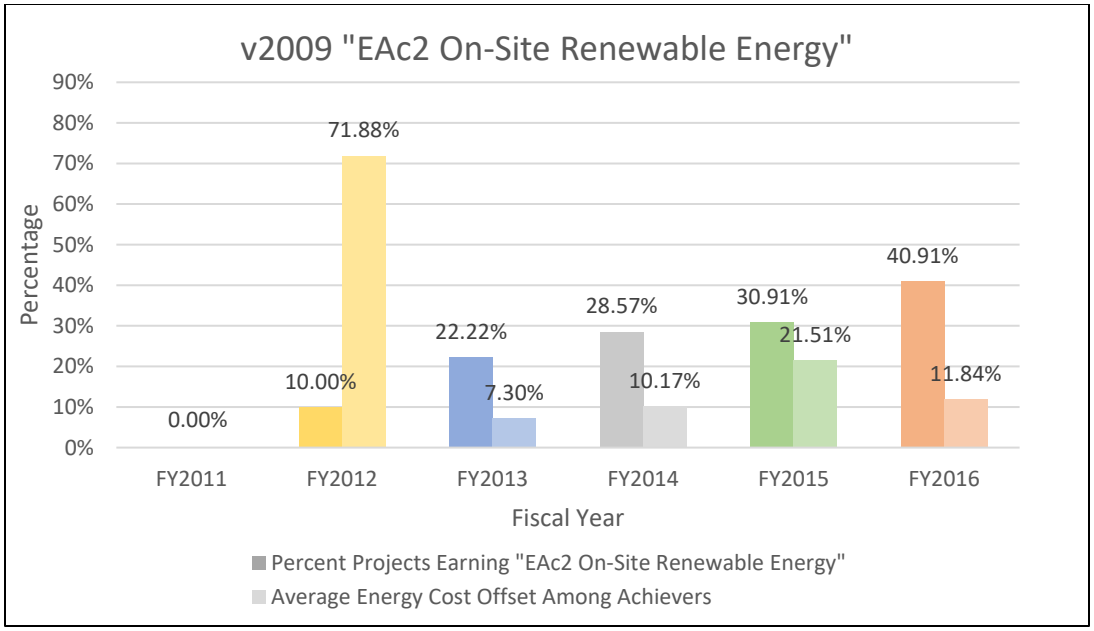
The percentage of projects earning EAc2 *On-Site Renewable Energy* credit ranged from 0% to 28.81% from FY2009 to FY2016. The percent of energy cost offset by on-site renewable among achievers of this credit ranged from 1.95% to 13.18%.

8.3 LEED v2009 EAc2: On-Site Renewable Energy

This credit has been changed from LEED 2.2. The point value earned by this credit has been separated into more strata. In addition, the energy baseline calculations used to assess energy offset percentage use ASHRAE 90.1-2007 instead of ASHRAE 90.1-2004.

Figure 8 shows the amount of on-site renewable energy use that Army LEED v2009 projects achieved between FY2011 and FY2016.

Figure 8. LEED v2009 EAc2 *On-Site Renewable Energy Use*.



The percentage of projects earning EAc2 *On-Site Renewable Energy credit* increased from 10% to 40.9% from FY2012 to FY2016. The percent of energy cost offset by on-site renewable among achievers of this credit ranged from 7.3% to 71.88%. In FY2011, the sole project certified did not attempt this credit. In FY2012, ten projects were certified, with one achieving EAc2. This project offset 71.88% of energy costs with on-site renewable energy.

9 Exterior Lighting

9.1 SDD Policy Update's relevance to exterior lighting

SDD Policy Update 5.a.ii.c (ASA [IE&E] 2013) specifies guidelines for exterior lighting, referencing ASHRAE 90.1 (2010) and the ASA(IE&E) memorandum *Exterior Lighting Technologies Policy* on 13 November 2012.

9.2 LEED alignment with SDD goals

Exterior lighting efficiency is not explicitly addressed by a credit. SS Credit 8: *Light Pollution Reduction* addresses light pollution reduction of interior and exterior lights.

10 Water Use

10.1 SDD Policy Update's relevance to indoor water use

SDD Policy Update 5.a.iii.a (ASA [IE&E] 2013) specifies guidelines for indoor water use. In addition to general encouragement of purple-pipe methods of water reuse-and reclamation, indoor water use is required to meet federal requirements for water efficiency per UFC 1-200-02 section 2-5.1 (DoD 2022b), this referencing ASHRAE 189.1 Sections 6.3.2.1 and 6.3.2.2 (2011).

10.2 LEED alignment with SDD goals

10.2.1 Water Efficiency (WE) Credit 2: Innovative Wastewater Technologies

10.2.1.1 LEED 2.2

This credit, WEc2 (USGBC 2005), is intended to reduce wastewater generation and potable water demand. This credit is awarded either by reducing potable water use for building sewage conveyance by 50% or by treating 50% of wastewater to tertiary standards on-site.

From FY2008 to FY2016 36 of 406, or 8.9%, of LEED 2.2 projects earned this credit.

10.2.1.2 LEED v2009

Implementation of this credit is unchanged from LEED 2.2.

From FY2008 to FY2016 13 of 188, or 7%, of LEED v2009 projects earned this credit.

10.2.2 WE Credit 3: Water Use Reduction

10.2.2.1 LEED 2.2

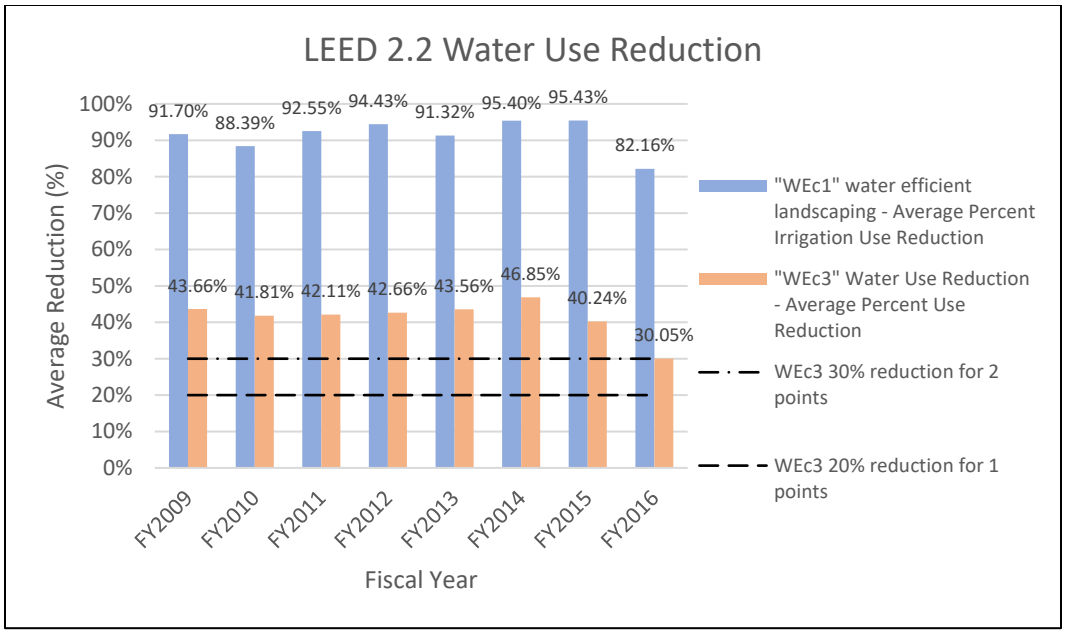
The intent of this credit, WEc3 (USGBC 2005), is to increase building water efficiency in order to reduce the burden on municipal water supply and wastewater systems. The percentage of water savings is assessed by comparing water use calculations to a baseline. Complying with Energy Policy Act (EPAct) of 1992 fixture performance requirements are a

stipulation of this credit (USGBC 2005). There are several achievement levels for this credit. It is notable that the Army is granted an exception and allowed to use a different male to female ratio in water calculation because of the current and continued demographic differences in certain Army buildings in relation to the general public.

From FY2008 to FY2016 399 of 406, or 98.3%, of LEED 2.2 projects earned this credit, with an average water use reduction of 42.8%.

Figure 9 shows the percent water use reduction that Army LEED 2.2 projects achieved between FY209 and FY2016.

Figure 9. LEED 2.2 WEc3 *Water Use Reduction*.



LEED 2.2 Projects between FY2009 and FY2016 on average reduced potable water use in landscaping between 82.16% and 96.43%. In addition, LEED 2.2 Projects from FY2009 to FY2016 on average reduced domestic water use between 30.05% and 46.85%. During that time the average amount of water use reduction exceeded the 30% amount required for WEc3 *30% Reduction*.

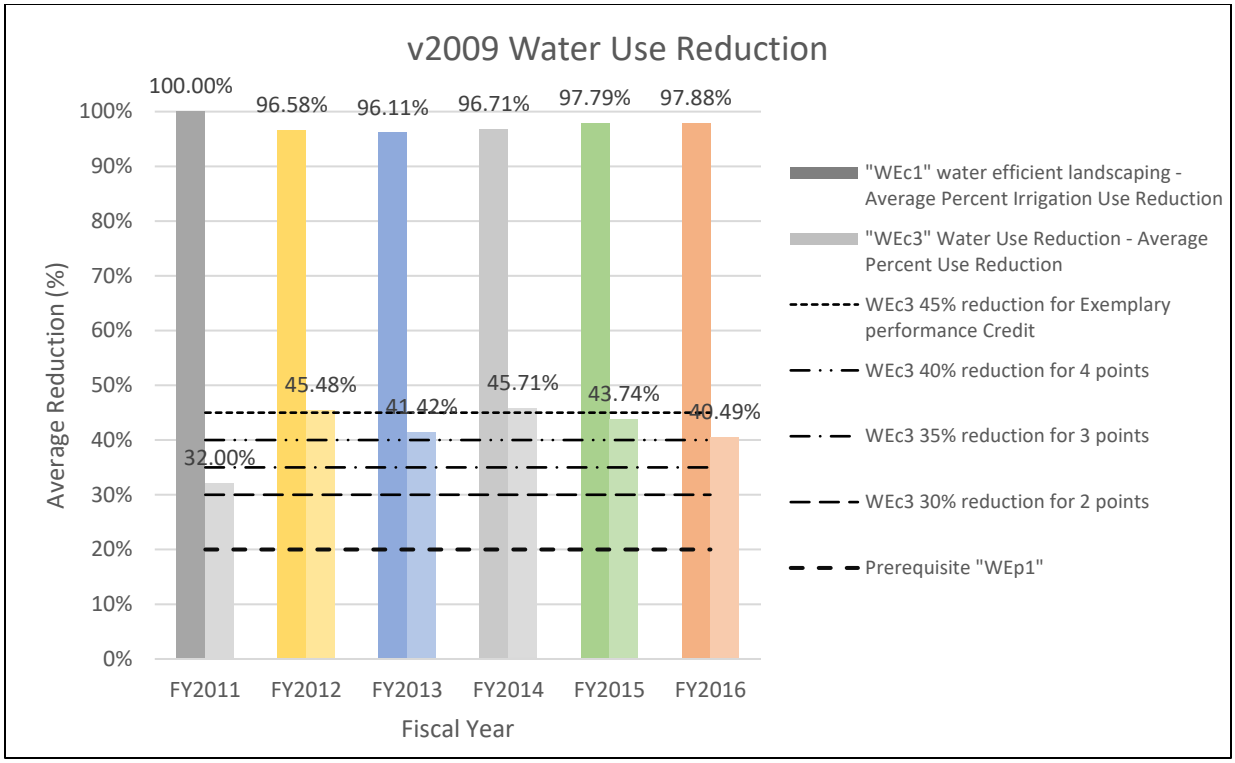
10.2.2.1 LEED v2009

The LEED v2009 credit was changed from LEED 2.2. Point valuations were changed and thresholds were added. In addition, the standards used

for fixture efficiency were updated to include the requirement of EPAct 2005 and 2006 Uniform Plumbing Code (USGBC 2016).

Figure 10 shows the percentage of water use reduced for Army LEED v2009 Projects between FY2011 and FY2016.

Figure 10. LEED v2009 *Water Use Reduction*.



LEED v2009 Projects in FY2012 to FY2016 on average reduced potable water use in landscaping between 96.1% and 97.9%. In FY2011, during which only one LEED v2009 Project was certified, the project achieved no potable water use for irrigation or no irrigation.

LEED v2009 Projects in FY2012 to FY2016 on average reduced domestic water use between 40.49% and 45.48%. During that time the average amount of water use reduction exceeded the 40% amount required for WEc3 *40% Reduction*.

WEc3 was the third most commonly achieved exemplary credit, with 41 total achievements under LEED v2009.

In FY2011, during which only one LEED v2009 Project was certified, the project achieved 32% water use reduction.

10.2.1 WE Credit 1.1: Water Efficient Landscaping—Reduce by 50%

10.2.1.1 LEED 2.2

The intent of this credit is to reduce or eliminate potable and natural water source use for landscape irrigation (USGBC 2005). The requirements are the reduction of potable water consumption for irrigation by 50% as compared to a calculated midsummer baseline case.

From FY2008 to FY2016 382 of 406, or 94.1%, of LEED 2.2 Projects earned this credit.

10.2.1.2 LEED v2009

This credit is unchanged from LEED 2.2 and requires a reduction of potable water consumption for irrigation by 50% from the calculated midsummer baseline case (USGBC 2016).

From FY2008 to FY2016 178 of 188, or 95%, of LEED v2009 Projects earned this credit.

10.2.2 WE Credit 1.2: Water Efficient Landscaping—No Potable Water Use or No Irrigation

10.2.2.1 LEED 2.2

This credit's requirements are the same as WE Credit 1.1 but stipulates the elimination of the use of potable water for landscape irrigation (USGBC 2005).

From FY2008 to FY2016 295 of 406, or 72.7%, of LEED 2.2 Projects earned this credit.

10.2.2.2 LEED v2009

Implementation of this credit is unchanged from LEED 2.2 and requires that WE Credit 1.1 is met and only nonpotable water is used for irrigation (USGBC 2016).

From FY2008 to FY2016, 163 of 188 or 87% of Army LEED v2009 Projects earned this credit.

11 Metering

11.1 SDD Policy Update's relevance to metering

SDD Policy Update 5.i.v specifies guidelines for metering, monitoring, and submonitoring. Citing UFC 1-200-02, this policy specifies that all new construction and major renovations require building-level monitoring via smart meters (ASA [IE&E] 2013). These meters should capture all consumed utilities, including electricity, natural gas, water, and steam. In addition to these requirements, major subsystems should be submonitored based on according to levels specified in ASHRAE 189.1-2011 Section 6.3.3 (*water consumption*) and 7.3.3 (*energy consumption*), practicality permitting (ASA [IE&E] 2013). This metering and monitoring data will report to the Army Enterprise Meter Data Management System (MDMS).

11.2 LEED alignment with SDD goals

While credits align with Army metering goals, the Army Enterprise MDMS and security requirements work largely apart from the LEED certification system.

12 Commissioning

12.1 SDD Policy Update's relevance to commissioning

SDD Policy Update 5.v specifies guidelines for Total Building Commissioning. The commissioning requirements prescribed in UFC 1-200-02 must be fulfilled by facility construction projects (ASA [IE&E] 2013). This includes using Total Building Commissioning practices to develop essential documentation, testing, training, and validation. The process' intent is to ensure that design intent and postconstruction operation needs are met, these being documented in the project Owner Project Requirements (ASA [IE&E] 2013).

12.2 LEED alignment with SDD goals

12.2.1 LEED 2.2 EA Credit 3: Enhanced Commissioning

This credit is intended to encourage early incorporation of the commissioning during the design process and specifies certain tasks to be completed following system performance verification (USGBC 2005). Conflicts between Army policy and organizational policy and the structuring of this credit have resulted in exceptions granted to Army construction regarding certain stipulations of the credit, particularly that the commissioning of Army building projects are not required to be the efforts of a third-party organization.

From FY2008 to FY2016 174 of 406, or 43%, of Army LEED 2.2 Projects earned this credit. This low rate is partially because of conflicts between Army policy and LEED credit structuring.

12.2.2 LEED v2009 EAc3: Enhanced Commissioning

This credit remains unchanged from LEED 2.2 in which an independent commissioning authority is designated to lead, review, and oversee the completion of all commissioning activities (USGBC 2016).

From FY2008 to FY2016 176 of 188, or 94%, of Army LEED v2009 projects earned this credit. The proportion of Army v2009 Projects achieving this credit is much larger than that of LEED 2.2 Projects because of updates in the SDD policy.

13 Construction Materials, Finishes, and Furnishings

13.1 SDD Policy Update's relevance to construction materials, finishes, and furnishings

SDD Policy Update 5.v.i specifies guidelines for construction materials, finishes, and furnishings. Cited are UFC 1-200-2, Section 2-6.4 (*Low Emitting Materials*), 2-7.1 (*Environmentally Preferable Products*), and 2-7.5 (*Ozone Depleting Substances*) (ASA (IE&E) 2013). Requirements are identified for the purchasing of water efficient, Energy Star or Federal Energy Management Program designated, and Electronic Product Environmental Assessment Tool designated products. In addition to these requirements, project materials must adhere to ASHRAE 189.1-2011 Section 9.3.2 (*Extracting, Harvesting, and/or Manufacturing*) (ASA [IE&E] 2013).

13.2 LEED Alignment with SDD goals

13.2.1 Environmental Quality (EQ) Credit 4: Low-Emitting Materials

Corresponding to UFC 1-200-2, Section 2-6.4 (Low-Emitting Materials) credits are

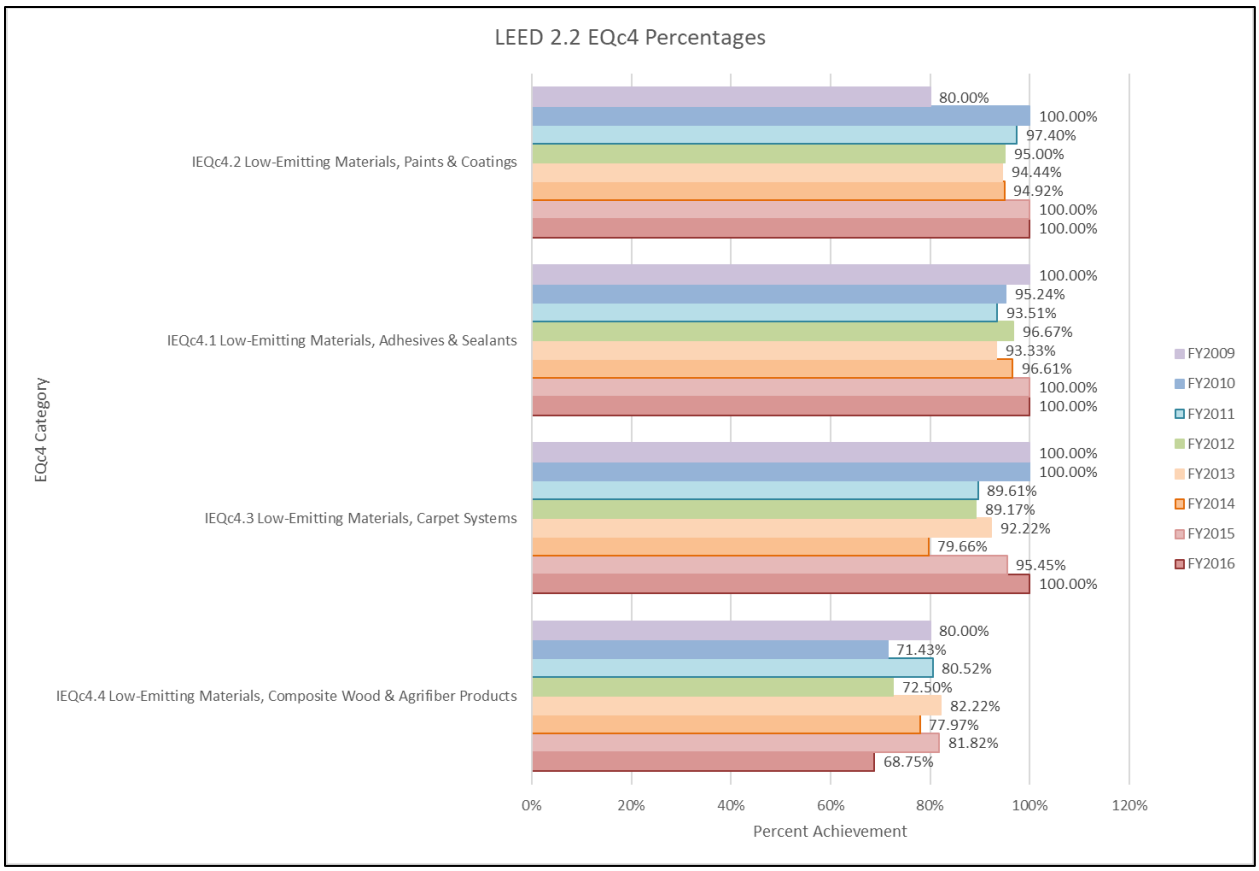
- EQ Credit 4.1 (EQc4.1) *Low-Emitting Materials—Adhesives and Sealants*;
- EQ Credit 4.2 (EQc4.2) *Low-Emitting Materials—Paints and Coatings*;
- EQ Credit 4.3 (EQc4.3) *Low-Emitting Materials—Carpet Systems*; and
- EQ Credit 4.4 (EQc4.4) *Low-Emitting Materials—Composite Wood and Agrifiber Products*.

The EQc4 remains generally unchanged between LEED 2.2 and v2009 in relation to the Adhesives and Sealants, Paints and Coatings, Carpet Systems, and Composite Wood and Agrifiber Products.

13.2.1.1 LEED 2.2

The graph shown in Figure 11 gives the percentage of credit achievement of Army LEED 2.2 Projects by year for Low-Emitting Materials credits EQc4.1–EQc4.4. It is arranged from most to least achieved credit.

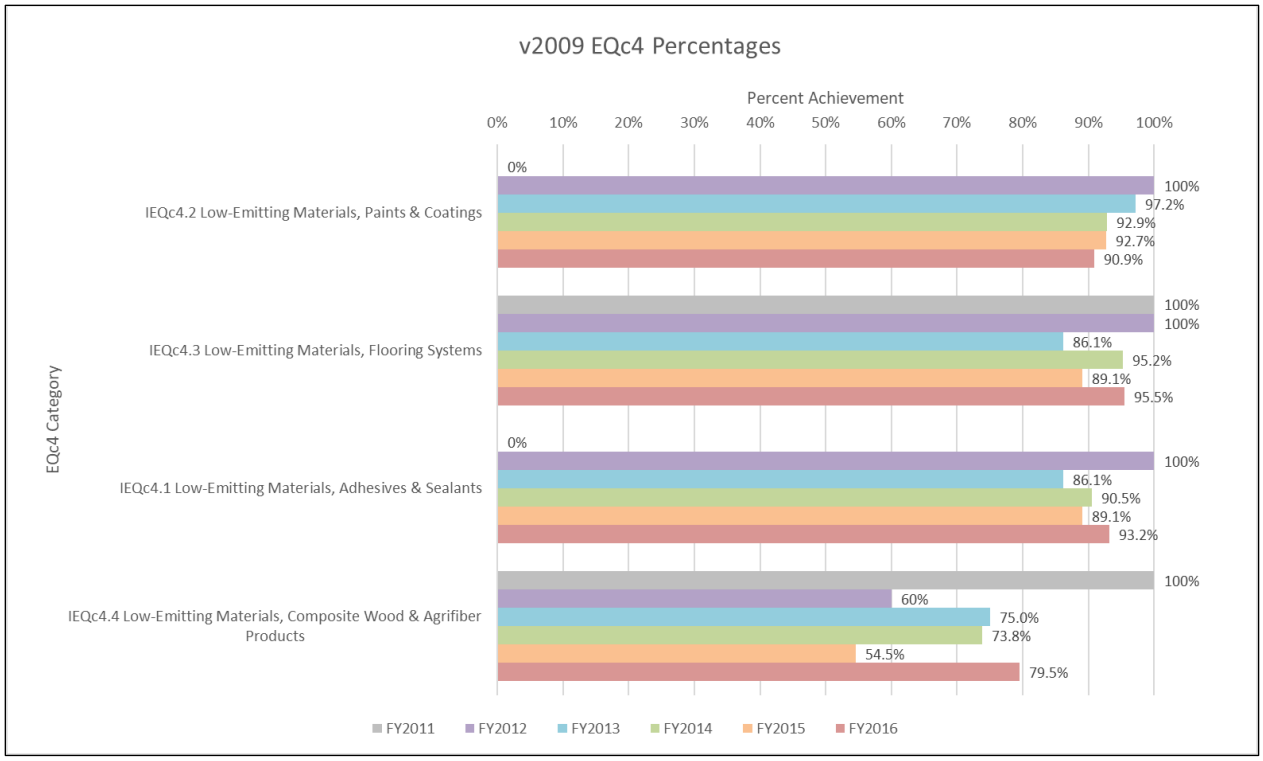
Figure 11. LEED 2.2 EQc4 *Low-Emitting Materials*.



13.2.1.1 LEED v2009

The graph in Figure 12 gives the percentage of credit achievement of LEED v2009 Projects by year for Low-Emitting Materials credits EQc4.1–EQc4.4. It is arranged from most to least achieved credit.

Figure 12. LEED v2009 *Low-Emitting Materials*.



13.2.2 Materials and Resources (MR) credits: Environmentally preferable products

UFC Section 2-7.1 and requirements associated with energy efficient product use correspond more broadly to LEED credits pertaining to energy efficiency. In reference to the use of environmentally preferable products, the following credits apply:

- Materials and Resources Credit 3.1 (MRc3.1): *Materials Reuse–5%*
- MR Credit 3.2 (MRc3.2): *Materials Reuse–10%*
- MR Credit 5.1 (MRc5.1): *Regional Materials–10% Extracted, Processed and Manufactured Regionally*
- MR Credit 5.2 (MRc5.2): *Regional Materials–20% Extracted, Processed and Manufactured Regionally*
- MR Credit 6 (MRc6): *Rapidly Renewable Materials*

The LEED Enhanced Refrigerant Management credit corresponds to UFC 1-200-2, Section 2-7.5 (*Ozone Depleting Substances*) and ASHRAE 189.1 section 9.3.3, which is listed as follows:

- EA credit 4: *Enhanced Refrigerant Management*

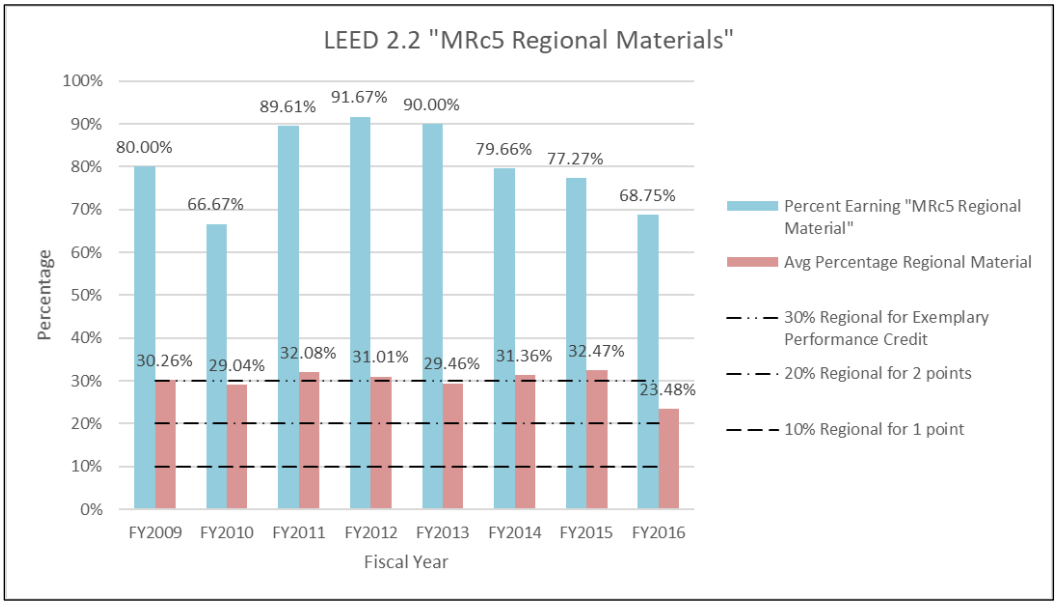
Corresponding to ASHRAE 189.1-2011 Section 9.3.2 (*Extracting, Harvesting, and/or Manufacturing*) is the MR credit listed below:

- MR Credit 7 (MRc7): *Certified Wood*

13.2.2.1 LEED 2.2

Figure 13 shows the percentage of Army LEED 2.2 Projects that earned the MRc5 *Regional Materials* credit between FY2009 and FY2016.

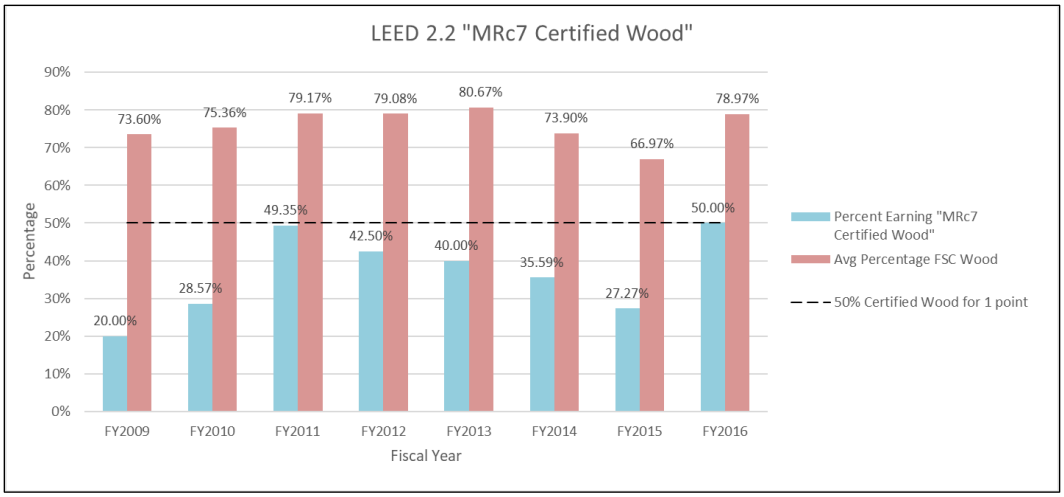
Figure 13. LEED 2.2 *Regional Materials*.



Between FY2009 and FY2016, the percentage of LEED 2.2 Projects earning MRc5 *Regional Materials* credit ranged from 66.67% to 91.67%. In this same period, the average waste diverted from landfill by weight among achievers ranged from 23.48% to 32.47%. Materials which qualified as regional were “extracted, harvested or recovered, as well as manufactured” within 500 mi of the site (USGBC 2005).

Figure 14 shows the percentage of Army projects that earned the LEED 2.2 credit MRc7 *Certified Wood* credit, and the average percentage of Forest Stewardship Council certified wood used between FY2009 and FY2016.

Figure 14. LEED 2.2 *Certified Wood*.

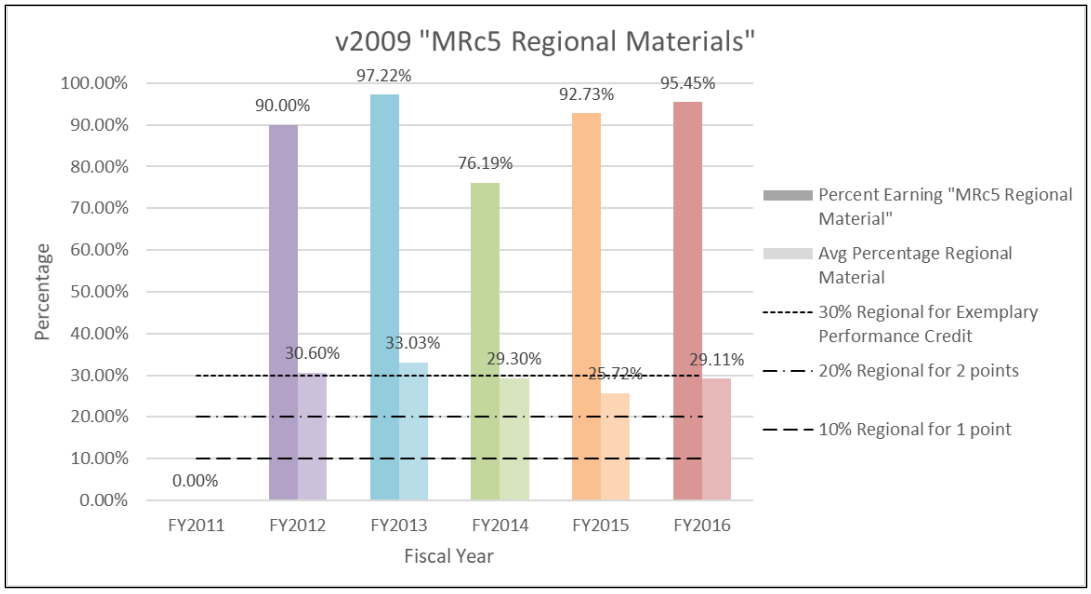


Between FY2009 and FY2016, the percentage of LEED 2.2 Projects earning MRc7 *Certified Wood* credit ranged from 20.00% to 50.00%. In this same period, the average percentage of certified wood as a proportion of total lumber used in the project among achievers ranged from 66.97% to 80.67%.

13.2.2.1 LEED v2009

Figure 15 shows the percentage of Army LEED v2009 Projects that earned the MRc5 *Regional Materials* credit between FY2011 and FY2016, along with the average percentage of regional materials used each FY.

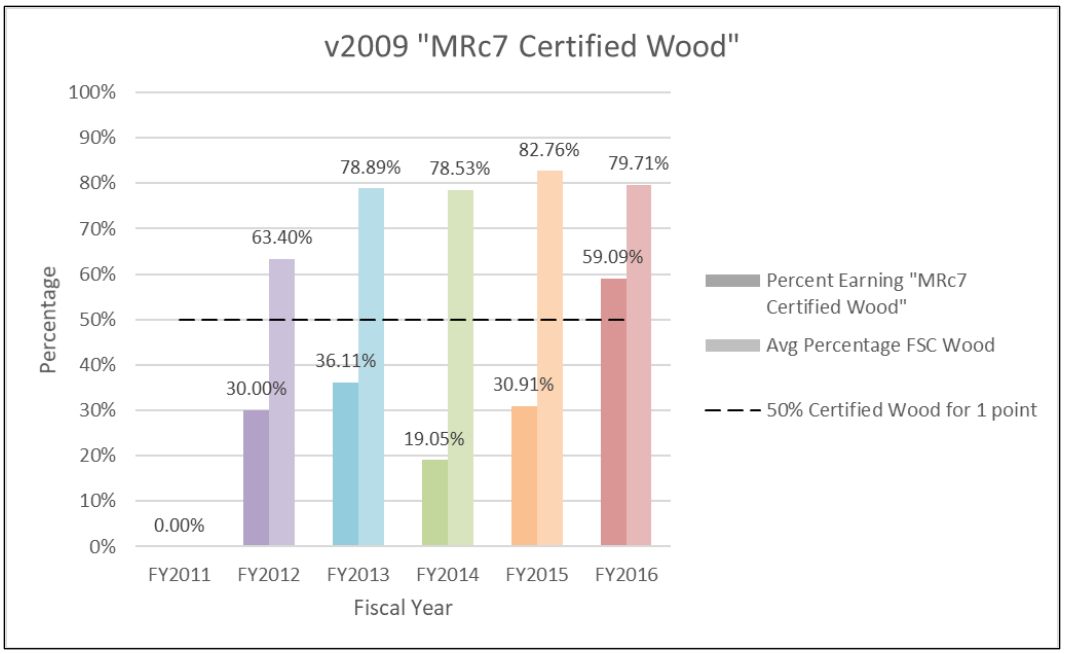
Figure 15. LEED v2009 *Regional Materials*.



Between FY2012 and FY2016, the percentage of projects earning MRc5 *Regional Materials* credit ranged from 90% to 95.45%. In this same period, the average waste diverted from landfill by weight among achievers ranged from 30.6% to 25.7%. Materials which qualified as regional were "extracted, harvested or recovered, as well as manufactured" within 500 mi of the site (USGBC 2016). In FY2011, the sole project certified did not attempt this credit.

Figure 16 shows the percentage of Army projects earning the LEED v2009 MRc7 *Certified Wood* credit between FY2011 and FY2016, along with the average percentage of FSSC wood used each FY.

Figure 16. LEED v2009 *Certified Wood*.



Between FY2012 and FY2016, the percentage of projects earning MRc7 *Certified Wood* credit ranged from 30.00% to 59.09%. In this same period, the average percentage of certified wood as a proportion of total lumber used in the project among achievers ranged from 63.40% to 82.27%. In FY2011, the sole project certified did not attempt this credit.

14 Waste Management

14.1 SDD Policy Update's relevance to waste management

SDD Policy Update 5.vii.a specifies guidelines for construction waste management. Referencing the DoD's Strategic Sustainability Performance Plan (SSPP; DoD 2016), the update requires 60% of construction and demolition debris to be diverted from the waste stream by FY2015 (ASA [IE&E] 2013). Furthermore, Net Zero waste disposal goals are reiterated and, consequently, the policy update encourages use of deconstruction and salvage.

14.2 LEED Alignment with SDD goals

The LEED rating system awards points both for the reuse of existing building elements (salvaged or existing on-site), and for diversion of waste from disposal. Associated credits are

- MR Credit 1.1: *Building Reuse: Maintain 75% of Existing Walls, Floors and Roof*;
- MR Credit 1.2: *Building Reuse: Maintain 95% of Existing Walls, Floors and Roof*;
- MR Credit 1.3: *Building Reuse: Maintain 50% of Interior Non-Structural Elements*;
- MR Credit 2.1: *Construction Waste Management—Divert 50% From Disposal*;
- MR Credit 2.2: *Construction Waste Management—Divert 75% From Disposal*;
- MR Credit 3.1: *Materials Reuse—5%*; and
- MR Credit 3.2: *Materials Reuse—10%*.

14.2.1 MR Credit 2: Construction waste management

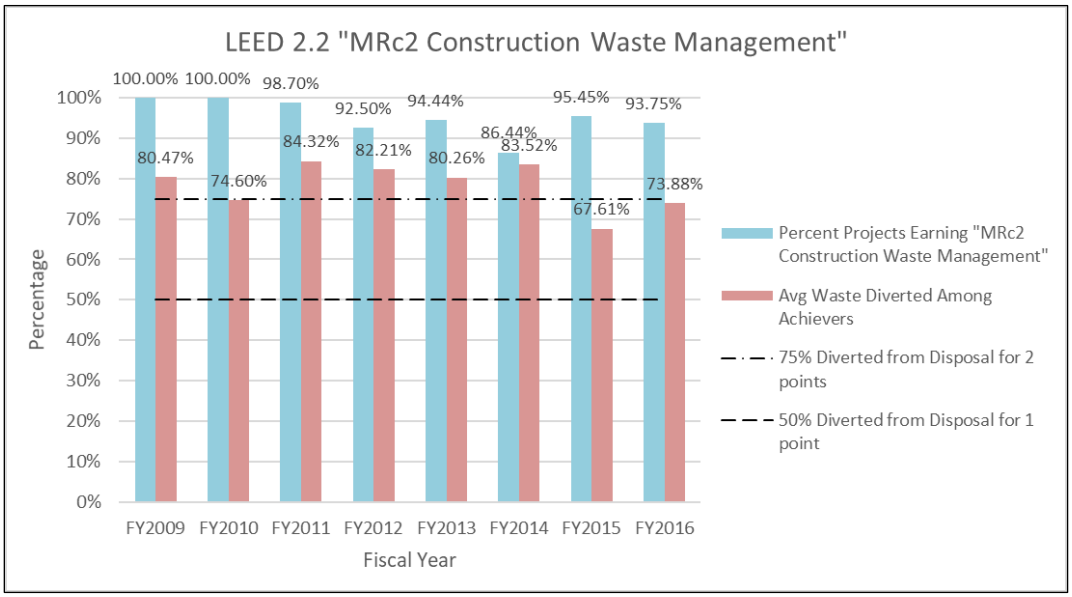
This credit is intended to reduce disposal of debris originating from demolition and land clearing into incinerators and landfills. The requirements for this credit are that 50% of nonhazardous debris from construction and demolition are recycled or salvaged (USGBC 2005). Materials to be diverted must be identified and whether the materials will be sorted or comingled must be determined as part of a construction waste management plan. Soil and land-clearing debris are not counted in the achievement of this credit.

This credit is graduated, with one credit awarded for 50% diverted and two credits awarded for 75% diverted (USGBC 2005). An additional credit for exemplary performance can also be attained at 95% diverted (USGBC 2005).

14.2.1.1 LEED 2.2

Figure 17 shows the percentage of Army projects that earned the LEED2.2 *Construction Waste Management* credit between FY2009 and FY2016, and the average waste achieved diverted each FY.

Figure 17. LEED 2.2 *Construction Waste Management*.



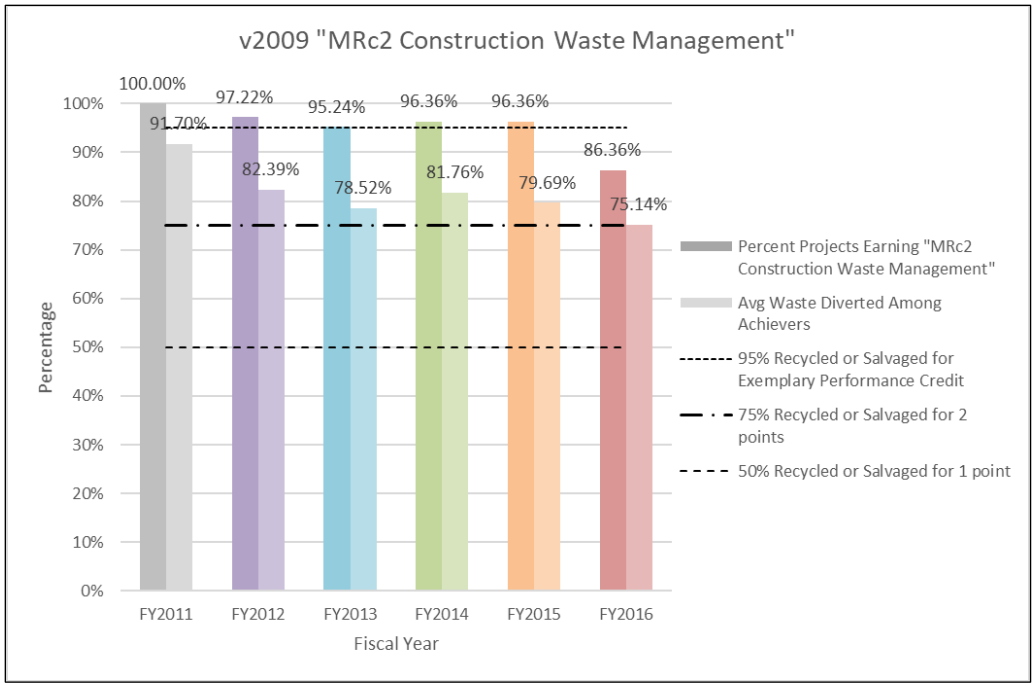
Between FY2009 and FY2016, the percentage of LEED 2.2 Projects earning MRc2 *Construction Waste Management* credit ranged from 86.44% to 100%. In this same period, the average waste diverted from landfill by weight among achievers ranged from 67.61% to 84.32%.

14.2.1.1 LEED v2009

This credit remained unchanged between LEED 2.2 and LEED v2009.

Figure 18 shows the percentage of Army projects that earned the MRc2 *Construction Waste Management* credit between FY2001 and FY2016, and the average waste diverted each FY.

Figure 18. LEED v2009 *Construction Waste Management*.



Between FY2012 and FY2016, the percentage of projects earning MRc2 *Construction Waste Management* credit ranged from 86.4% to 97.2%. In this same period, the average waste diverted from landfill by weight among achievers ranged from 75.1% to 82.4%.

14.2.2 MR Credit 4: Recycled Content

This credit is intended to reduce impacts from material extraction and processing by increasing demand for building products with recycled content.

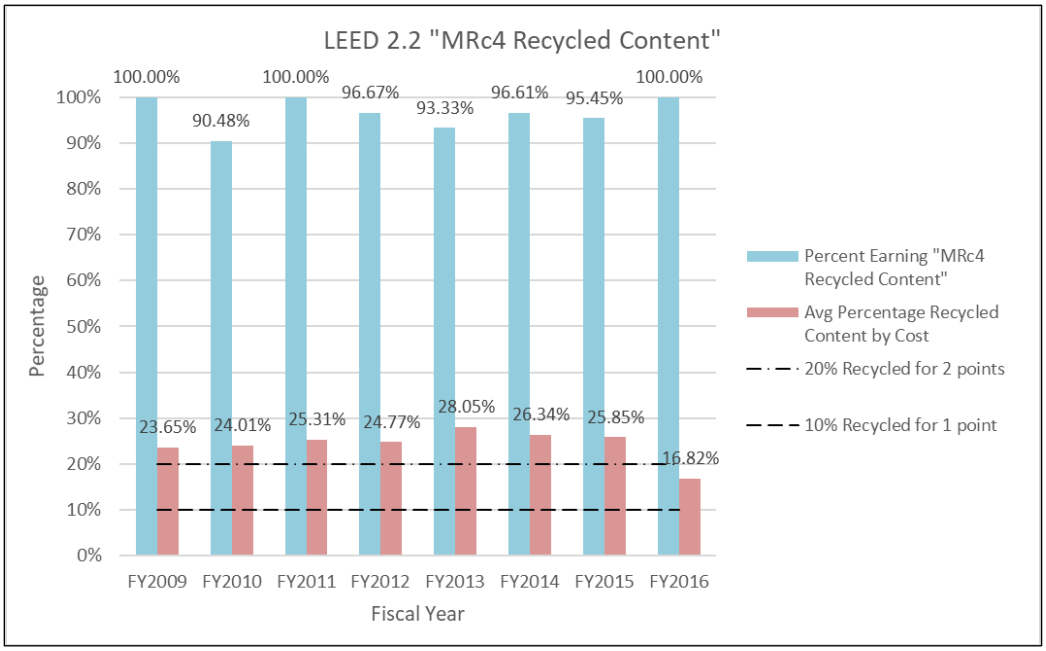
> Use materials with recycled content such that the sum of post-consumer recycled content plus 1/2 of the pre-consumer content constitutes at least 10% or 20%, based on cost, of the total value of the materials in the project. The recycled content value of a material assembly is determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.*

* LEED 2.2 Manual, Credit 4.1.

14.2.2.1 LEED 2.2

Figure 19 shows the percentage of Army LEED 2.2 Projects that earned the LEED MRc4 *Recycled Content* credit, along with the average percentage of recycled content by cost for each FY between FY2009 and FY2016.

Figure 19. LEED 2.2 *Recycled Content*.



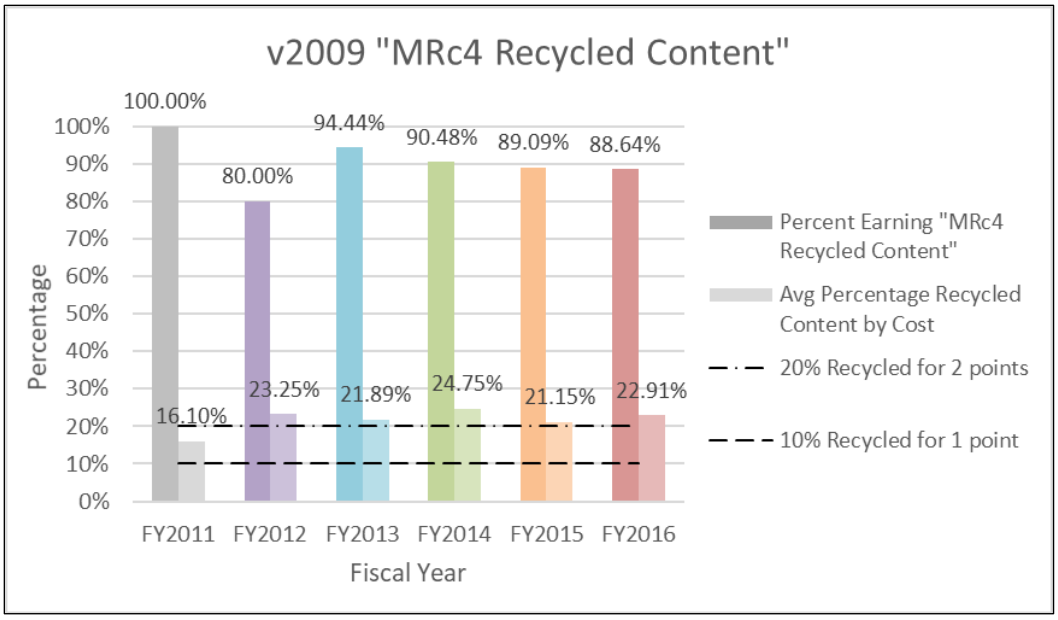
Between FY2009 and FY2016, the percentage of LEED 2.2 Projects earning MRc4 *Construction Waste Management* credit ranged from 90.48% to 100%. In this same period, recycled materials accounted for between 16.82% and 28.05% of total material cost. These values were calculated by multiplying the proportion of the material which was recycled (by mass) by the total cost of the associated assembly.

14.2.2.1 LEED v2009

This credit remained unchanged between LEED 2.2 and v2009.

Figure 20 shows the percentage of Army LEED v2009 Projects that earned the MRc4 *Recycled Content* credit between FY2011 and FY2016, along with the average percentage of recycled content by cost for each FY.

Figure 20. LEED v2009 *Recycled Content*.



Between FY2012 and FY2016, the percentage of projects earning MRc4 *Recycled Content* credit ranged from 80% to 94.4%. In this same period, recycled materials accounted for between 21.15% and 24.75% of total material cost. These values were calculated by multiplying the proportion of the material which was recycled (by mass) by the total cost of the associated assembly. In FY2011, the sole project certified earned 16.10% percent recycled content.

15 Recyclables Management

15.1 SDD Policy Update's relevance to waste management

SDD Policy Update 5.vii.b specifies guidelines for recyclables management. In support of DoD SSPP goals and Army Net Zero waste goal, projects must adhere to ASHRAE 189.1-2011, Section 9.3.4, and should provide appropriate space for recycling and reuse for building occupants (ASA [IE&E] 2013).

15.2 LEED alignment with SDD goals

MR Prerequisite 1: *Storage and Collection of Recyclables* is a prerequisite for earning any *Materials and Resources* credits. All projects from 2008 to 2016 met this prerequisite.

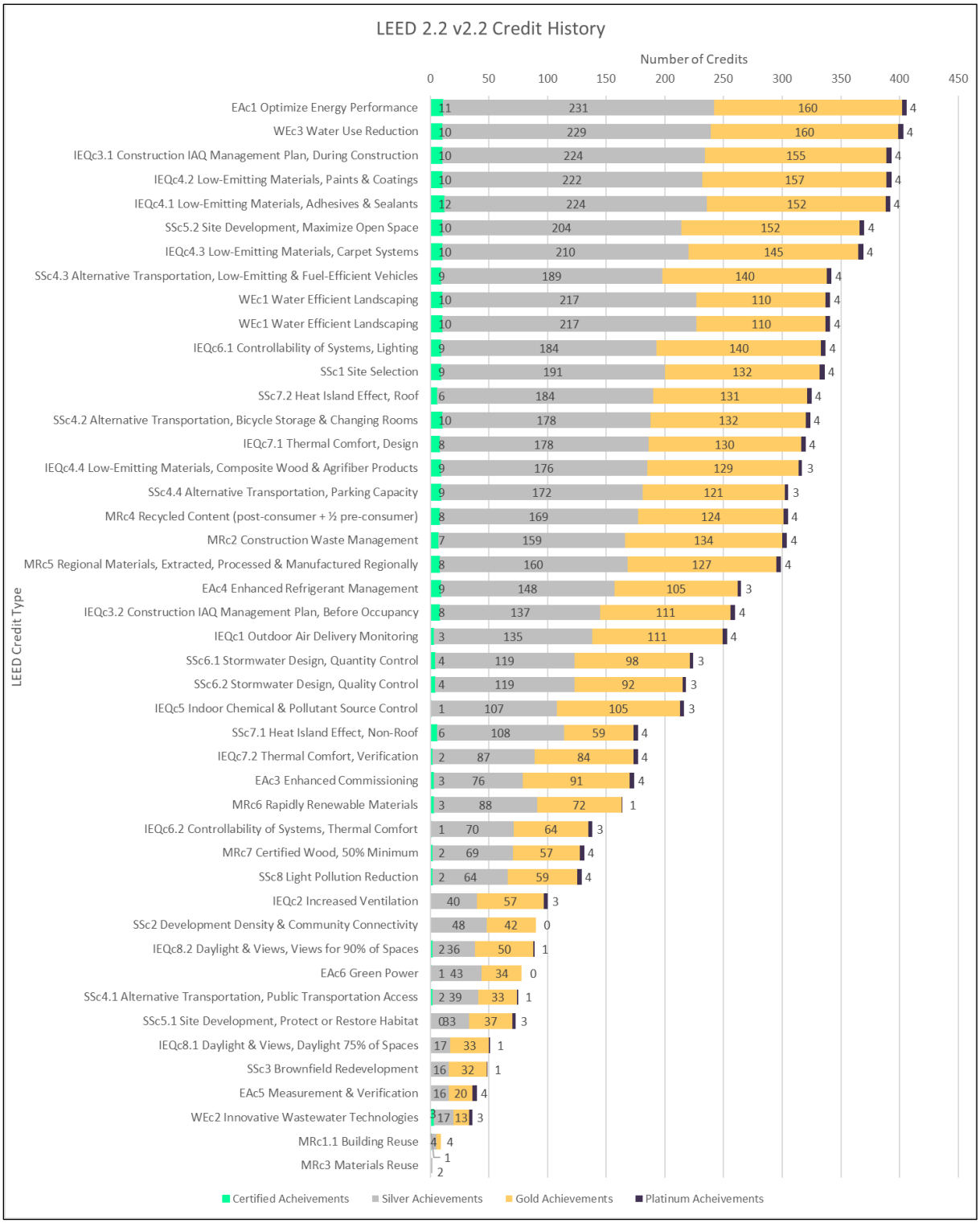
Section 5.vii.b of the SDD policy update specifies guidelines for recyclables management.

16 Most Prevalent LEED Credits Earned by Army MILCON Projects

16.1 LEED v2.2 credit history

Figure 21 shows the achieved credits for Army LEED 2.2 Projects, ranked from most to least popular and separated by whether the project in achievement was attained *Certified*, *Silver*, *Gold*, or *Platinum* rating. The credit most commonly achieved by LEED 2.2 Projects is EAc1 *Optimize Energy Performance*, with 406 projects achieving this credit. Following are WEc3 *Water Use Reduction* which 403 projects achieved and IEQc3.1 *Construction IAQ Management Plan-During Construction*, which 393 projects achieved.

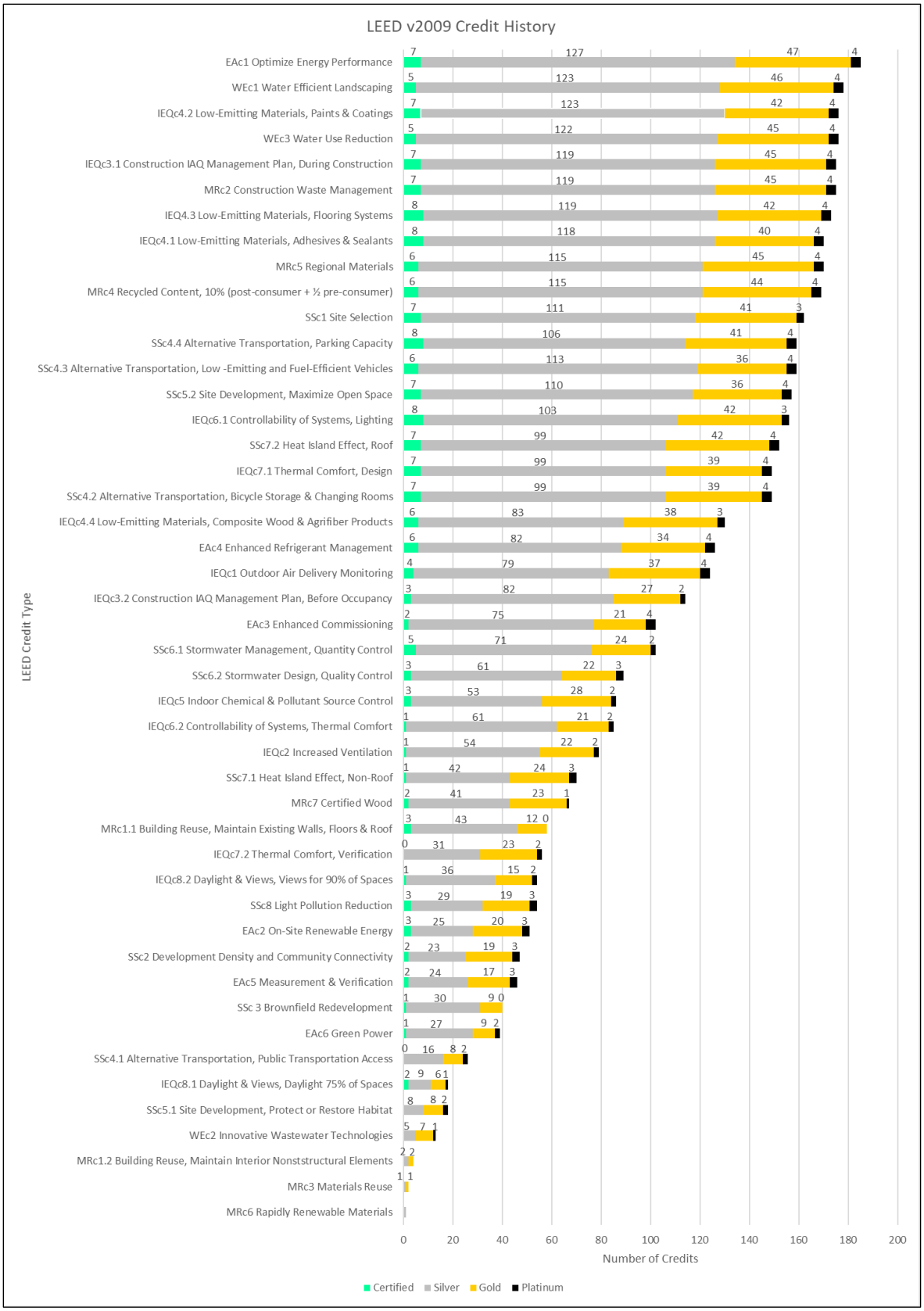
Figure 21. LEED v2.2 credit history.



16.1 LEED v2009 credit history

Figure 22 shows credits for Army LEED v2009 Projects, ranked most to least popular, and separated by whether the project in achievement was attained *Certified*, *Silver*, *Gold*, or *Platinum* rating. The credit most commonly achieved by v2009 Projects was EAc1 *Optimize Energy Performance* with 185 projects achieving this credit. Following are WEc1 *Water Efficient Landscaping* with 178 projects achieving this credit and IEQc4.2 *Low-Emitting Materials, Paints, and Coatings* with 176 projects achieving this credit.

Figure 22. LEED v2009 credit history.



17 Conclusions

This report describes our analysis of how Army LEED certification data demonstrates success in meeting Army SDD policy goals.

Specifically, the research team evaluated how LEED 2.2 and v2009 credits related to Army SDD policy objectives, then identified trends over time in Army LEED 2.2 and v2009 rated Projects. This is a historical assessment of actual project data, captured before the Army transitioned to the newer LEED v4.

Sections 2–15 explain how implementation of LEED NC 2.2 and v2009 credits helped Army projects achieve SDD policy objectives. Emphasis was placed on LEED credits that directly related to SDD policy requirements which Army construction and major renovation projects need to meet.

The project team analyzed data collected on Army LEED certified projects between FY2009 to FY2016. Data is shown for similar LEED NC 2.2 and LEED NC v2009 Credits.

Figures throughout the report illustrate how many Army LEED certified projects earned LEED NC credits 2.2 from FY2009 to FY2016 and LEED v2009 credits from FY2011 to FY2016. Figures in Chapter 16 rank the LEED 2.2 and LEED v2009 credits from most popular to least popular.

Implementation of the Army's 2013 SDD policy requiring LEED certification generated data which was analyzed to show how Army MILCON projects achieved energy, water, and waste goals on a large scale. Waste reduction is measured during construction, while energy and water goals are modeled during design. LEED Certification also aided in the organized collection of less primary resiliency goal achievements.

Future work to study patterns of success for Army projects being certified using LEED v4 could continue this effort to benchmark progress towards achieving current SDD policy, executive orders and Army Climate Strategy goals.

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Abbreviations

BMP	Best management practice
CERL	Construction Engineering Research Laboratory
EA	Energy and atmosphere
EUI	Energy use intensity
EPAct	Energy Policy Act
EQ	Environmental Quality
ERDC	Engineer Research and Development Center
FTE	Full-Time Equivalent
LEED	Leadership in Energy and Environmental Design
EISA	Energy Independence and Security Act
MDMS	Meter Data Management System
MILCON	Military construction
MR	Materials and Resources
NC	New construction
OPR	Owner Project Requirements
SDD	Sustainable design and development
SRI	Solar radiation index
SS	Sustainable sites
SSPP	Strategic Sustainability Performance Plan
TSS	Total suspended solids
UFC	Unified Facilities Criteria
USGBC	US Green Building Council
WE	Water Efficiency

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14. ABSTRACT

This report describes our analysis of how Army Leadership in Energy and Environmental Design (LEED®) certification data demonstrates success in meeting Army sustainable design and development (SDD) policy goals.
Specifically, the research team evaluated how LEED 2.2 and v2009 credits related to Army SDD policy objectives, then identified trends over time in Army LEED 2.2 and v2009-rated Projects. This is a historical assessment of actual project data, captured before the Army transitioned to the newer LEED v4.

This report explains how implementation of LEED NC 2.2 and v2009 credits helped Army projects achieve SDD policy objectives. Emphasis was placed on LEED credits that directly related to SDD policy requirements which Army construction and major renovation projects need to meet.

Figures throughout the report illustrate how many Army LEED certified projects earned LEED New Construction (NC) credits 2.2 from FY2009 to FY2016 and LEED v2009 credits from FY2011 to FY2016. Some figures also rank the LEED 2.2 and LEED v2009 credits from most popular to least popular.

Implementation of the Army's 2013 SDD policy requiring LEED certification has allowed analysis of how Army military construction (MILCON) projects achieved energy, water, and waste goals on a large scale.

15. SUBJECT TERMS

Army LEED Certified Projects; Army MILCON; Army SDD Policy 2013; Leadership in Energy and Environmental Design; LEED; Sustainable Design and Development

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