TURNING SILVER INTO Platinum

Exceeding Sustainable Goals with Simple Strategies

BY STEPHEN G. VAN DE KIEFT, P.E., CEM AND CODY M. HOFF, P.E.

WHAT STARTED OUT AS A PATH TO SILVER, turned out to be an opportunity for Platinum certification for a new Aviation Support Battalion (ASB) Hangar at Fort Carson in Colorado. By 2012, the plans for the new ASB Hangar were well under way. The United States Army was looking to build a new Silver LEED certified ASB Hangar. As the design process moved forward, it was evident that Silver could be easily obtained, and additional credits were within reach for a Gold certified facility. As the project was completed in 2015, Platinum certification was achieved without additional funding.

Jackie Shumaker Photography

On the surface one would think that complex, and normally cost-prohibitive systems are required for a LEED Platinum certification. However, due to a strategy built around cost effective, simple and predictable, energy-efficiency measures, a Platinum certification was achieved.

Project Description and Goals

As part of the relocation of the 4th Infantry Division to Fort Carson, Colo., a Combat Aviation Brigade (CAB) was established at Butts Army Airfield (BAAF) on Fort Carson. Several new hangar facilities were required to support the brigade, including an Aviation Support Battalion (ASB) hangar. The facility functions similarly to a very active private sector maintenance hangar, office and warehouse type facility.

This 136,377 square foot aircraft maintenance facility includes administrative/operations space, maintenance and repair shops, parts and tool storage, over 86,500 square feet of aircraft maintenance bays, 58,000 square yards of airfield pavement, and two exterior rotary wing wash racks. The facility houses up to 14 rotary wing aircraft and supports the maintenance activities of 328 soldiers.

In 2002, Fort Carson adopted long-term goals for achieving a sustainable installation by 2027. In April 2011, the assistant secretary of the army (installations, energy, and environment) identified Fort Carson as a net zero pilot installation for energy, water, and waste, which accelerated the sustainability deadline to 2020.

In support of Fort Carson's goal of becoming a net zero energy (NZE) installation by 2020, the development of BAAF required that all facilities be net zero ready through maximizing

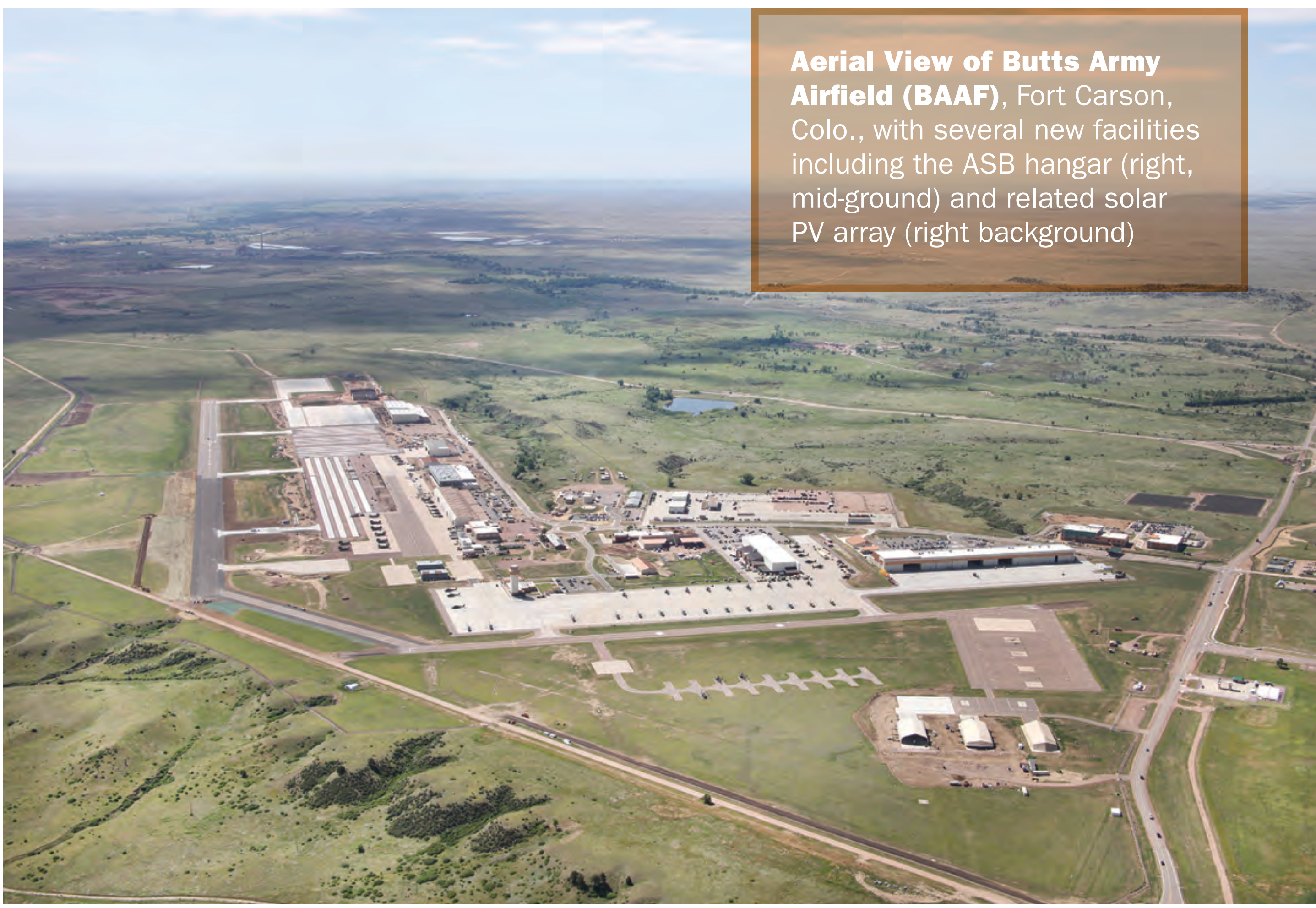
All Photos Harry Weddington, USACE Photographer, except where indicated.

Hangar Exterior. The hangar consists of high bay hangar, administration, and maintenance facilities.

the use of energy-efficient equipment, constructing highly insulated building envelopes, optimizing building orientation, while promoting continuous commissioning and energy monitoring during operation. The BAAF development sustainability goal was that all new construction achieves a minimum Silver Certification under LEED for New Construction 2009 (v3.0).

Fort Carson powers its vision with the obligation to ensure the soldiers of today and soldiers of the future have the land, water, and air resources they need to train; a healthy environment in which to live; and the support of local communities and the American people.

These goals of NZE and LEED Silver were requirements placed in the ASB Hangar design build request for proposal (RFP). Soon after the release of the RFP in January 2012 by USACE Omaha District, the design-build team conducted a series of integrated planning sessions to develop a strategy to achieve the energy efficiency and sustainability goals identified in the RFP. The strategy focused on maximizing the



Aerial View of Butts Army Airfield (BAAF), Fort Carson, Colo., with several new facilities including the ASB hangar (right, mid-ground) and related solar PV array (right background)

BUILDING AT A GLANCE

Name 13th CAB ASB Hangar

Location Fort Carson, Colo.

Miles from nearest major city 20 Miles South of Colorado Springs, Colo.

Owner U.S. Federal Government

Principal Use Hangar for Rotary Wing Aircraft
Includes Conditioned Hangar Bays, Administrative Operations, Maintenance Areas, Airfield, Parking, 80 total acres of site development

Employees/Occupants 328

Expected (Design) Occupancy 328
Percent Occupied 100%

Gross Square Footage 136,377
Conditioned Space 136,377

Distinctions/Awards
LEED Platinum Certification, GreenGov Presidential–Building the Future Award

Total Cost $54,531,000
Cost per Square Foot $399.85 (includes hangar and site improvements, including but not limited to the airfield and solar PV array)

Substantial Completion/Occupancy
October 2014

ENERGY AT A GLANCE (U.S)

Annual Energy Use Intensity (EUI) (Site) 52.56 (EUI is based on energy modeling. Actual data yielded similar results; data available at publication contained anomalies and gaps due to training and commissioning activities.)
Electricity (Grid Purchase) 0.00
Electricity (on-Site Solar or Wind Installation) 52.56

Annual On-Site Renewable Energy Exported 0

Annual Net Energy Use Intensity 0 kBtu/ft^2

Annual Source (Primary) Energy 0 kBtu/ft^2

Heating Degree Days (Base 65°F) 4,727

Cooling Degree Days (Base 65°F) 789

Annual Hours Occupied 8,760

KEY SUSTAINABLE FEATURES

Water Conservation
Water Conserving Urinals 1/8 gallon per flush, Water Closets 1.28 gallon per flush, Showers 1.5 gpm and lavatories 0.5 gpm.

Recycled Materials
Recycled content consisted of 28% of the total materials cost.

Daylighting
Use of translucent panels

Individual Controls
Individual controls for task lighting, dimming features in office, zoned lighting in the hangar bay

Carbon Reduction Strategies
Provided transpired solar collectors to reduce heating

Solar PV array

Reduced interior electrical lighting loads by 70%

Reduced exterior lighting by 80%

Provided air barrier to reduce infiltration load

Provided additional seals to reduce infiltration caused by hangar bay doors

Used high-efficiency district cooling/heating plant for source cooling and heating

Provided energy recovery from exhaust air streams and compressed air equipment

Transportation Mitigation Strategies
Alternative transportation: bicycle storage and changing rooms, parking for low emitting and fuel-efficient vehicles

Other Major Sustainable Features
Construction Waste Management: 89% waste diversion

Regional Materials: 20% of total material value

Certified Wood: 73.3% of wood based building materials were obtained in accordance with FSC criteria

Dedicated Open Space: 393,000 ft^2

Heat Island Effect: Minimize impact with high SRI materials

Internal recycling storage areas

Indoor chemical pollutant source control

Enhanced commissioning

Enhanced refrigerant management

Measurement and verification

Low VOC materials, IAQ plan and management strategies, and post-construction building flush-out

BUILDING ENVELOPE

Roof
Type TPO & Standing Seam Metal Roof
Overall R-value 50
Reflectivity 0.77

Walls
Type Insulated Metal Panel
Overall R-value 43.5
Glazing Percentage 10%

Basement/Foundation
Basement Wall Insulation R-value n/a
Basement Floor R-value n/a
Under-Slab Insulation R-value 1.67

Windows / Translucent Panel
Effective U-factor for Assembly 0.27/0.20
Solar Heat Gain Coefficient (SHGC) 0.27/0.10
Visual Transmittance 42%/12%

Location (Fort Carson, CO)
Latitude 29°N
Orientation South East Orientation

BUILDING TEAM

Building Owner/Representative
U.S. Army Corps of Engineers

Architect Jacobs Engineering

General Contractor
Hensel Phelps Construction Co.

Mechanical Engineer Jacobs Engineering

Electrical Engineer Jacobs Engineering

Energy Modeler Jacobs Engineering

Structural Engineer Jacobs Engineering

Civil Engineer Jacobs Engineering

Environmental Consultant Jacobs Engineering

Landscape Architect Jacobs Engineering

Lighting Design Jacobs Engineering

LEED Consultant Jacobs Engineering

Commissioning Agent
U.S. Army Corps of Engineers

Electronics shop with high efficiency, high bay lighting; highly reflective finishes to improve lighting; and insulated translucent panels for daylighting.

use of enhanced energy conservation measure (ECM) features that add value and maximize the building's energy savings for the project within the budget, and included a guaranteed energy savings over ASHRAE Standard 90.1-2007 baseline facility (as required by the RFP and calculated in accordance with Appendix G of the standard) of 51% without renewable energy systems with an additional 49% savings through the

Table 1 ENERGY CONSERVATION FEATURES

Hangar Door Leakage Reduction
Hangar door leakage can be a substantial source of energy use during the heating season; this project used sliding insulated doors that use double seals to reduce air leakage and, therefore, heating energy.

Improved Building Envelope
Increased Roof and Wall Insulation: Insulation performance (R-50 and R-43, respectively) exceeded ASHRAE Standard 90.1-2007 requirements.

Improved Glazing Performance: The maximum glazing U-value is 0.27 and solar heat gain coefficient is 0.27. For additional improvements, translucent panels with U-value of 0.20 and solar heat gain coefficient of 0.10 were installed in the hangar bay. These values comply with ASHRAE Standard 189.1-2009.

Building Air Barrier: Building air leakage was reduced from the building-type standard of 0.4 cfm/ft² to 0.15 cfm/ft² through an enhanced air barrier.

LED and High Pressure Sodium Exterior Lights
LEDs and high pressure sodium fixtures were used to further reduce lighting energy use with an 80% reduction being achieved for exterior lighting.

LED Lighting in the Admin/Workshop Areas
LED lighting further reduced energy use beyond the traditional lighting fixture type of T8 fluorescent; these areas were reduced from an aggregate of 1.1 W/ft² to 0.7 W/ft² as a result.

Automated Lighting Controls and Daylighting
Advanced building lighting automation was employed to reduce energy use from lighting systems; spaces with appropriate glazing will have daylight dimming capacity, occupancy sensors were used throughout the building and manual controls were provided to further reduce energy use. Continuous dimming was provided for the LED lights in the hangar space in order to reduce energy use during periods with adequate ambient lighting conditions.

Variable Speed Air Compressor
One of two air compressors was fitted with a variable frequency drive to reduce energy consumption during part load.

In-slab Radiant Heating System
A hydronic radiant heating system was employed to distribute heat through the floor slab; this system saves energy by using mean radiant effects and avoiding stratification.

Energy Recovery Ventilation
All major ventilation units were provided with energy recovery to recapture energy typically lost in exhaust airstreams; this feature significantly reduced energy use at extreme ambient conditions.

Low-Flow Plumbing Fixtures
Plumbing fixtures were selected to provide substantial water savings over industry standard plumbing fixtures. Water savings directly translates into domestic hot water heating energy savings.

Building Automation System
A building automation system was incorporated into the design to provide operators with centralized control, diagnostics, and system verification abilities.

Transpired Solar Collectors
Transpired solar collectors were employed to pre-heat ventilation air for the hangar spaces while in heating mode; this feature was expected to save about 222,800 kWh/yr.

Solar Photovoltaics (PV)
The remaining projected energy use was covered by the installation of PV. The design-build team identified the potential to provide enough PV to make the 13th CAB, ASB Hangar net zero with respect to energy through the use of ground mounted systems. This feature is expected to save approximately 2,130,000 kWh/yr.

LED Lighting in the Hangar Bays
Lighting power density was reduced substantially from the typical values associated with high-bay applications, achieving 0.5 W/ft² on average.

ABOVE Hangar Exterior. Black portion of exterior wall is the transpired solar collector that captures solar energy and preheats outdoor air used for ventilation.

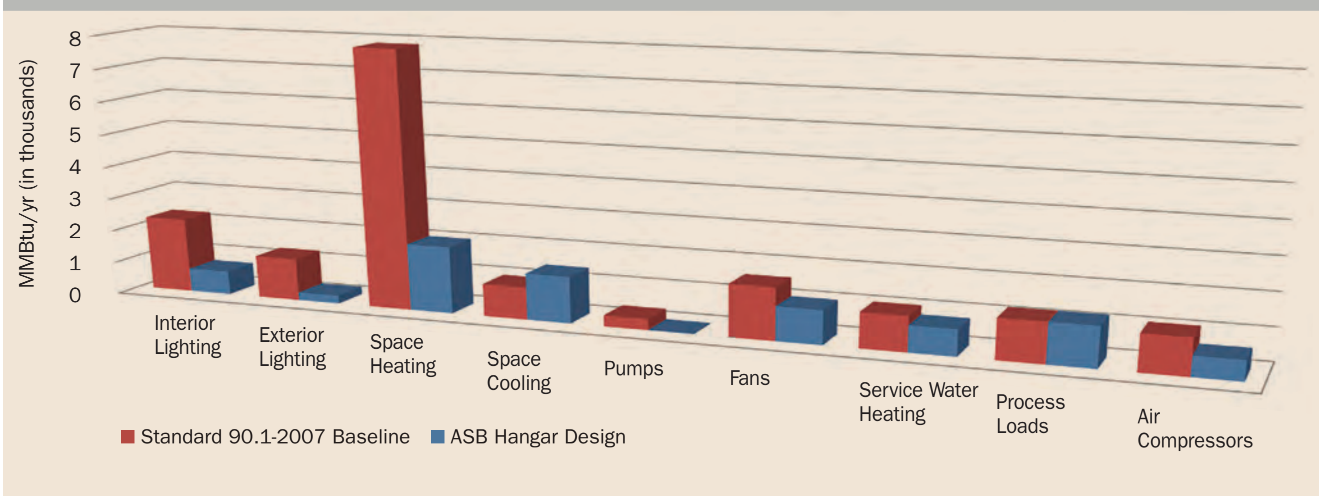
BELOW LEFT Hangar bays showing finished interior with high-efficiency, high bay lighting; bay doors with low leakage seals; in-slab radiant heating; highly reflective finishes to improve lighting; transpired solar collection air system; and industrial ceiling fans to improve air circulation.

BELOW RIGHT Distribution piping serving hangar, providing chilled water and hot water from high-efficiency district energy plant.

use of renewable systems. Key to this strategy was to implement proven, cost-effective, efficient energy measures. This provided three main benefits: (1) The construction cost would remain competitive; (2) The systems would yield predictable results; and (3) The systems, being simple, could be maintained effectively to ensure efficient operation for years to come.

The project was awarded to the design-build team in August 2012 at a value of $44,800,000, significantly below the identified construction cost limitation (CCL) of $55,000,000. When completed and accepted in October 2014, the final contract value was $54,531,000. The project cost growth was primarily due to a change in design criteria at the 90% design stage and coordination

Figure 1 COMPONENT ANNUAL ENERGY USE



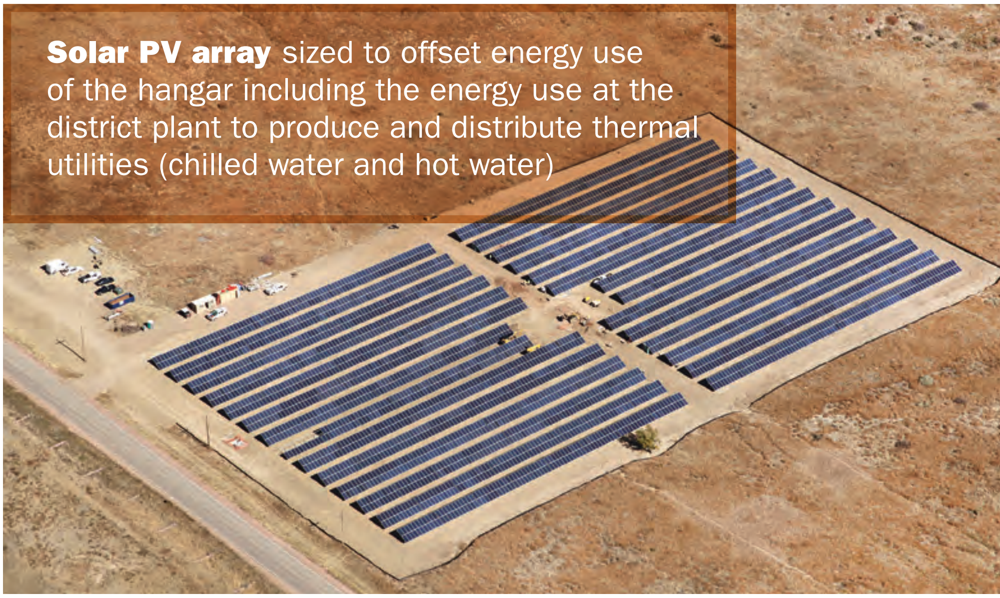
Jackie Shumaker Photography

Solar PV panel are fixed angle/position.

with a separate utility infrastructure contract. No additional funds were added for high performance sustainable building features or to achieve LEED Platinum, which was certified in December 2015.

Building on the strategy presented in the accepted proposal, the design-build team focused on ensuring the identified ECM and sustainable features were maintained throughout the design and construction of the projects. Examples of ECM features incorporated are discussed in *Table 1* (Page 25). These measures included simple, cost effective, and proven technology.

Because of the net zero requirement and the energy reduction that would need to be achieved to obtain that requirement, 33 of 35 energy and atmosphere (EA) credits were anticipated. This provided a substantial platform to obtain the initial LEED Silver credits. Overall, 61 LEED points were anticipated with potential for additional credits to be considered as the project moved forward. These points passed the project's Silver requirement, Gold was in reach, and Platinum was on the horizon.

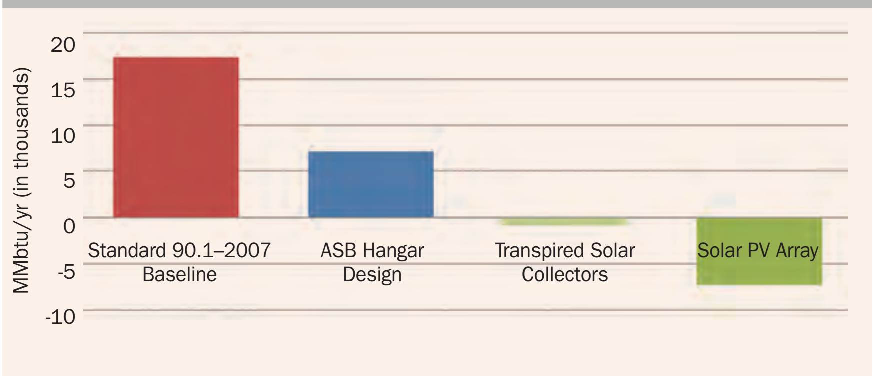


Results

The project met the Army's standards for ASB hangar design and meets or exceeds the Fort Carson's goals for energy, water, and construction waste reduction with a facility type not normally associated with sustainable design. Using the LEED strategy categories, the ASB hangar's results demonstrate a comprehensive approach to ecologically sustainable, low-impact, and fiscally responsible development. The project achieved all the anticipated energy and atmosphere credits attempted and an overall total 81 credits toward LEED Platinum.

The project incorporated the reuse of an existing developed site, and was part of a master planned campus addition that combined residential,

Figure 2 ANNUAL ENERGY CONSUMPTION



Hangar Airfield Side. The hangar uses low leakage weather seals on the hangar bay doors to drastically reduce air leakage.

professional and all of the traditional community services into a compact walkable area, decreasing the need for privately owned vehicles. Additionally, designs for parking provided preferential spaces for low-emission and carpool vehicles. The site and building materials were selected to be of a high reflectivity to reflect solar radiation back into the sky and decrease the urban heat island effect.

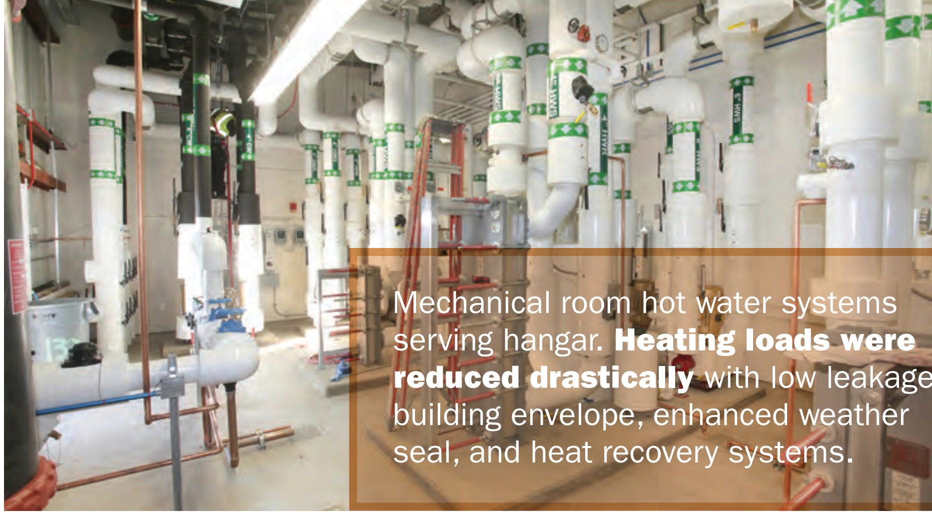
Local native plant species were used in the landscape design to decrease the need for constant irrigation and still provide beautiful greenery to the site. With efficient landscape design and the careful selection of low-flow water fixtures, the facility decreased its potable water usage by 96.4% for landscaping and 39.4% for plumbing fixtures, calculated from a U.S. Environmental Protection Agency baseline. That results in a calculated savings of 2.8 million gallons of water per year.

The construction materials were carefully selected to be sourced from local fabricators. Those with a high recycled content were given preference, and those such as the wood used on the project were sourced from vendors that had a verifiable record of environmental stewardship.

Furthermore, material selection was influenced by the chemical components within them, so that products with low amounts of volatile organic compounds were given preference to those with a higher quantity, in order to decrease the indoor air pollution of the building occupants. By selecting sustainable materials, the contractor was able to coordinate quantities and recycling procedures, so that they were able to divert 89.6% of the construction waste from the local landfill.

However, the most substantial achievement was that of the energy efficiency and resulting net zero facility design. The implementation of enhanced ECM strategies and technologies resulted in a calculated 119.7% reduction in energy cost (105% energy use reduction). The energy use reduction is comprised of a 56% reduction in energy use without renewable systems included with an additional 49% reduction by the renewable energy systems. The energy use intensity of the baseline facility was calculated to be 127.3 kBtu/ft^2 with the designed and constructed facility EUI estimated to be 52.4 kBtu/ft^2 (without renewable

In-slab radiant heating system being installed.



Mechanical room hot water systems serving hangar. **Heating loads were reduced drastically** with low leakage building envelope, enhanced weather seal, and heat recovery systems.

TOP LEFT Aircraft maintenance utility pedestal in hangar bay.

BOTTOM LEFT Shop air compressors with heat recovery.

BOTTOM RIGHT District Energy Plant. Chilled water distribution pumps and heating system boilers

energy systems). Facility measurement and verification (LEED EA Credit 5) is ongoing at this time. Based on initial readings, it appears the facility is performing as designed and constructed.

The resulting NZE facility is a major step in support of Fort Carson's 2020 goals and in the ability to provide NZE high performance sustainable buildings in accordance with the Executive Order 13514 2030 NZE goal and the directive of the federal government to lead by example.

The facility design achieved the Army's first USGBC LEED 2009 (v3.0) Platinum certification for a hangar, produced less waste, generated less pollution, uses less water and puts energy back into the grid.

Going Forward

Fort Carson has a sustainability legacy of over 56 LEED-certified projects, including over 82 certified buildings with over half of them at Gold. This facility is a testament of that sustainability commitment since it was pursued on a hangar, which is a facility type not typically considered suitable for net zero design. The most remarkable aspect is that this project's success, the energy/water/waste reduction goals, was achieved through the use of basic and fundamental strategies which could be more easily replicated on other facilities. The fundamental concept of intense electrical and mechanical energy efficiency, along with building envelope performance, and furthermore supplemented by renewable energy is a recipe that can be applied to any new construction. The project development team has been and will continue to incorporate the lessons learned from this project at similar facilities at installations located around the world.

The facility is in full compliance with the Army's standard for this facility type, it is constructed of standard materials, uses commercially available mechanical and electrical systems, employs well-established and proven energy conservation measures, and uses common low-flow water fixtures. The building systems also use well-developed mechanical control schemes and the project development team used well-established workflow procedures to maximize efficiency and establish a high rate of achieving LEED credits. Projects at this location have also had a high success rate for exceeding the government's water and waste reduction requirements. Complying with Army directives, using current energy and light modeling systems, and incorporating lifecycle cost analysis, the team was able to construct a realistically functional and sustainable facility. Attaining LEED v3.0 Platinum certification, this industrial type facility positively reflects a continued Fort Carson legacy for excellence in sustainability and energy reduction and is an example for others to follow. ●

ABOUT THE AUTHORS

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